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ENERGY USE IN THE COMMERCIAL BUILDING SECTOR

HISTORICAL PATTERNS AND FUTURE SCENARIOS

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I. INTRODUCTION

Energy use in the commercial sector increased at a rapid 4.7 percent average annual rate between 1960 and 1978. This rate of growth exceeded those of all other sectors. Consequently the share of total U.S. energy used in commercial buildings increased from 10.2 percent in 1965 to 13.7 percent in 1978. Future changes in commercial energy use patterns will have a significant impact on future energy demands. To forecast changes in future commercial energy use patterns, the underlying structure of commercial sector energy use demand must be understood. The objective of this study is to describe historical energy use patterns in the commercial sector, with a particular emphasis on the causal factors which produce these patterns, and to develop forecasts of commercial sector energy use for several scenarios.

This report is organized as follows. Sections I and II describe commercial energy use patterns and causal factor relating to commercial energy demand for the nation and each of the ten federal regions. The impacts of conservation and solar technologies on commercial energy use are explored in Section III. Section IV provides a description of end use hourly load profiles for several prototype commercial buildings. The commercial end use model used to develop end use profiles for the historical analysis and to forecast future commercial energy use under the different scenario assumptions is presented in Section VI.

The assumptions for each of the forecast scenarios are presented in Section VII along with commercial energy use forecasts for a baseline scenario, a baseline scenario with conservation programs, a high fuel price scenario and a low energy consumption scenario. Each of these scenarios incorporates forecasted impacts of solar heating, water heating, and cooling systems in commercial buildings. The final section compares forecasts presented in this study with forecasts from other commercial sector studies.

II. NATIONAL COMMERCIAL ENERGY USE AND PRICES: 1960-1978

This section describes trends in commercial sector energy use from 1960 to 1978. Energy use by fuel, building type and end use are presented for each year in this period. Trends in the most important factors influencing commercial energy use including economic activity variables and fuel prices are also described.

National Fuel Use Trends

Trends in energy use over the last two decades can be characterized easily if one distinguishes between pre embargo (1960-1973) and post embargo years.[1/] Pre embargo years are characterized by rapid rates of increase in electricity, natural gas and oil use. Nationally (Table II-I and Figure II-1), these rates were 8.1, 7.5 and 2.8 percent for electricity, natural gas and oil respectively. Use of other fuels (i.e., coal and liquid gases) declined dramatically over this period with a growth rate of -6.2 percent nationally. Total energy use increased at an annual rate of 5.8 percent in this period.

[1/] The historical fuel use series described in this report were developed by means of a rather involved procedure. First, fuel use data were collected for 1970 from publications of Edison Electric Institute (1971), the American Gas Association (1971) and the Bureau of Mines (1971) on a state level basis. Next, information from other sources including housing census data from the U. S. Department of Commerce (1972) were used to adjust the fuel use estimates to conform more closely to our definition of the commercial sector These initial adjustments are described in Jackson and Johnson (1978) and Cohn (1978). The next step involved a comparison of state level fuel use totals with state level commercial floor space stock (developed in Jackson and DeGenring (1980)) and with engineering-based energy use indexes (EUI) relating energy use by end use and building type. When state fuel use totals were inconsistent with state floor space and EUI estimates, fuel use series were reevaluated and in many cases adjusted to conform more closely to floor space stock estimates which were considered more accurate.

Our best state level estimates were then used to adjust the Federal Energy Data System (FEDS) state fuel use data to obtain a fuel use time series from 1960 to 1978.

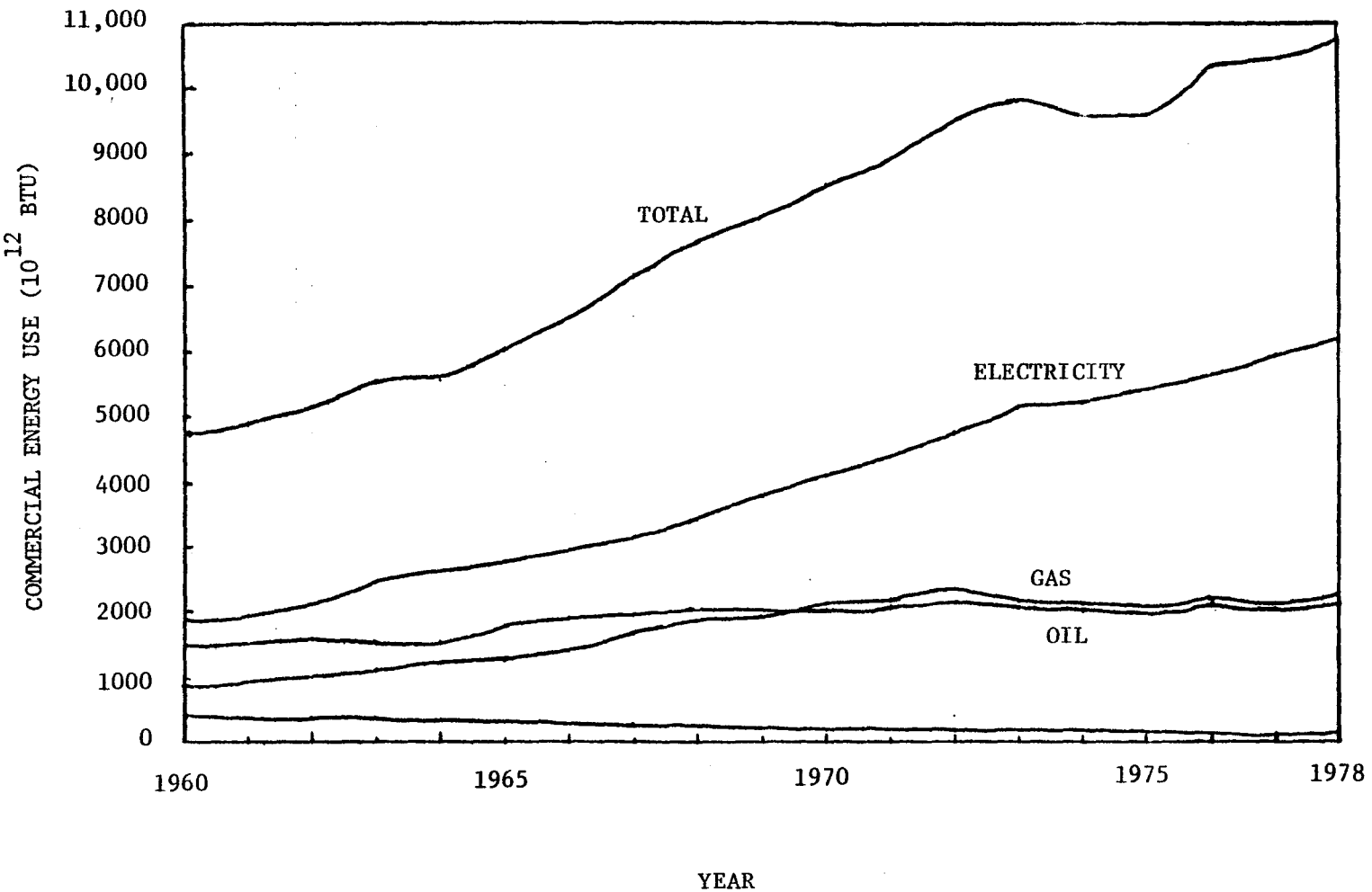
Table II-1.
National Commercial Energy
Use: 1960-1978

Year	Electricity[a]	Natural Gas	Oil	Other[b]	Total
			(10^{12} Btu)		
1960	1866.06	895.9	1566.32	406.1	4730.38
1961	1988.63	945.96	1586.01	373.67	4894.27
1962	2150.61	1063.87	1606.09	377.03	5197.60
1963	2500.21	1114.14	1593.82	322.14	5530.51
1964	2534.64	1209.93	1579.62	287.92	5612.11
1965	2704.78	1274.66	1810.86	281.65	6071.95
1966	2942.45	1432.69	1886.77	289.27	6551.18
1967	3164.85	1716.26	1983.96	258.52	7123.59
1968	3465.65	1819.95	2075.69	244.36	7604.65
1969	3780.18	1984.02	2014.70	244.22	8023.12
1970	4093.91	2149.20	2085.48	217.59	8546.18
1971	4387.74	2226.90	2075.43	211.49	8901.56
1972	4783.57	2306.42	2206.44	186.65	9483.08
1973	5149.64	2284.81	2231.65	177.82	9843.92
1974	5188.42	2263.20	2028.35	174.43	9654.40
1975	5417.04	2220.91	1907.36	150.07	9695.38
1976	5691.51	2341.50	2200.12	147.82	10380.95
1977	5939.97	2186.61	2157.59	150.41	10434.58
1978	6187.68	2263.49	2151.53	157.43	10760.13
Average Annual Growth Rates (%)					
1960-1973	8.12	7.47	2.76	-6.15	5.80
1973-1978	3.74	-0.19	-0.73	-0.93	1.62

[a] Electricity is reported in terms of primary energy; that is, losses in generation, transmission and distribution are included. The conversion factor is 11,500 Btu/KWhr. For conversion to SI units, 1 Btu = 1055 joules.

[b] Includes coal and liquid natural gases.

FIGURE II-1. NATIONAL COMMERCIAL ENERGY USE: 1960-1978



After 1973, trends in fuel use changed dramatically as a result of rapid fuel price increases and a slower growth of economic activity. Only electricity use was greater in 1978 than in 1973. Rates of growth of electricity, natural gas, oil and other fuels were 3.7, -.2, -.7 and -.9 respectively over the 1973 to 1978 period. In the aggregate, total energy use grew at a rate of 1.6 percent over this period.

Additional perspective on these energy use trends can be provided by relating total energy use to the stock of commercial floor space for each year in this period. Floor space provides a good measure of the stock of energy using equipment since most energy using systems are designed on the basis of area served.[2/] Commercial floor space stock grew at relatively stable rates over the 1960 to 1973 period as indicated in Table II-2. Reduced economic activity after 1973 is reflected in smaller floor space stock increases compared to pre-embargo years.

The energy intensity of commercial buildings is indicated in a rough way by dividing total energy use by commercial floor area (Table II-3 and Figure II-2). Total energy intensity, which increased secularly from 1960 through 1973, declined from 1973 through 1975, held roughly constant in 1977 and 1978 and registered an increase in 1976. If the trend established between 1960 and 1973 had continued, the energy intensity measure would have risen to 404,600 Btu/ft^2 in 1978; this figure is 14.3% greater than what actually occured. While factors other than conservation influence this measure (e.g., changes in fuel choice will reflect differences in fuel spcific efficiencies), voluntary conservation was undoubtedly the primary contributor to a significant reduction in energy use relative to what would have occured in the absence of price increases.

The electricity intensity series shown in Table II-3 and Figure II-2 reflects a clear trend. With the exception of 1974, commercial sector electricity intensity increased every year since 1960. Increasing penetration of air conditioning and other electric appliances (e.g., office machines, eleva-

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[2/] See Jackson and Johnson (1978) for further discussion of this issue. Floorspace stock estimates were developed from data published in the Statistical Abstract of the United States, U. S. Department of Commerce (1977). See Jackson and Johnson (1978) for detailed methodology and data sources.

Table II-2
Commercial Buildings Floor Space
Stock: 1960-1978

	10^6 ft^2				
	1960	1965	1970	1973	1978
Floor Space Stock	16.8	20.3	24.3	26.9	30.4
Average Annual Rate of Increase over previous period (%)	3.9[a]	3.8	3.7	3.5	2.5

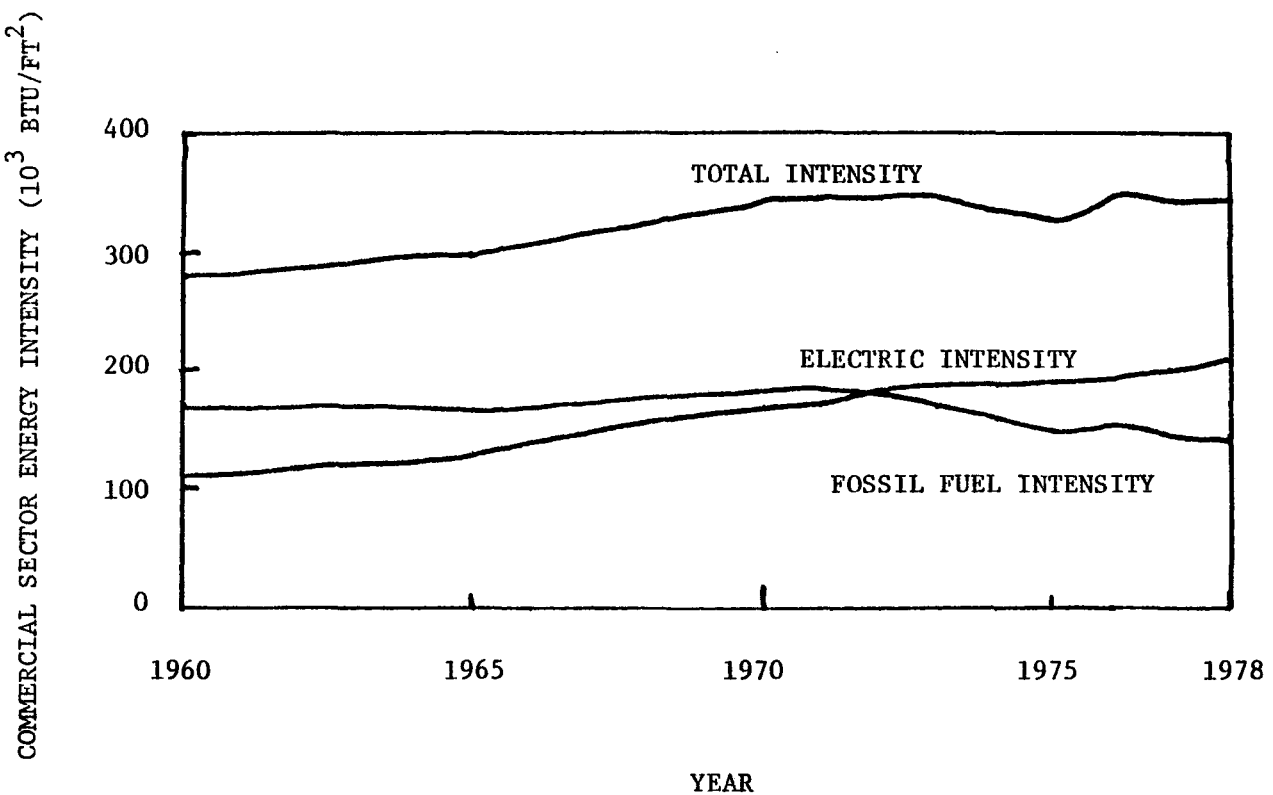
[a]Rate of increase calculated using 1955 stock estimate.

Table II-3
Commercial Sector Energy Intensities

	10^3 Btu/ft^2										
Intensity Measure[a]	1960	1965	1970	1971	1972	1973	1974	1975	1976	1977	1978
Total Energy Intensity	281.5	299.0	351.9	354.6	366.0	365.8	348.4	342.8	359.2	352.4	353.9
Electricity Intensity	111.3	133.0	168.3	174.9	184.6	191.4	187.4	191.5	196.9	200.7	203.6
Fossil Fuel Intensity	170.2	166.0	183.1	179.7	181.5	174.3	161.4	151.2	162.3	151.7	150.3

[a] Energy intensity measures are developed by dividing the energy use measure by floor space stock.

FIGURE II-2. COMMERCIAL SECTOR ENERGY INTENSITY MEASURES



vators, and computers), trends towards more brightly lit commercial space, the development of modern space heating and ventilation systems, and recent architectural trends all contributed to the substantial rates of increase in electric intensity in both pre and post embargo periods.[3/] Electricity price increases since 1973 have, however, resulted in a reduction in the intensity trend to half its pre-1973 level (2.1 percent versus 4.3 percent annually). Inceases in the intensity factor at the pre-embargo rate would yield a factor 15.8 percent greater than what actually occured in 1978.

While the fossil fuel intensity measure increased at a very slow rate of .5 percent from 1960 through 1972, the post embargo reduction has been surprisingly large (-3.1 percent perannum). In 1978, the fossil fuel intensity is 24.7 percent less than the figure expected if pre-embargo trends had persisted.

Causal factors which explain trends in energy intensity measures also explain trends in changes in the relative importance of the different fuels over the 1960-1978 periods. As indicated in Figure II-3 electricity increased its share of the commercial sector fuels market from 39 percent in 1960 to 57 percent in 1978. Increased air conditioning penetration, lighting levels and electromechanical levels all contributed to the more predominant role of electricity in supplying commercial energy needs. Oil's market share has dropped significantly since 1960. Oil's 1978 20 percent share is only two-thirds of its 1960 share (33 percent). Conservation resulting from the large post embargo oil price increases and a switching to less expensive natural gas have been the primary causes of the decline in oil's importance. Gas market share held relatively constant over this period: 18 percent in 1960 and 21 percent in 1978. Price induced conservation appears to have been offset by an increased use resulting from fuel switching. Finally, other

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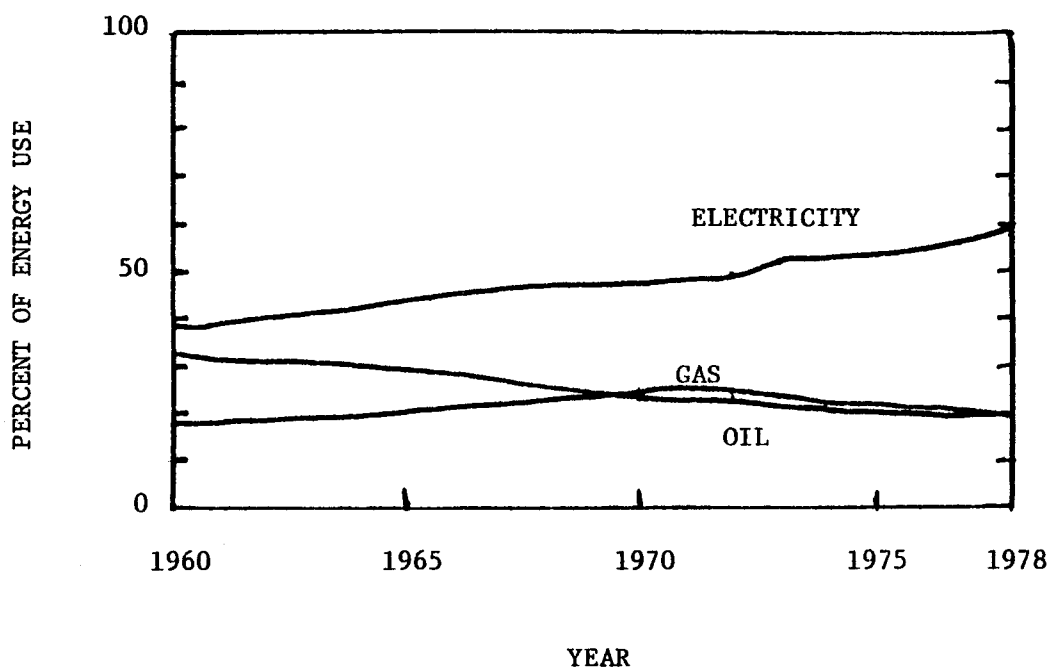
[3/] All of these trends are verified by the casual observations of architects and engineers in the buildings industry. Unfortunately detailed survey data do not exist to statistically establish our observations except for the case of increased choice of electric space heating. The Department of Commerce (1979) reports electric space heating systems chosen by between 32 and 35 percent for private commercial buildings and between 21 and 32 percent for state and local government buildings started in the 1975-1978 period. This choice of electric space heating in new buildings is on the order of seven times greater than electric space heating choice in 1970.

FIGURE II-3. COMMERCIAL FUEL USE AS A PERCENT OF TOTAL ENERGY USE



fuels have declined from a 9 percent share in 1960 to a 1 percent share in 1978. The expense of liquid gases and the emissions problems associated with coal have resulted in an other fuels category that was almost insignificant in 1978.

The price increases of recent years which brought about changes in relative importance of the fuels and the relationship between commercial buildings floor space and energy use represents a reversal of long standing fuel price trends.

Prices measured in constant dollars declined significantly over the 1960-1970 period (Table II-4 and Figure II-4).[4/] Electricity experienced the largest decline, 3.6 percent per year on the average. Gas and oil declined at more modest rates of 1.0 and 0.3 percent respectively over the same period. After 1973, prices reflect a general upward trend. For oil the rate of increase over the last five years presented in the table is 10.5 percent. Gas prices increased at a sizeable 10.2 percent rate in real terms, while the average annual electricity price increase over this period is 4.0 percent. It is interesting to note that while natural gas and oil prices have surpassed by far their price levels in 1960, electricity prices in 1978 are comparable with prices paid in 1966. Electricity prices will have to increase by another 32 percent before they reach their 1960 level

Recent fuel price increases undoubtedly represented a major influence on fuel use since 1973. An even stronger influence on commercial energy use is provided by the stock of commercial floor space. As indicated earlier the stock of energy using capital in the commercial sector is most accurately measured by the stock of floor space. An inventory of the number of office buildings heating systems, for instance, means little since office buildings frequently vary from 40,000 ft^2 single story buildings to 1,000,000 ft^2 multistory buildings.

It is also through impacts on floor space that economic activity influences energy use in the commercial sector. Short run increases in economic

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[4/] State fuel price series were provided in a personal communication with Thomas Mooney (1980) of the Department of Energy. National and regional prices are consumption weight state prices.

Table II-4.
National Commercial Fuel Prices:
1960-1978

Year	Electricity[a]	Natural Gas	Oil	Other[b]
	(1975 $/10^6$ Btu)			
1960	3.87	1.26	1.37	.85
1961	3.65	1.26	1.40	.82
1962	3.58	1.26	1.37	.79
1963	3.40	1.26	1.33	.85
1963	3.26	1.24	1.27	.59
1965	3.14	1.22	1.22	.89
1966	2.95	1.18	1.20	.99
1967	2.82	1.17	1.21	1.27
1968	2.66	1.11	1.22	.96
1969	2.50	1.07	1.15	.94
1970	2.40	1.03	1.16	1.19
1971	2.42	1.06	1.32	1.22
1972	2.45	1.11	1.18	1.24
1973	2.41	1.10	1.43	1.47
1974	2.68	1.14	2.44	1.85
1975	2.79	1.32	2.35	1.98
1976	2.82	1.51	2.29	2.52
1977	2.94	1.79	2.46	c
1978	2.93	1.79	2.35	c
Average Annual Growth Rates (%)				
1960-1973	-3.58	-1.04	0.33	4.30
1973-1978	3.98	10.22	10.45	19.68*

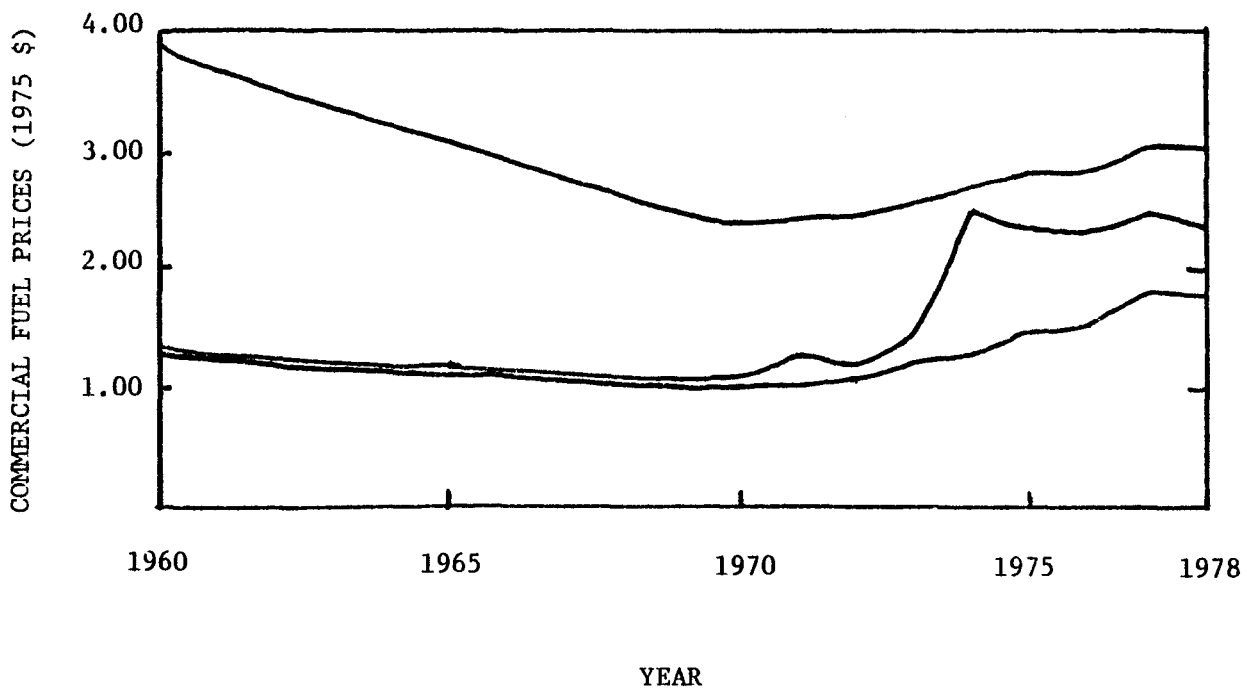
[a] Electricity is reported in terms of primary energy; that is, losses in generation, transmission and distribution are included. The conversion factor is 11,500 Btu/KWhr. For conversion to SI units, 1 Btu = 1055 joules.

[b] Includes coal and liquid natural gases.

[c] Not available for commercial sector.

* Calculation based on 1973 and 1976 prices.

FIGURE II-4. NATIONAL COMMERCIAL FUEL PRICES: 1960-1978



activity are not likely to have a significant impact on commercial energy use since most energy is used to space condition and light commercial buildings; thus, a short run increases in economic activity must lead to sustained longer operating hours for energy use to increase. A short run increase in activity in the commercial sector that is maintained for some time will, however, lead to building construction as new commercial firms and/or expansion of existing firms brings the demand and supply for commercial goods and services back into balance removing excess profit and the incentive for commercial sector expansion.[5/]

With the exception of utility service area models developed for the state of California (Lann (1979)), efforts at relating floor space investment to variables suggested by economic theory (e.g., cost of construction, interest rates, credit availability, etc.) have not been successful. Cohn, et.al. (1980), have, however, developed statistical relationships between floor space stock, population and income variables using business economic areas (BEA's) as the basic unit of observation. Results of this analysis applied to historical levels of income and population in Table II-5 suggests that income growth since 1960 has accounted for slightly over two-thirds of floor space stock additions in that period. Further analysis with the statistical relationships in Cohn et.al. (1980) and the 1960-1973 trends in population and per capita income suggest that the reduction in floor space stock growth since 1973 (relative to pre-1973 trends) is more a result of slower income growth (3/4 of the short fall) than the slower rate of population growth.

[5/] See Dorfman (1980) for a good initiative description of mechanisms which relate the stock of commercial floor space to economic activity.

Table II-5
Relationships Between Floor Space Stock Growth,
of Population and Income[a]

	1965	1970	1973	1978
Average Annual Rate over Preceeding Period (%)				
Population	1.5[b]	1.0	1.0	.8
Per Capita Disposable Income	3.2	2.8	3.9	1.7
Average Annual Percent Contribution to Floor Space Stock Additions over Preceeding Period				
Population	37	31	25	38
Per Capita Diposable Income	63	69	75	62

[a]Developed from statistical results presented in Cohn et.al. (1980)

[b]1960 figures are used to develop 1960-1965 growth rates.

National Trends in Energy Use by End Use and Building Type

To develop a picture of energy use with building type and end use detail, we have used regional fuel prices, population and income variables as inputs to a commercial end use model, to forecast energy use from 1970 through 1978. Model forecasts by fuel conformed reasonably well with our regional fuel use series presented in Section II for 1970-1978. When the energy use forecasts deviated from actual total energy use data, we adjusted the model forecasts to correspond with actuals. These adjustments were made in the space heating series for gas and oil since these end uses represent about 80 percent of total gas use and 95 percent of total oil use. Discrepancies with the electricity series were allocated across space heating and air conditioning. While these two end uses represent only about 40 percent of total electricity use, they also are the least accurately forecast, so it is appropriate to adjust them while leaving our estimates of electric water heating, lighting, and other end uses unchanged.

On a national basis, commercial energy use is distributed across building types as indicated in Table II-6. In 1978, the retail/wholesale sector consumed the most energy, 22.6 percent of the total of 10.74 QBtu.[6/] Educational buildings closely followed with 19.7 percent. Office buildings (16.5 percent) and health care buildings (11.4 percent) are next in importance of energy use. These four building types consume 70.2 percent of total commercial energy use. Between 1970 and 1978, office and retail buildings increased their share of total energy use while educational and health care buildings' share declined.

Building specific energy use shares largely reflect the stock of commercial buildings (i.e., floor space) represented by each subsector. Estimated floor space stock in 1978, along with rates of growth of floor space stock,

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[6/] Small descrepancies in energy use estimates presented in Table II-1 and model forecasts over the 1970-1978 period still exist. Adjustments were made within the model in a rather complex way; consequently it was not economically feasible to proceed further through the iterative process to insure an exact correspondence.

are presented in Table II-7. While energy use correlates highly with floor space stock, the differences in energy use intensity by building type are apparent when the fraction of floor space (Table II-7) is compared to the fraction of energy use (Table II-6). Health care buildings reflect an importance in terms of energy use that is twice as great as the fraction of floor space in that subsector. Educational buildings, on the other hand show a smaller than average energy use intensity.

Energy use by end use is given for all commercial buildings nationally from 1970-1978 in Table II-8 and Figure II-5.

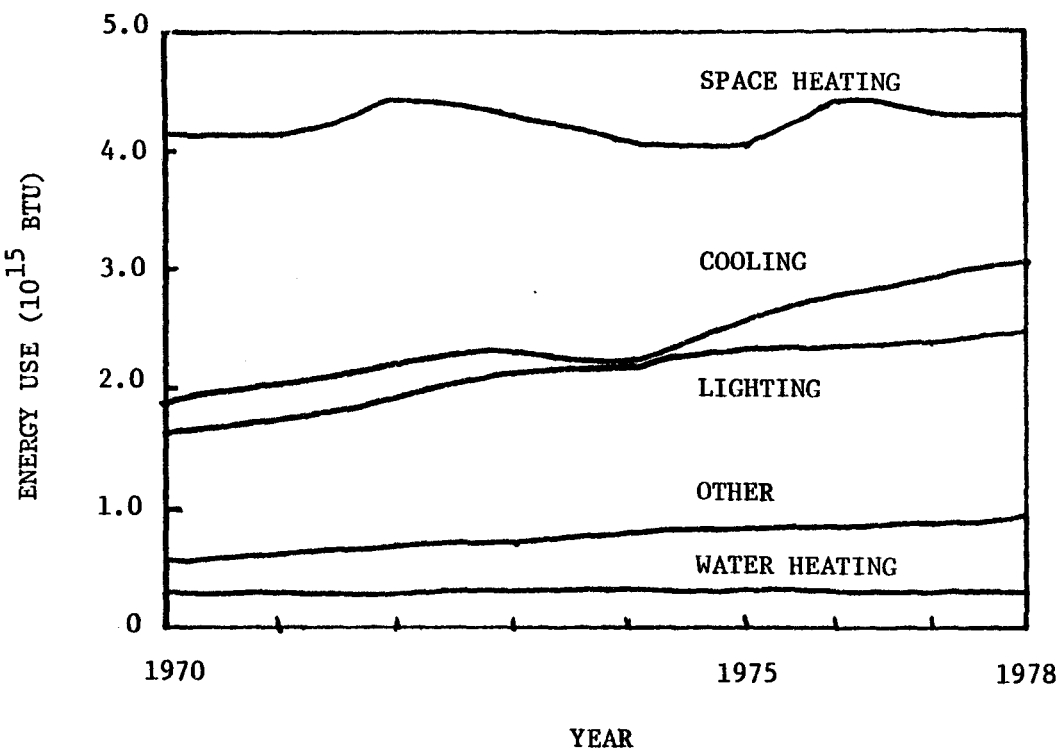
Table II-6
National Commercial Energy Use As A Percentage of Total
By Building Type, 1970 and 1978

Building Type	1970 (%)	1978 (%)
Office	15.0	16.5
Retail/Wholesale	21.9	22.6
Auto Repair	1.0	.9
Warehouse	3.2	3.4
Education	20.8	19.7
Public Administration	2.9	2.6
Federal	1.3	1.2
Health	12.1	11.4
Religious	3.4	3.1
Hotel/Motel	6.9	6.3
Miscellaneous	12.0	12.3

Table II-7
National Commercial Floor Space by Building Type, 1978

Building Type	(10^6 ft^2)	% of Total	Average Annual Rate of Growth 1970-1978 (%)
Office	4,497	15.4	3.32
Retail/Wholesale	5,017	17.2	2.56
Auto Repair	581	2.0	1.06
Warehouse	2,298	7.9	3.18
Education	6,926	23.8	1.77
Public Administration	750	2.6	.99
Federal	337	1.2	1.00
Health	1,988	6.8	1.86
Religious	1,514	5.2	1.63
Hotel/Motel	1,624	5.6	2.20
Miscellaneous	3,626	12.4	2.38
Total	29,159		2.29

FIGURE II-5. NATIONAL COMMERCIAL ENERGY USE
BY END USE: 1970-1978



By way of reference, total floor space is included in the last row of Table II-8. Space heating energy use increased until 1972 and declined for the next three years. The most drastic reduction is space heating energy use occurred between 1973 and 1974 when space heating energy use dropped by 6.2 percent while floor space stock grew by 3.0 percent. The impact of weather on space heating energy use can be significant. Figure II-6 shows trends in both population weighted national heating degree days and space heating energy use intensities derived by dividing space heating energy use by floor space stock in each year. The higher post embargo fuel prices appear to have generated downward trends in intensities; however, climatic influences quite clearly cause a fluctuation around that trend. We have also made an attempt to remove some of the weather caused variation by utilizing a relationship developed in prior engineering analysis between heating degree days and space heating energy use.[7/] The weather adjusted space heating intensity trend in Figure II-6 is quite obvious.

Air conditiong energy use increased until 1974 when it declined by 4 percent before pursuing its relatively steady upward trend. Since air conditioning penetration continued to increase over that period and the stock of floor space rate of increase was relatively stable, variations in the air conditioning energy use series are predominately reflections of price induced conservation. Water heating energy use reflects a reduction from 1973 to 1974 and a constant energy use afterwards in spite of the increase in floor space of 7.9 percent from 1975 to 1978. Lighting energy use increased quite rapidly from 1970 to 1973 (9.9 percent per annum) reflecting increased use of artificial lighting in all vintages of commercial buildings. Lighting energy use declined in 1975 and then increased slowly through 1978 (1.5 percent per annum). The more recent rate of lighting energy use increase which is less than the rate of increase in floor space stock over that period (2.6 percent per year) reflects both a trend towards lower lighting level designs in new buildings and reduction in lighting levels of existing buildings. The other end use category which reflects electromechanical (elevators, computers, business machines) and miscellaneous uses such as cooking and refrigeration shows a constant increase in the 1970-1978 period although the rate of

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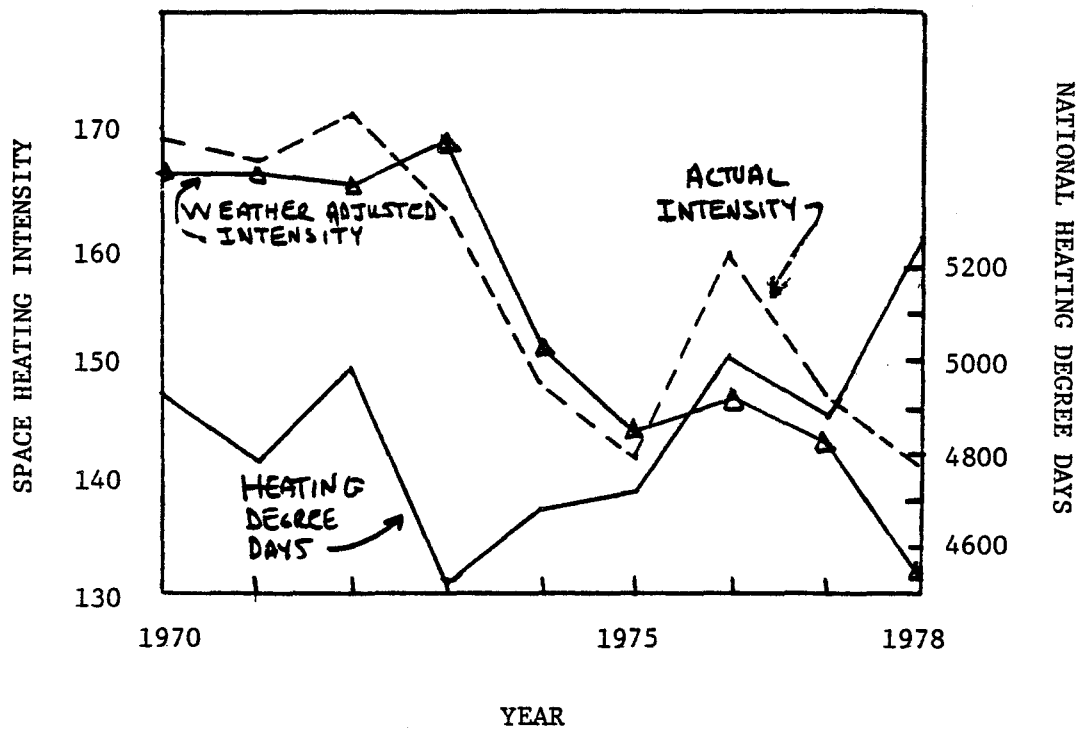
[7/] Personal communication with William J. Johnson (1979).

FIGURE II-6. NATIONAL SPACE HEATING INTENSITIES AND HEATING DEGREE DAYS



increase after 1973 is less than half the pre embargo growth rate (1.7 percent versus 4.9 percent) due primarily to a price induced change in the intensity with which this equipment is used.

Table II-9 shows end use fuel components as a percent of total energy use. Although growing in importance, electricity is still a small influence in commercial buildings space heating systems. On the other hand, cooling, lighting, and other end uses are fueled almost entirely by electricity. Ninety-five percent of electricity was consumed in producing these end use services in 1978. Figure II-7 illustrates the changing importance of the various end uses over the 1970-1978 period. In terms of relative importance, space heating and water heating have declined while importance of the other end uses has increased. These changes have occurred for several reasons; oil and natural gas prices have risen sharply in this period and are used almost entirely in space heating. The cooling end use reflects an increasing penetration while the other end use reflects increased use of electro-mechanical equipment.

An evaluation of regional energy use and price series reveals considerable variations of the trends reflected in the national series. An examination of these trends provides considerable insight on historical commercial energy use characteristics. Since these characteristics are important determinants of future trends, we now turn to a discussion of historical regional energy use and price series.

Table II-9

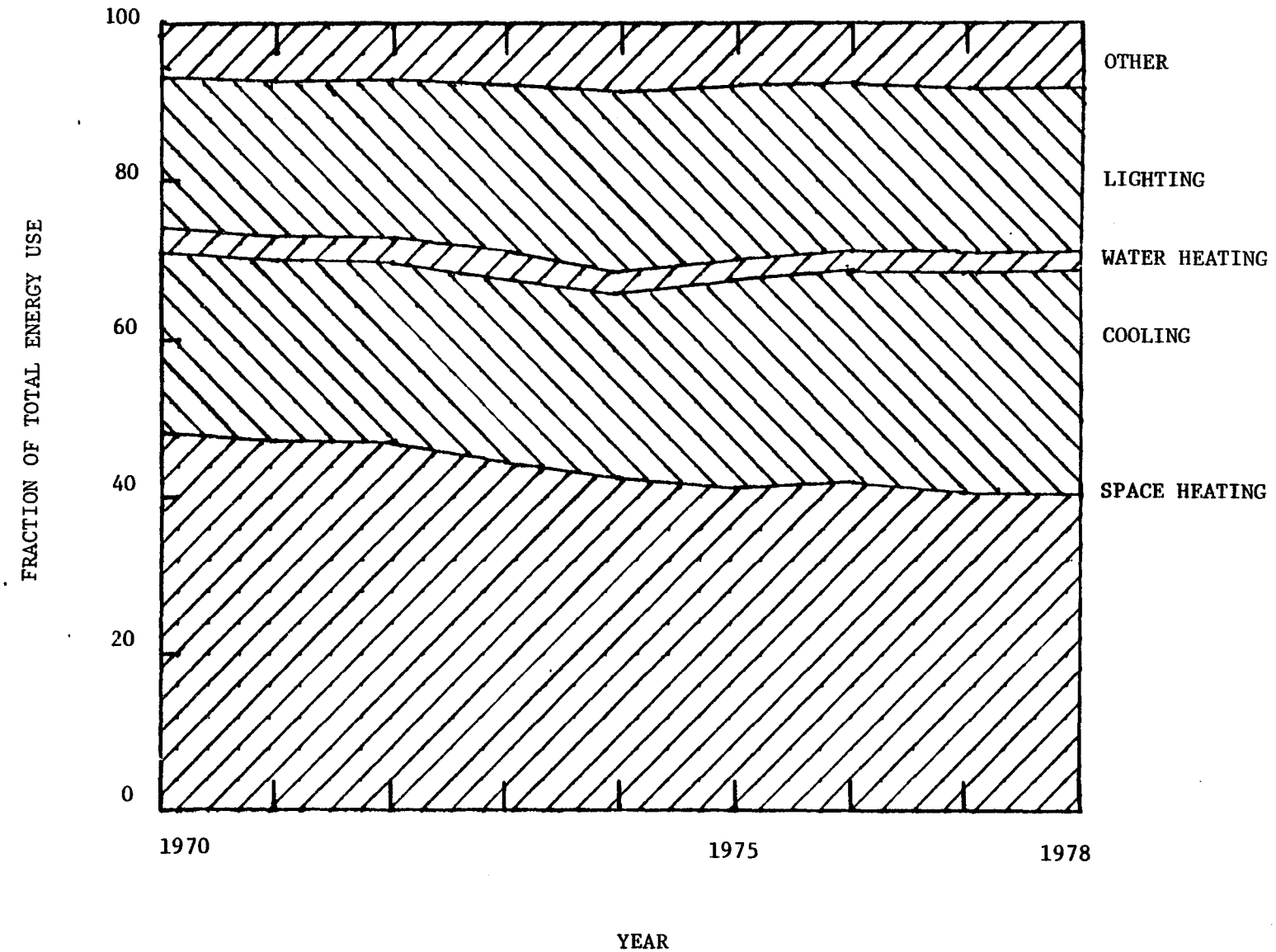
NATIONAL COMMERCIAL ENERGY USE BY FUEL AND END USE

PERCENT OF TOTAL ENERGY USE

1970	SPACE HEATING	COOLING	WATER HEATING	LIGHTING	OTHER	TOTAL
Electricity	2.2	21.1	.5	19.0	5.3	47.9
Gas	21.2	1.5	.8		1.5	25.2
Oil	22.4		2.1			24.5
Other	2.6					2.6
TOTAL	48.2	22.6	3.4	19.0	6.8	100.0
1978						
Electricity	2.7	27.0	.4	20.8	7.0	57.8
Gas	16.8	1.4	.7		1.3	20.9
Oil	18.5		1.3			19.9
Other	1.4					1.4
TOTAL	39.4	28.4	2.4	20.8	8.3	100.0

FIGURE II-7

NATIONAL COMMERCIAL ENERGY USE BY END USE, 1970-1978



III. REGIONAL COMMERCIAL ENERGY USE AND PRICES 1960 - 1978

This analysis of regional fuel and prices uses the federal region definitons indicated in Table III-1 and Figure III-1. As shown in Figure III-2, considerable variation existed in total regional commercial energy use in 1978. Total energy use of 2,369 trillion Btu (TBtu, hereafter) in region 5 is approximately twice as great as energy use in regions 2, 3, 4, 6 and 9 (1301, 1177, 1388, 1119 and 1260 respectively). Regions 1 and 7 are comparable in terms of total energy use with 621 and 665 TBtu respectively, while regions 8 and 10 are the smallest consumers of commercial energy with 360 and 434 TBtu energy use totals.

Energy use varies regionally almost propotionately to regional variation in floor space as indicated in Figure III-3 for 1978. An exact proportionately is not expected, however, because of several factors. First, as indicated in Table II-2, considerable variation exists in climatic influences both accross regions and over time. An unusually cold winter would obviously result in a region appearing higher on the vertical scale than an average winter. Second, since electricity is the least efficient fuel, when measured in terms of primary energy, a greater use of electricity will also result in a greater use of energy relative to the floor space stock than otherwise. Many other less important factors may contribute to a nonporportionately including interregional variation in building vintage and building type.[1/]

Considerable variation in energy use patterns also exists across regions, as indicated in Figures III-4 through III-6. Electricity use as a fraction of total use varies from 43 percent in region 2 to 73 percent in region 9. As indicated in Tables III-3 through III-12 (which present fuel use and prices for each region over the 1960 through 1978 period), the larger dependence of Region 9 on electricity is accompanied by a price that is about 20 percent less than that of Region 2. Other regions fall between these two extremes and are distributed around the 58 percent market share of

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[1/] The floor space stock estimates used to develop Figure II-7 are estimated using relationships in Jackson, and DeGenring (1980); thus, some nonporportionately may actually be the result of errors in our floor space stock estimates.

Table III-1

United States Federal Regions

Region I

Connecticut
Maine
Massachusetts
New Hampshire
Rhode Island
Vermont

Region II

New Jersey
New York
Puerto Rico
Virgin Islands

Region III

Delaware
District of Columbia
Maryland
Pennsylvania
Virginia
West Virginia

Region IV

Alabama
Canal Zone
Florida
Georgia
Kentucky
Mississippi
North Carolina
South Carolina
Tennessee

Region V

Illinois
Indiana
Michigan
Minnesota
Ohio
Wisconsin

Region VI

Arkansas
Louisiana
New Mexico
Oklahoma
Texas

Region VII

Iowa
Kansas
Missouri
Nebraska

Region VIII

Colorado
Montana
North Dakota
South Dakota
Utah
Wyoming

Region IX

American Samoa
Arizona
California
Guam
Hawaii
Nevada
Trust Territory of
the Pacific Islands

Region X

Alaska
Idaho
Oregon
Washington

Source: Building Energy Use Data Book Edition 2, J. L. Blue et.al, Oak Ridge National Laboratory ORNL-5552, December, 1979.

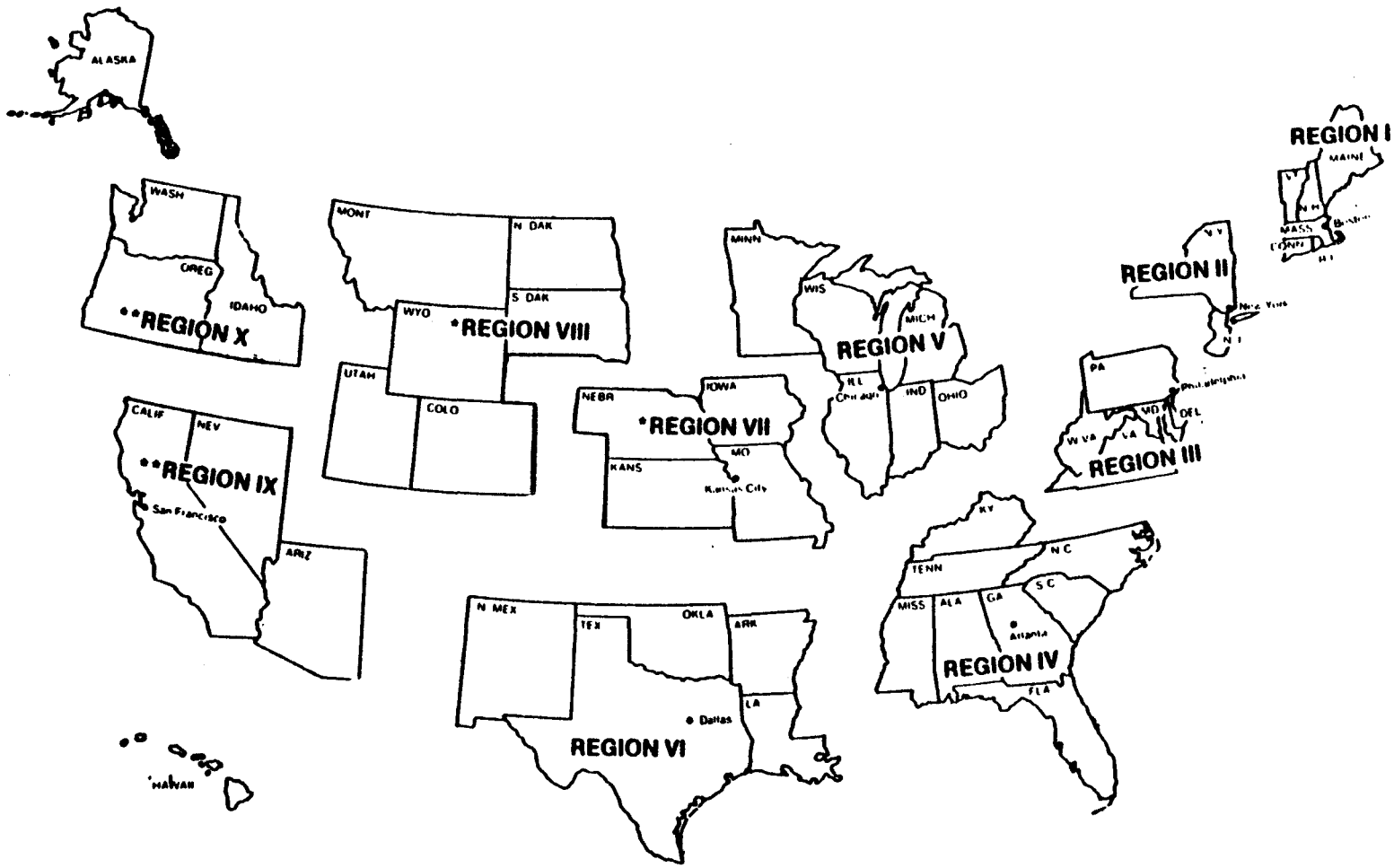


FIGURE III-1

UNITED STATES FEDERAL REGIONS

FIGURE III-2

TOTAL COMMERCIAL ENERGY USE BY REGION

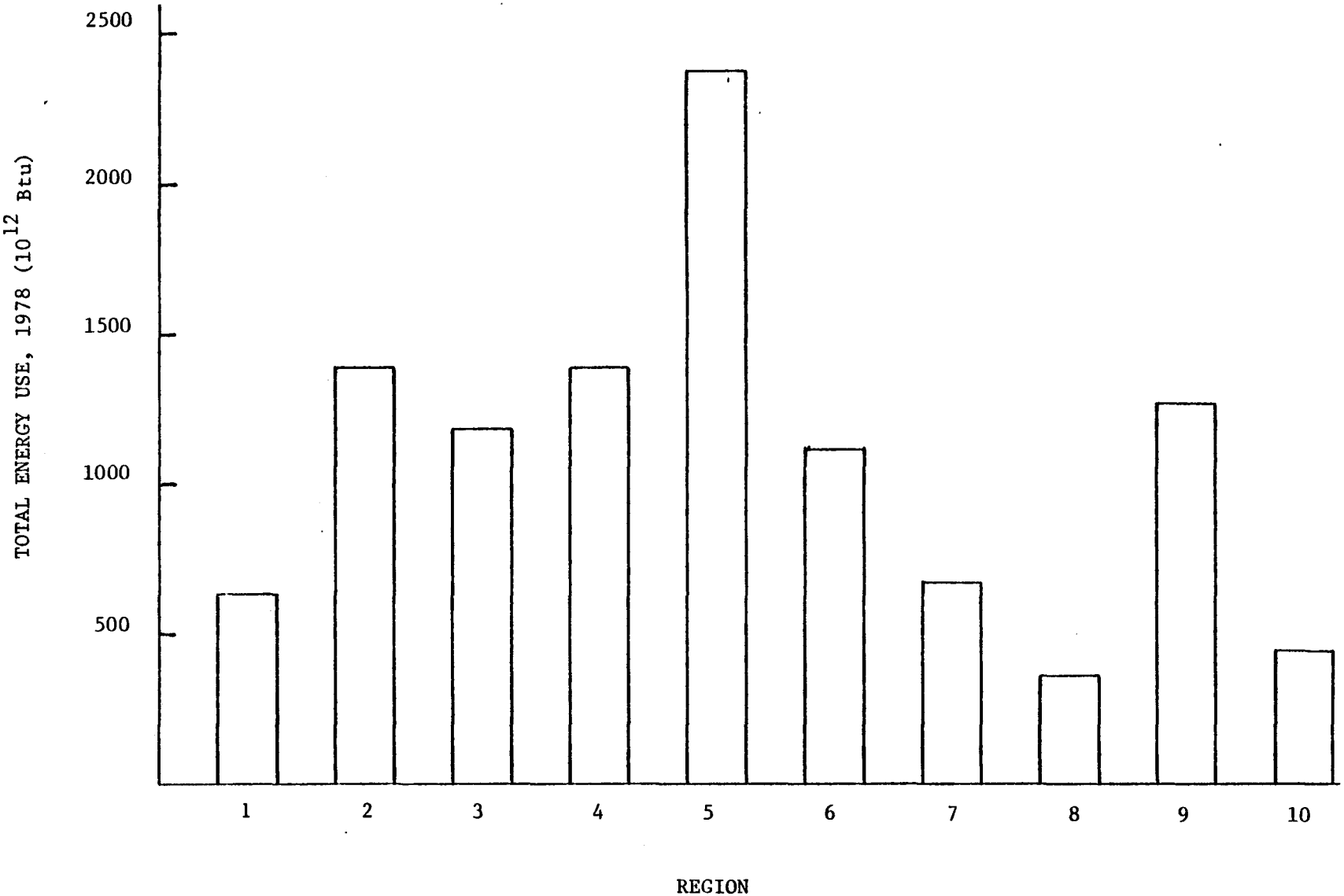


FIGURE III-3

RELATIONSHIP BETWEEN REGIONAL FLOOR SPACE AND ENERGY USE, 1978

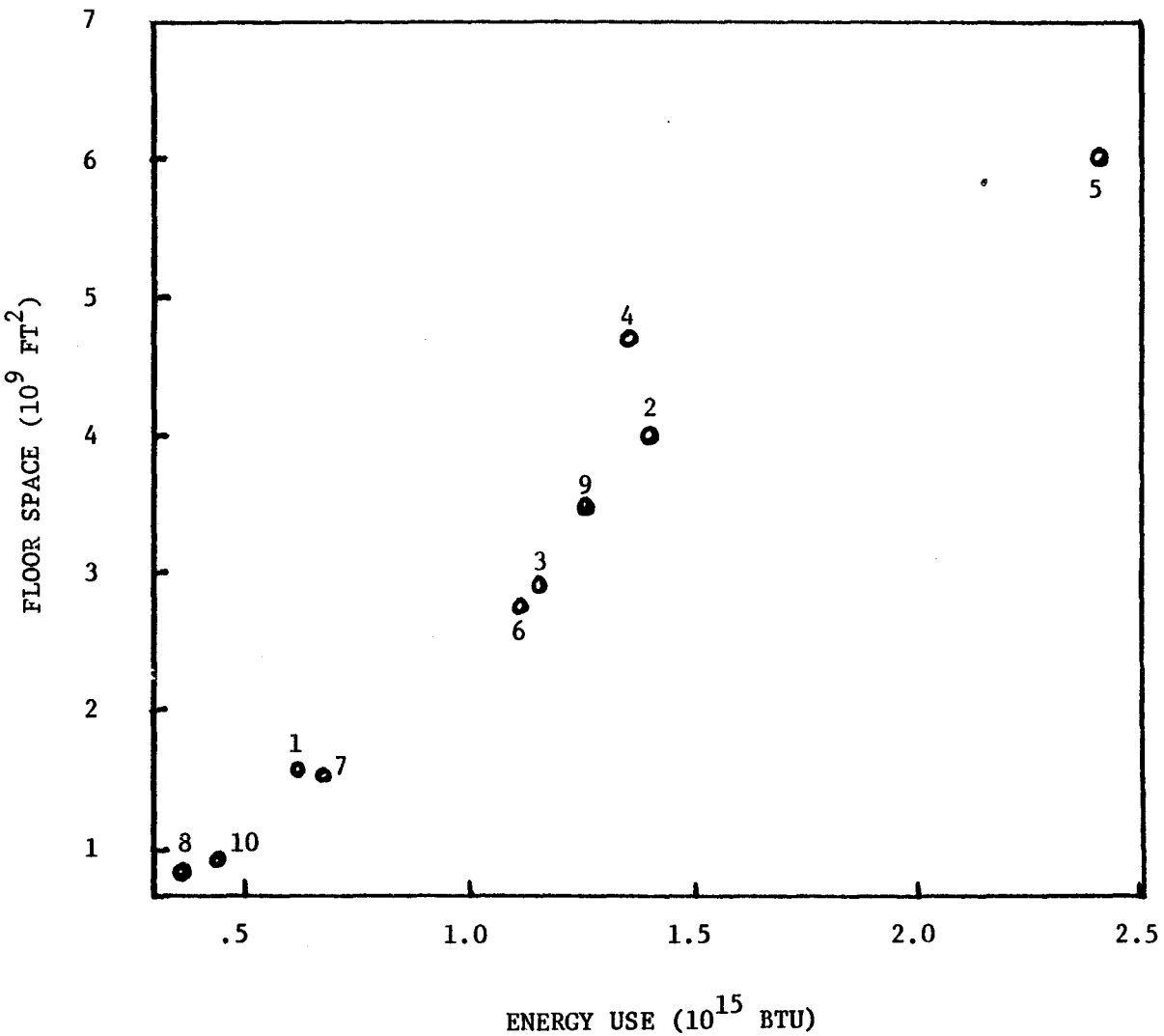


Table III-2

Heating Degree Days

Region	Time 1970	1971	1972	1973	1974	1975	1976	1977	1978	35 year average
1	6780	6629	6693	6059	6555	6292	6772	6518	7003	6488
2	5985	5790	6112	5336	5717	5478	5713	5880	6337	5809
3	5367	5183	5395	4877	5017	5003	5182	5383	5781	5195
4	2878	2619	2596	2575	2404	2518	2954	2987	3113	2644
5	6676	6439	7009	5968	6466	6380	6823	7100	7267	6493
6	2578	2195	2438	2502	2283	2388	2576	2557	2911	2394
7	5763	5547	5460	5288	5467	5661	5769	5649	6503	5645
8	7794	7848	7827	7651	7447	7967	7144	6967	7561	7450
9	2610	3061	2678	2802	2691	3005	2199	2472	2527	2708
10	5773	6080	5468	5635	5586	5998	5448	5722	5697	5698

FIGURE III-4

COMMERCIAL ELECTRICITY USE AS

PERCENT OF TOTAL COMMERCIAL ENERGY USE, 1978

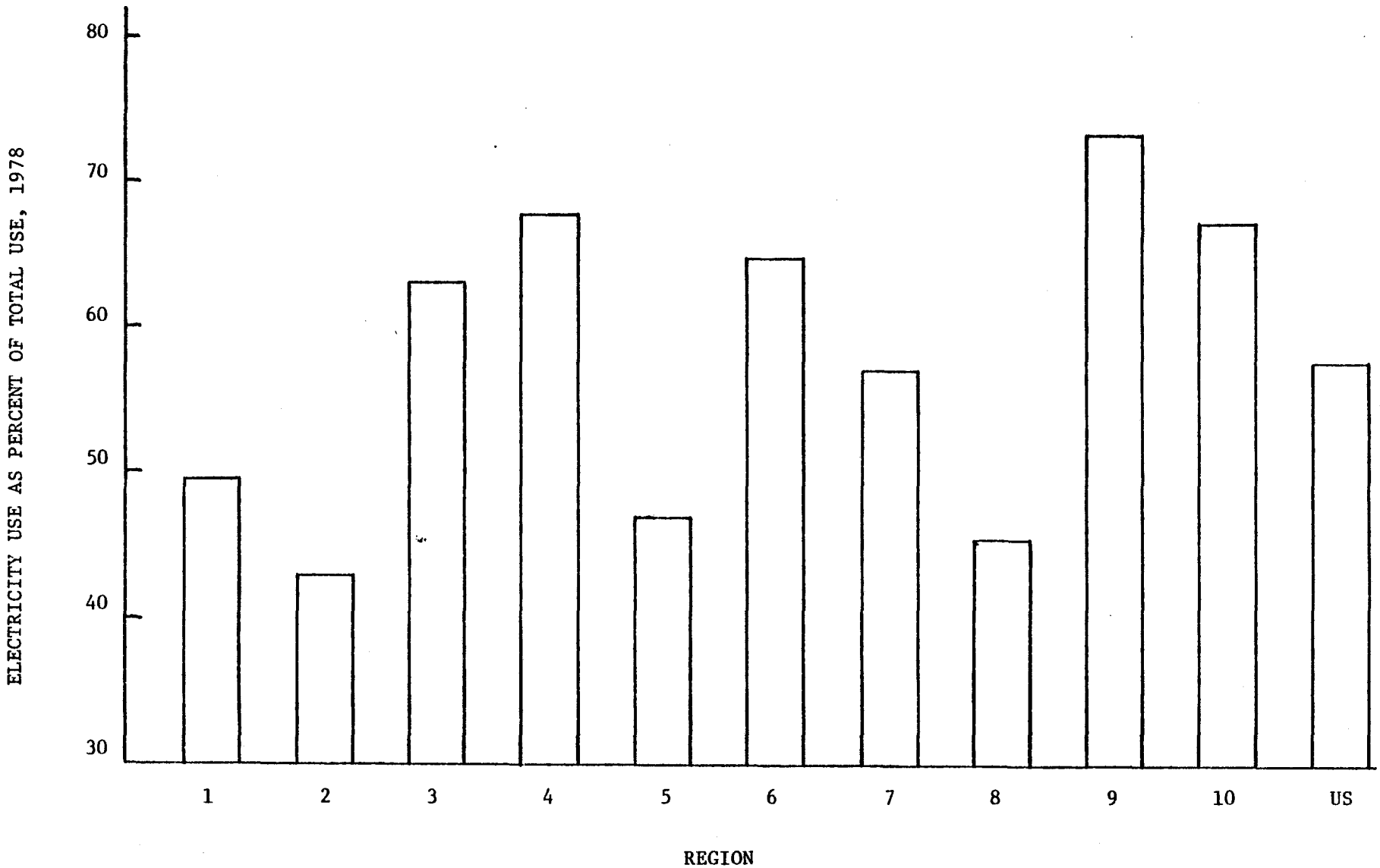


FIGURE III-5

COMMERCIAL NATURAL GAS USE AS

PERCENT OF TOTAL COMMERCIAL ENERGY USE, 1978

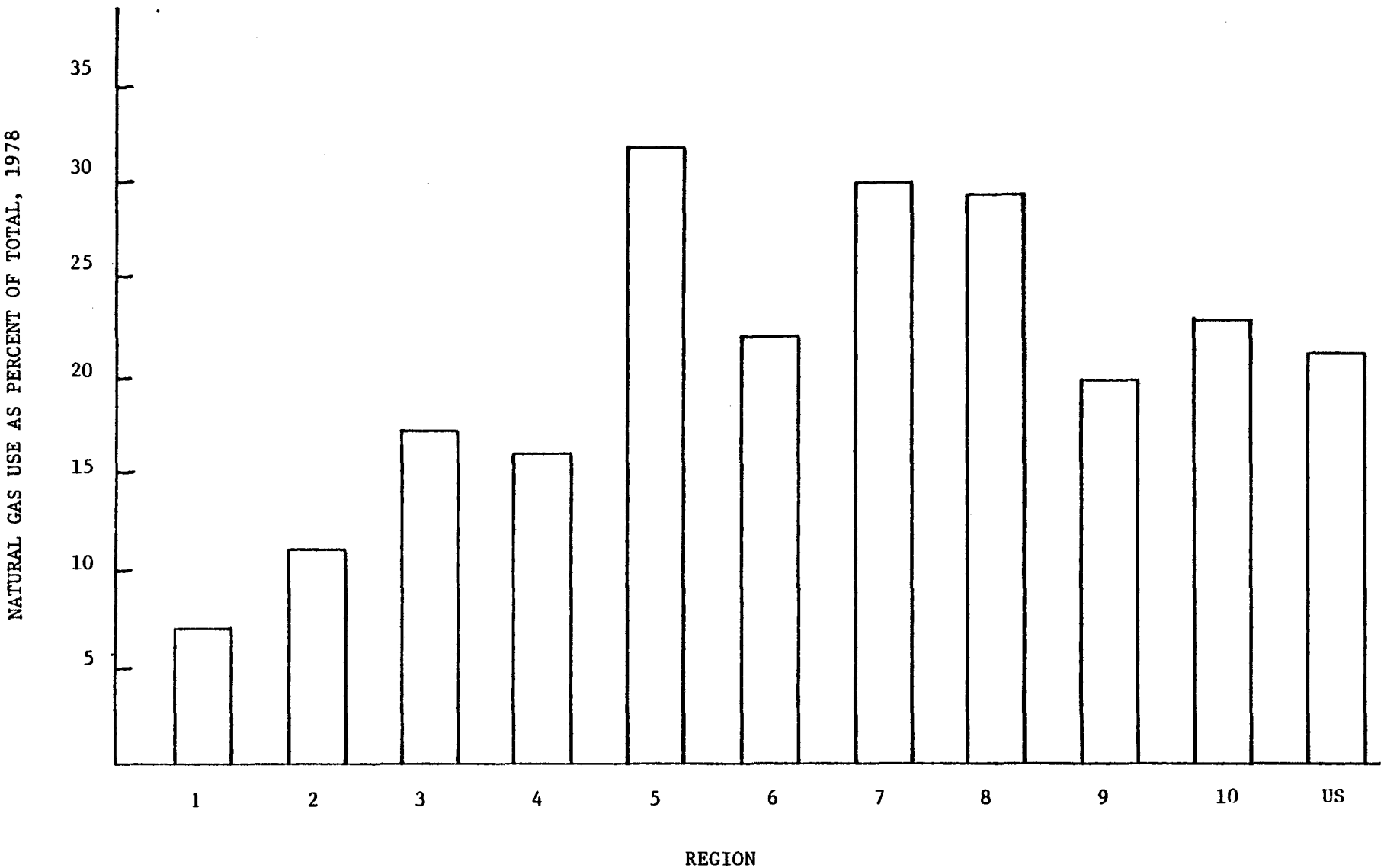


FIGURE III-6

COMMERCIAL OIL USE AS

PERCENT OF TOTAL COMMERCIAL ENERGY USE, 1978

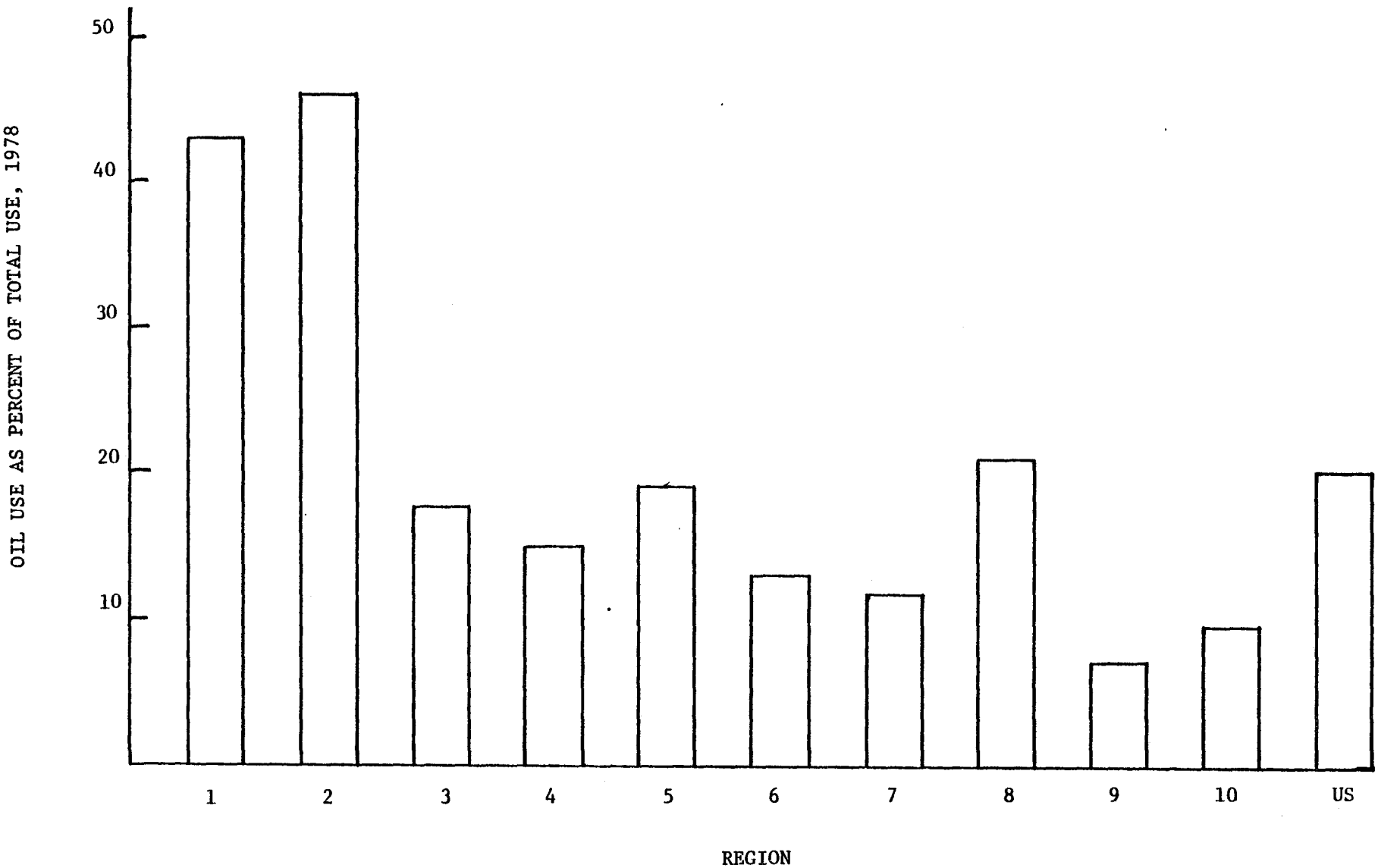


TABLE III-3

REGION I COMMERCIAL ENERGY USE AND PRICES: 1960-1978

	Energy Use (10^{12} Btu)					Price (1975 $/$10^6$ Btu)		
Year	Electricity	Natural Gas	Oil	Other	Total	Electricity	Natural Gas	Oil
1960	79.78	9.59	225.04	14.50	328.91	5.51	2.82	1.18
1961	86.45	11.30	218.72	11.32	324.67	5.09	2.80	1.27
1962	92.97	13.00	229.76	11.13	346.86	4.74	2.64	1.18
1963	99.68	14.19	214.61	8.20	336.68	4.58	2.54	1.12
1964	107.84	14.57	244.36	7.12	373.89	4.41	2.56	1.03
1965	116.24	15.53	304.90	6.18	442.85	4.24	2.53	1.00
1966	125.24	18.21	337.28	5.50	486.23	3.99	2.38	.97
1967	150.81	23.24	334.77	4.86	513.68	3.79	2.22	.98
1968	164.90	25.58	324.59	4.42	519.49	3.42	2.13	.99
1969	179.16	29.67	330.33	3.79	542.95	3.19	2.02	.91
1970	198.10	35.60	349.31	3.10	586.11	2.99	1.93	.88
1971	217.91	37.45	357.46	2.95	615.77	3.01	2.03	1.24
1972	238.49	37.92	377.58	3.14	657.13	3.09	2.11	1.14
1973	260.70	37.94	374.04	3.27	675.95	3.03	2.13	1.30
1974	251.98	37.36	302.20	3.31	594.85	3.79	2.28	2.43
1975	273.39	37.44	264.62	3.12	578.57	3.81	2.55	2.31
1976	289.32	36.95	300.53	3.18	629.98	3.71	2.85	2.20
1977	297.66	38.83	270.82	3.39	610.70	3.69	2.98	2.41
1978	307.94	43.29	266.30	3.18	620.71	3.51	2.85	2.18
Average Annual Growth Rates (%)								
1960-1973	9.54	11.16	3.99	-10.82	5.70	-4.50	-2.14	0.75
1973-1978	3.39	2.67	-6.57	- 0.56	-1.69	2.98	6.0	10.89

TABLE III-4

REGION 2 COMMERCIAL ENERGY USE AND PRICES: 1960-1978

	Energy Use (10^{12} Btu)					Price		
Year	Electricity	Natural Gas	Oil	Other	Total	Electricity	Natural Gas	Oil
1960	265.86	55.04	430.98	26.54	778.42	4.53	2.45	1.26
1961	223.34	62.40	459.73	24.72	770.19	4.40	2.45	1.29
1962	233.83	66.04	475.49	22.83	798.19	4.37	2.30	1.25
1963	315.35	72.81	479.22	19.75	887.13	3.86	2.19	1.22
1964	338.96	77.15	440.13	16.83	873.07	3.77	1.97	1.22
1965	361.04	80.20	582.60	15.68	1039.52	3.72	1.96	1.17
1966	385.76	105.37	616.94	12.37	1120.44	3.54	2.05	1.16
1967	410.97	113.24	663.58	9.76	1197.55	3.46	1.96	1.15
1968	441.38	116.86	698.49	8.77	1265.50	3.30	1.84	1.14
1969	473.94	122.43	661.14	7.64	1265.15	3.09	1.76	1.08
1970	508.50	147.90	674.87	7.50	1338.77	3.02	1.69	1.11
1971	534.15	155.73	663.62	6.87	1360.37	3.29	1.71	1.30
1972	566.92	158.65	675.46	5.75	1406.78	3.39	1.70	1.09
1973	602.50	153.36	675.91	6.05	1437.82	3.45	1.68	1.35
1974	675.14	146.37	588.72	5.57	1415.80	4.44	1.77	2.43
1975	594.45	136.05	544.57	4.95	1280.02	4.43	2.04	2.25
1976	607.21	136.50	634.38	4.29	1382.38	4.41	2.31	2.16
1977	616.82	138.27	620.77	5.08	1380.94	4.46	2.52	2.33
1978	649.10	142.01	597.74	6.03	1394.88	4.08	2.51	2.14
Average Annual Growth Rates (%)								
1960-1973	6.50	8.20	3.52	-10.75	4.80	-2.07	-2.86	0.53
1973-1978	1.50	-1.53	-2.43	-0.03	-0.01	3.41	8.36	9.65

TABLE III-5

REGION 3 COMMERCIAL ENERGY USE AND PRICES: 1960-1978

	Energy Use (10^{12} Btu)					Price		
Year	Electricity	Natural Gas	Oil	Other	Total	Electricity	Natural Gas	Oil
1960	201.10	93.95	220.57	51.49	567.11	3.96	1.56	1.17
1961	212.30	98.93	196.08	46.98	554.29	3.79	1.57	1.24
1962	226.35	104.77	214.27	44.71	590.10	3.67	1.55	1.22
1963	241.76	108.26	226.43	41.26	617.71	3.54	1.56	1.17
1964	260.60	107.76	246.12	40.35	654.83	3.24	1.55	1.10
1965	286.61	113.21	264.33	36.05	700.20	3.08	1.52	1.07
1966	313.77	125.01	278.78	34.32	751.88	2.90	1.51	1.05
1967	336.84	147.86	288.78	30.96	804.44	2.78	1.43	1.07
1968	373.70	158.28	282.38	28.90	843.26	2.60	1.38	1.09
1969	409.70	173.61	277.13	26.19	886.63	2.43	1.32	1.03
1970	440.20	182.50	304.70	24.60	952.00	2.38	1.28	1.07
1971	469.80	201.84	301.77	24.54	997.95	2.48	1.28	1.25
1972	504.13	219.44	302.27	20.04	1045.88	2.52	1.33	1.12
1973	548.74	213.22	306.85	23.17	1091.98	2.46	1.31	1.49
1974	536.42	196.86	253.29	22.17	1008.74	2.87	1.33	2.40
1975	588.37	185.92	221.52	16.17	1011.98	3.07	1.63	2.31
1976	618.29	212.18	238.93	16.50	1085.90	3.04	1.64	2.27
1977	636.22	196.83	226.59	18.53	1078.67	3.20	2.28	2.47
1978	741.66	205.77	209.08	20.16	1176.67	3.15	2.01	2.35
Average Annual Growth Rates (%)								
1960-1973	8.03	6.51	2.57	-5.96	5.17	-3.60	-1.33	1.88
1973-1978	6.21	-0.71	-7.40	-2.74	1.51	5.07	8.94	9.54

TABLE III-6

REGION 4 COMMERCIAL ENERGY USE AND PRICES: 1960-1978

	Energy Use (10^{12} Btu)					Price		
Year	Electricity	Natural Gas	Oil	Other	Total	Electricity	Natural Gas	Oil
1960	223.71	94.63	64.37	36.34	419.05	3.91	1.17	1.53
1961	237.51	116.51	76.47	32.62	463.11	3.62	1.04	1.54
1962	266.65	132.86	77.49	34.84	511.84	3.49	1.09	1.54
1963	288.57	132.99	72.52	33.04	527.12	3.37	1.10	1.52
1964	322.08	137.21	71.53	29.33	560.15	3.21	1.10	1.52
1965	357.73	124.26	68.20	26.39	576.58	3.07	1.08	1.53
1966	387.69	130.56	81.60	29.14	628.99	2.91	1.03	1.49
1967	425.27	162.45	99.34	26.35	713.41	2.71	1.08	1.43
1968	478.62	182.67	100.88	28.02	789.79	2.54	1.03	1.42
1969	537.92	201.73	110.67	31.64	881.95	2.39	.97	1.34
1970	598.60	207.90	121.40	29.70	957.60	2.27	.96	1.32
1971	653.14	216.82	124.59	27.92	1022.47	2.24	1.01	1.36
1972	722.32	215.91	144.35	26.93	1109.71	2.26	1.05	1.26
1973	797.86	216.10	156.28	27.72	1197.96	2.22	1.04	1.45
1974	815.36	209.73	158.48	24.83	1208.40	2.40	1.06	2.18
1975	805.42	215.47	153.73	22.37	1196.99	2.59	1.13	2.33
1976	847.18	243.22	223.26	20.63	1334.29	2.61	1.30	2.30
1977	918.16	238.37	218.90	22.42	1397.85	2.66	1.60	2.48
1978	939.58	223.40	202.75	22.60	1388.33	2.63	1.64	2.45
Average Annual Growth Rates (%)								
1960-1973	10.28	6.56	7.06	-2.06	8.42	-4.26	-0.902	-.41
1973-1978	3.32	0.67	5.34	-4.00	2.99	3.45	9.54	11.06

TABLE III-7

REGION 5 COMMERCIAL ENERGY USE AND PRICES: 1960-1978

	Energy Use (10^{12} Btu)					Price		
Year	Electricity	Natural Gas	Oil	Other	Total	Electricity	Natural Gas	Oil
1960	374.84	240.65	370.14	217.25	1202.88	4.06	1.34	1.56
1961	402.89	267.97	385.35	201.95	1258.15	3.84	1.30	1.55
1962	434.71	328.26	383.07	204.76	1350.80	3.75	1.31	1.56
1963	459.82	350.76	374.31	171.71	1356.60	3.62	1.31	1.52
1964	497.61	363.20	361.73	144.96	1367.50	3.50	1.29	1.46
1965	532.68	415.35	385.36	148.23	1481.62	3.33	1.25	1.40
1966	587.32	484.18	367.85	159.16	1598.51	3.17	1.16	1.40
1967	628.01	567.45	390.00	139.47	1724.93	3.03	1.18	1.42
1968	682.25	593.30	448.47	128.57	1852.59	2.88	1.12	1.43
1969	747.62	660.67	403.03	124.53	1935.85	2.73	1.07	1.34
1970	806.71	688.50	399.30	105.19	1999.70	2.63	1.05	1.35
1971	857.11	716.99	377.95	101.55	2053.60	2.61	1.06	1.42
1972	910.46	764.78	401.65	83.60	2160.49	2.65	1.10	1.36
1973	986.34	764.87	385.93	71.51	2208.65	2.57	1.10	1.54
1974	980.78	789.14	389.61	73.93	2233.46	2.66	1.13	2.56
1975	1001.21	752.45	405.98	66.62	2226.26	2.82	1.29	2.40
1976	1047.90	762.17	458.10	65.51	2333.68	2.86	1.51	2.42
1977	1093.41	677.03	447.35	60.65	2278.44	2.94	1.72	2.64
1978	1106.72	751.15	453.74	57.86	2369.47	2.99	1.77	2.58
Average Annual Growth Rates (%)								
1960-1973	7.73	9.30	0.32	-8.19	4.79	-3.47	-1.51	-0.10
1973-1978	3.89	-0.36	3.29	-4.15	1.42	3.07	9.96	10.87

TABLE III-8

REGION 6 COMMERCIAL ENERGY USE AND PRICES: 1960-1978

	Energy Use (10^{12} Btu)					Price		
Year	Electricity	Natural Gas	Oil	Other	Total	Electricity	Natural Gas	Oil
1960	150.57	101.69	25.33	8.59	286.18	3.38	.61	1.50
1961	188.60	103.35	21.23	8.44	321.62	3.19	.64	1.48
1962	208.20	106.18	18.65	9.15	342.18	3.21	.66	1.54
1963	231.20	114.65	18.18	7.94	371.97	3.03	.70	1.57
1964	248.54	126.92	15.72	10.41	401.59	2.91	.70	1.48
1965	271.14	125.14	13.78	10.56	420.62	2.76	.67	1.53
1966	294.09	137.92	11.71	10.37	454.09	2.62	.68	1.47
1967	322.82	214.03	10.57	10.57	557.99	2.49	.70	1.47
1968	352.68	225.63	14.38	12.00	604.69	2.35	.66	1.45
1969	392.05	223.24	25.54	14.09	654.92	2.20	.65	1.38
1970	425.00	244.10	28.80	13.90	711.80	2.06	.61	1.36
1971	466.05	232.27	29.01	13.88	741.21	1.99	.63	1.35
1972	518.13	231.08	47.05	15.06	811.32	1.98	.65	1.32
1973	554.83	227.67	56.08	14.29	852.87	1.91	.66	1.45
1974	565.84	211.03	77.07	12.88	866.82	1.97	.74	2.27
1975	593.53	192.51	86.59	11.06	883.69	2.05	.91	2.25
1976	622.36	211.07	100.49	11.02	944.94	2.21	1.14	2.16
1977	676.23	224.52	129.68	10.84	1041.27	2.38	1.38	2.43
1978	719.64	245.45	142.83	10.74	1118.66	2.41	1.52	2.58
Average Annual Growth Rates (%)								
1960-1973	10.55	6.40	6.30	3.99	8.76	-4.30	0.61	-0.26
1973-1978	5.34	1.52	20.36	-5.55	5.58	4.76	18.68	12.21

TABLE III-9

REGION 7 COMMERCIAL ENERGY USE AND PRICES: 1960-1978

	Energy Use (10^{12} Btu)					Price		
Year	Electricity	Natural Gas	Oil	Other	Total	Electricity	Natural Gas	Oil
1960	107.79	98.69	60.03	23.58	290.09	4.13	1.01	1.57
1961	114.89	86.00	62.39	20.31	283.59	3.80	.99	1.64
1962	128.45	96.38	56.69	21.06	302.58	3.71	1.01	1.62
1963	139.29	97.00	56.52	15.81	308.62	3.54	1.01	1.62
1964	147.65	114.87	56.21	13.64	332.37	3.43	1.04	1.49
1965	157.77	114.19	54.89	13.58	340.43	3.32	1.05	1.43
1966	162.48	134.79	60.33	13.68	371.28	3.19	.93	1.46
1967	170.86	163.46	64.96	12.86	412.14	3.05	.98	1.47
1968	192.26	171.07	68.59	12.17	444.09	2.85	.96	1.44
1969	213.49	183.89	60.17	13.18	470.73	2.66	.91	1.42
1970	229.80	193.70	61.10	13.10	497.70	2.50	.90	1.38
1971	245.00	199.91	55.12	11.62	511.65	2.47	.89	1.42
1972	258.53	209.89	60.43	12.40	541.25	2.48	.96	1.36
1973	274.33	192.53	60.40	13.08	540.34	2.39	.96	1.61
1974	269.04	196.79	57.08	12.69	535.60	2.39	.96	2.52
1975	292.58	197.85	58.39	11.94	560.76	2.53	1.10	2.49
1976	344.78	210.81	69.30	11.41	636.30	2.68	1.29	2.46
1977	361.51	197.84	68.78	10.77	638.88	2.68	1.63	2.56
1978	377.04	197.60	77.29	13.12	665.05	2.72	1.53	2.55
Average Annual Growth Rates (%)								
1960-1973	7.45	5.27	0.05	-4.43	4.90	-4.12	-0.39	0.19
1973-1978	6.57	0.52	5.06	3.08	4.24	2.62	9.77	9.63

TABLE III-10

REGION 8 COMMERCIAL ENERGY USE AND PRICES: 1960-1978

	Energy Use (10^{12} Btu)					Price		
Year	Electricity	Natural Gas	Oil	Other	Total	Electricity	Natural Gas	Oil
1960	45.41	53.19	30.33	15.64	144.57	3.64	.89	1.66
1961	49.00	57.31	42.99	15.26	164.56	3.45	.87	1.61
1962	54.87	60.58	48.71	16.21	180.37	3.39	.86	1.55
1963	61.99	62.01	46.05	13.26	183.31	3.26	.86	1.51
1964	66.94	71.29	34.21	13.29	186.23	3.18	.88	1.45
1965	74.87	73.48	35.55	12.74	196.64	3.05	.86	1.49
1966	84.31	71.72	34.88	13.44	204.35	2.92	.79	1.47
1967	90.13	73.24	37.92	12.66	213.95	2.74	.84	1.53
1968	97.33	80.31	38.05	11.87	227.56	2.57	.80	1.53
1969	105.60	90.63	43.22	12.28	251.73	2.43	.78	1.51
1970	113.40	99.30	39.60	10.30	262.60	2.27	.76	1.50
1971	121.30	100.85	41.41	11.77	275.33	2.21	.77	1.51
1972	132.25	105.05	44.69	11.51	293.50	2.19	.78	1.45
1973	142.72	106.68	50.56	10.93	310.89	2.07	.82	1.63
1974	148.21	103.52	61.89	11.97	325.59	1.97	.89	2.56
1975	147.73	109.60	66.50	8.36	332.19	2.05	.97	2.63
1976	145.78	116.58	71.78	9.24	343.38	2.11	1.04	2.40
1977	153.82	107.64	62.84	11.43	335.73	2.10	1.24	2.41
1978	163.80	105.39	75.01	15.51	359.71	2.18	1.35	2.23
Average Annual Growth Rates (%)								
1960-1973	9.21	5.50	4.01	-2.72	6.07	-4.25	-0.63	-0.14
1973-1978	2.79	-0.24	8.21	7.25	2.96	1.04	10.49	6.47

TABLE III-11

REGION 9 COMMERCIAL ENERGY USE AND PRICES: 1960-1978

	Energy Use (10^{12} Btu)					Price		
Year	Electricity	Natural Gas	Oil	Other	Total	Electricity	Natural Gas	Oil
1960	332.01	127.26	81.62	2.66	543.55	3.30	1.05	1.69
1961	382.73	118.93	71.38	2.59	575.63	3.24	1.13	1.63
1962	405.57	128.56	50.24	3.30	587.67	3.20	1.14	1.66
1963	426.56	130.56	50.11	3.17	610.40	2.98	1.12	1.54
1964	430.15	155.96	43.15	4.07	633.33	2.76	1.09	1.57
1965	431.80	172.78	39.96	4.44	648.98	2.68	1.09	1.60
1966	472.42	179.39	36.73	3.96	692.50	2.40	1.07	1.53
1967	490.61	200.18	32.74	3.75	727.28	2.32	1.03	1.48
1968	534.18	205.74	36.45	3.71	780.08	2.20	1.00	1.44
1969	556.77	223.71	36.45	5.10	822.03	2.09	.96	1.45
1970	598.90	266.20	40.40	6.00	911.50	2.00	.97	1.45
1971	634.82	257.91	52.88	4.64	950.25	2.02	.97	1.52
1972	707.61	252.46	75.37	3.95	1039.39	2.08	1.00	1.45
1973	742.26	257.15	99.00	3.81	1102.22	2.11	.99	1.64
1974	705.68	256.55	79.77	3.62	1045.62	2.40	1.03	2.58
1975	863.79	266.59	59.03	2.33	1191.74	2.46	1.25	2.71
1976	902.13	255.24	68.38	2.58	1228.33	2.57	1.45	2.71
1977	910.60	258.64	73.78	2.59	1245.70	2.97	1.76	2.66
1978	919.69	250.34	86.39	3.13	1259.55	3.31	1.80	2.45
Average Annual Growth Rates (%)								
1960-1973	6.38	5.56	1.50	2.80	5.59	3.38	-0.45	-0.23
1973-1978	4.38	-0.54	-2.69	-4.86	2.70	9.42	12.70	8.36

TABLE III-12

REGION 10 COMMERCIAL ENERGY USE AND PRICES: 1960-1978

	Energy Use (10^{12} Btu)					Price		
Year	Electricity	Natural Gas	Oil	Other	Total	Electricity	Natural Gas	Oil
1960	84.99	21.21	57.91	9.51	173.62	2.16	2.16	1.54
1961	90.83	23.26	51.67	9.48	175.24	2.04	1.88	1.53
1962	99.01	27.24	51.72	9.04	187.01	2.37	1.83	1.54
1963	105.99	30.91	55.87	8.00	200.77	2.22	1.87	1.45
1964	114.27	40.50	66.46	7.92	229.15	2.16	1.94	1.35
1965	114.90	40.52	61.39	7.80	224.61	2.09	1.92	1.37
1966	129.37	45.54	60.67	7.33	242.91	1.90	1.82	1.33
1967	138.53	51.11	61.30	7.28	258.22	1.74	1.81	1.35
1968	148.35	60.51	63.81	5.93	278.60	1.67	1.60	1.34
1969	163.93	77.44	67.02	5.78	314.17	1.56	1.42	1.33
1970	174.70	83.50	66.00	4.20	328.40	1.48	1.37	1.30
1971	188.46	98.13	71.62	5.75	363.96	1.48	1.36	1.27
1972	224.73	111.24	77.59	4.27	417.83	1.44	1.39	1.19
1973	239.36	115.29	66.60	3.99	425.24	1.37	1.38	1.46
1974	239.97	115.85	60.24	3.46	419.52	1.33	1.38	2.36
1975	256.57	127.03	46.43	3.15	433.18	1.33	1.56	2.61
1976	266.56	116.82	34.97	3.46	421.81	1.31	1.82	2.47
1977	275.54	108.64	37.99	4.71	426.88	1.36	2.06	2.42
1978	289.51	99.09	40.40	5.12	434.12	1.31	2.05	2.15
Average Annual Growth Rates (%)								
1960-1973	8.29	13.91	1.08	-6.46	7.13	-3.44	-3.38	-0.41
1973-1978	3.88	-2.98	-9.51	5.11	0.41	-0.69	8.24	8.05

electricity on a national level. In general, the northernmost regions are smaller users of electricity than the other regions. The one exception is region ten, where the price of electricity is less than one-half the national average. Regions 1, 2, 5 and 8 utilize less electricity than the national average. An obvious reason for the greater dependence on electricity in the other southerly regions is the greater demand for space cooling which is provided primarily by electricity. The greater proportion of new buildings in the more southern regions, which exhibit a more frequent choice of electricity for space heating than older buildings, is a secondary factor in this regional pattern.

Natural gas use follows, largely, the availability of natural gas supplies. No good measure of natural gas supply restrictions is available; however, for all regions except 1, 2, 3 and 10, the price of natural gas has always been less than the price of oil. In 1978, oil prices varied from 35 to 70 percent higher than natural gas prices in regions 4-9. Since oil and gas are easily substituted in their primary end use, space heating, only supply restrictions can account for a commercial firm's choice of oil over natural gas when the price of oil on a Btu basis is 70 percent more than that of gas. Regions 10, 8, 7, 6 and 5, which are contiguous, all consume more natural gas relative to total energy use than the national average of 21 percent. Use of natural gas varies from a low of 7 percent to a high of 32 percent of total energy use for regions 1 and 5 respectively.

Oil use represents from 7 to 46 percent of total energy use. Region 7 has the least and region 2 the greatest dependence on oil use. Only regions 1, 2 and 8 consume more oil relative to total energy use than the 20 percent national average. Region 1's use of oil represents 43 percent of total energy while region 8 represents 21 perent of total energy use. While the price for oil and gas varies by region, the supply availability of natural gas as discussed above has probably been the primary determinant of use of oil relative to natural gas.

Regional variation in the rates of growth of the different fuels provides an interesting picture of commercial energy use over the 1960-1978 period. These data are presented graphically in Figures III-7 through III-10 and in Tables III-3 through III-12. Both pre- and post-embargo growth rates

FIGURE III-7

AVERAGE ANNUAL GROWTH RATE OF TOTAL COMMERCIAL ENERGY USE

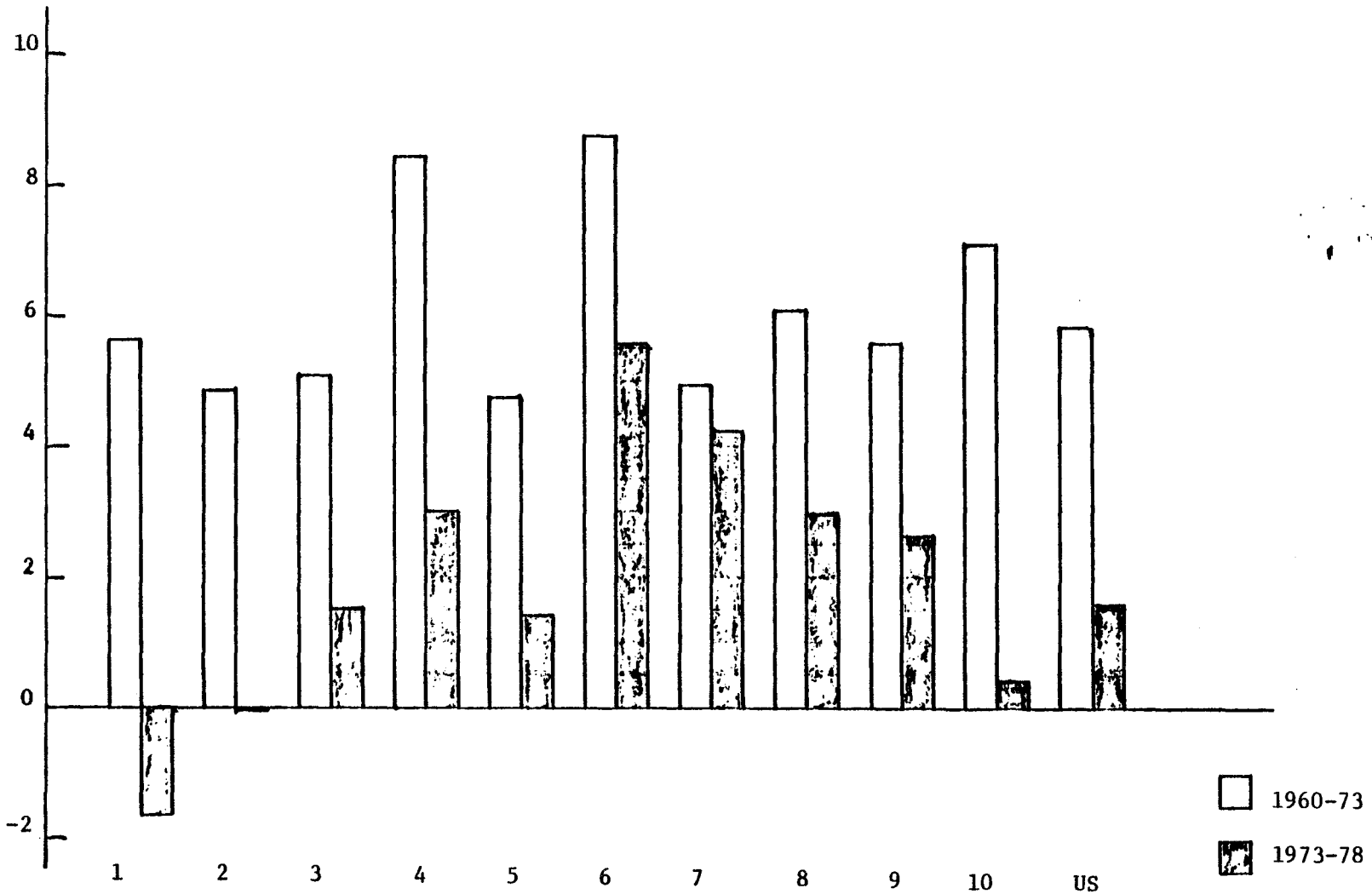


FIGURE III-8

AVERAGE ANNUAL GROWTH RATE OF COMMERCIAL ELECTRICITY USE

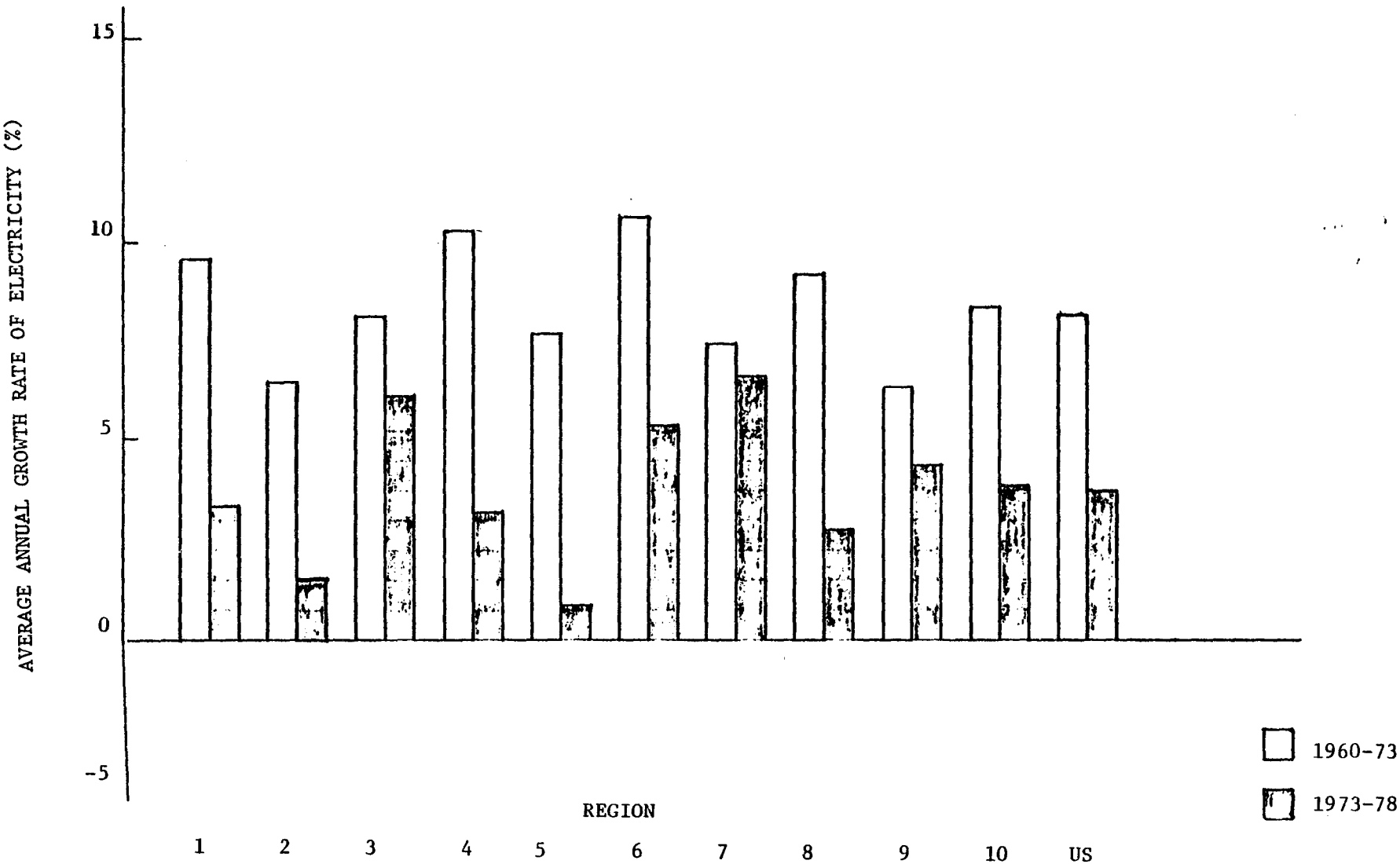


FIGURE III-9

AVERAGE ANNUAL GROWTH RATE OF COMMERCIAL NATURAL GAS USE

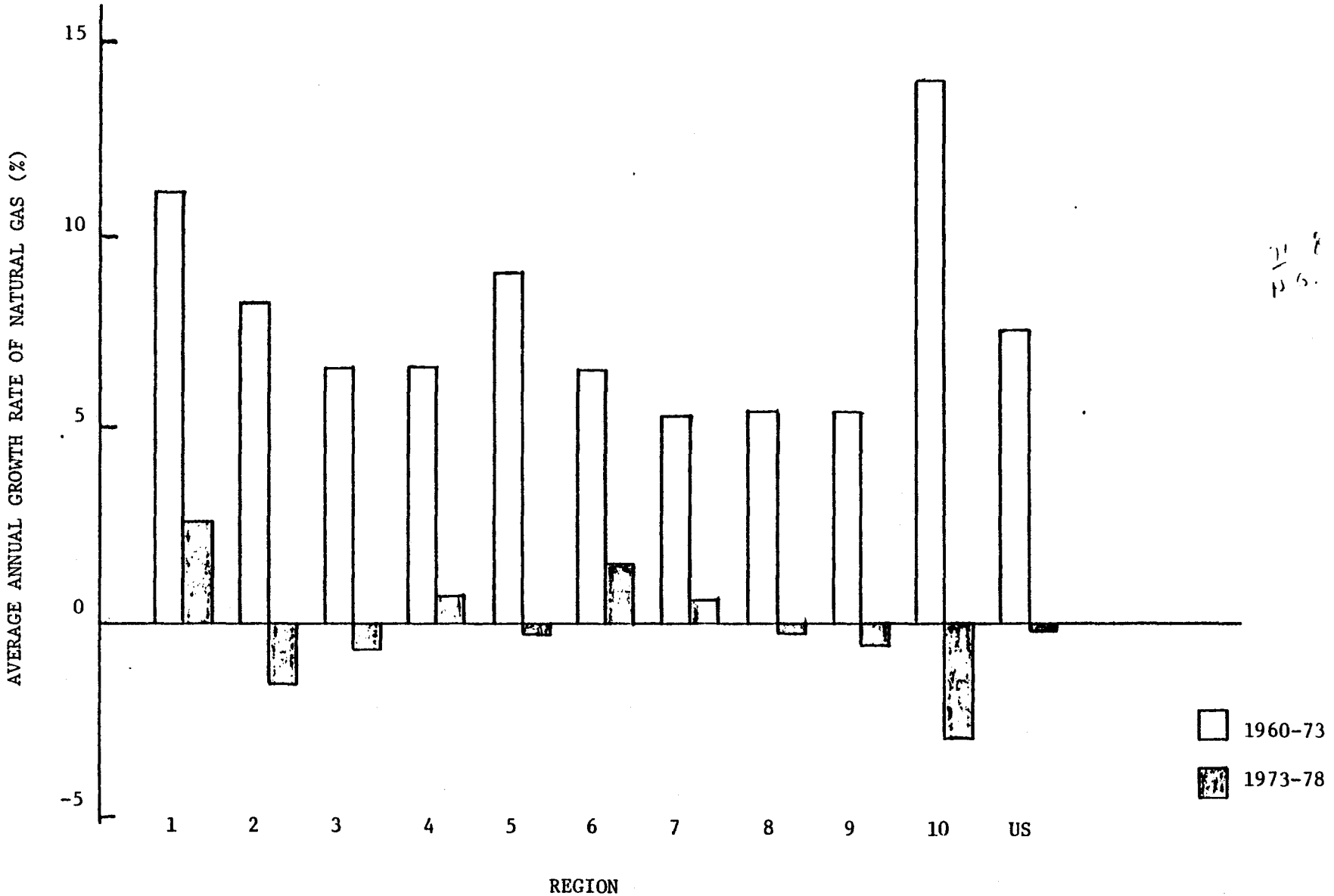
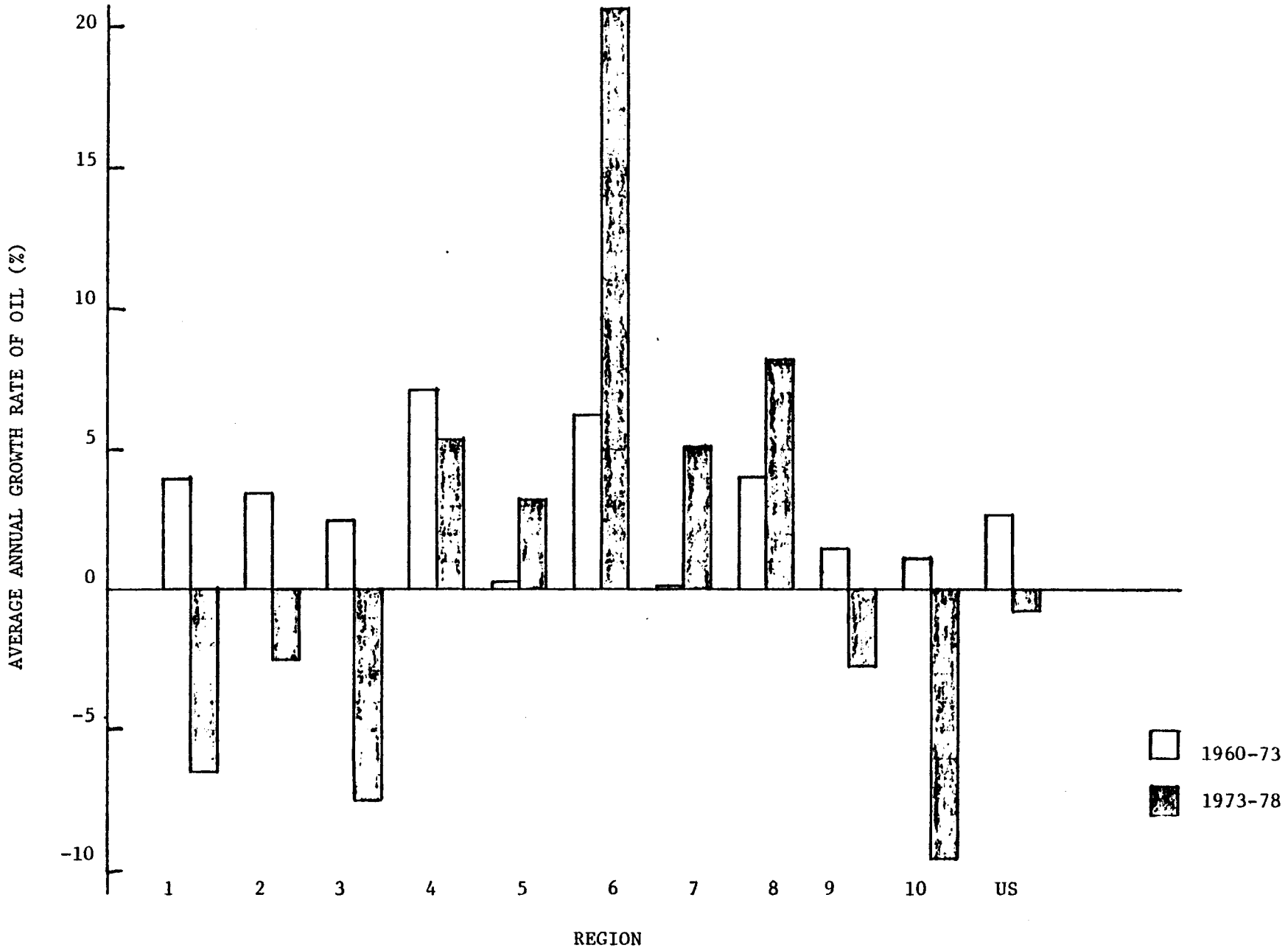


FIGURE III-10

AVERAGE ANNUAL GROWTH RATE OF COMMERCIAL OIL USE



are included in these figures and tables. Differences between these two periods in terms of fuel growth rates reflect both growth in floor space and fuel price increases.

Difference in total energy use growth rates between pre- and post-embargo periods is most drastic in Regions 1 (New England) and 2 (New York and New Jersey), where the total energy use growth rates drop from 5.7 and 4.8 percent to -1.7 and -.01 percent respectively. Region 1, which was one of the slowest growing regions in terms of floor space (.1 percent per year from 1973-1978) was also one of the hardest hit by increased oil price increases because of its unusully heavy dependence on oil. Region 2 on the other hand, was also heavily dependent on oil in 1973; the 1.3 annual rate of growth of floor space, however, kept the rate of increase in total energy use from declining as drastically as region 1.

Although Region 10's total energy use growth rates are slightly positive after 1973, the change in growth rates (-6.7 percent) is the second largest change of any region (Region 1 change is the largest, -7.4 percent). This response in Region 10 appears to result from price increases since floor sace growth was comparable in the pre and post 1973 periods.

Total energy use in Region 7, on the other hand, grows at similar rates both before and after 1973 (4.9 versus 4.2). A heavy reliance on electricity and a smaller than average increase in electricity prices after 1973 appears to account for the modest difference in pre- and post-embargo growth rates.

Region 6 (Southwest U.S.) total energy use growth rate is the greatest of all regions, both before and after the oil embargo. Region 4 (Southeast), which ranked second in growth in the 1960-1973 period, reflects the third fastest growing region in terms of energy use after 1973. Both of these regions experienced greater floor space growth and generally lower energy prices in the post embargo period relative to the national average.

Turning to growth rates of individual fuels, the electricity growth rates exhibit the greatest change after 1973 in Region 4 when the second largest pre-embargo growth rate of 10.3 fell to 3.3 in the 1973-1978 period. Region 5, which is the largest region in terms of total energy use, exhibits the smallest post-embargo growth rate. Changes in electricity growth between the 1960-1973 and 1973-1978 periods are similar for most regions.

Natural gas growth rate differentials between pre- and post-embargo periods reflect primarily differences in supply constraints. Growth rates in the 1960-1973 period ranged from 5.3 to 13.9 percent. Rates ranged from -3.0 to 2.7 in the 1973-1978 period. Six of the ten regions reflect post-embargo growth rates for natural gas of between -1.0 and 1.0 percent.

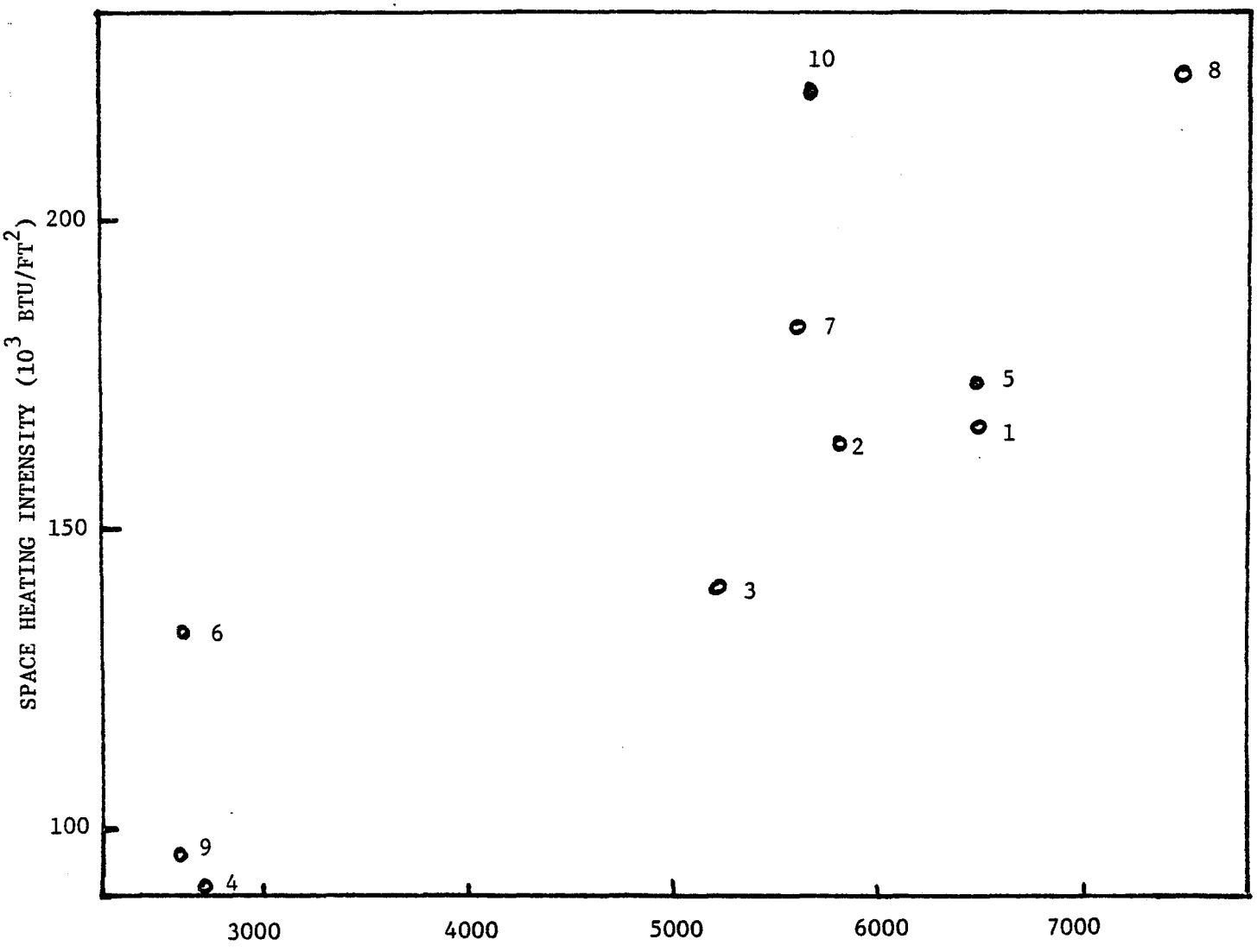
Regions 6, 7 and 8 show increased rates of growth of oil after 1973. The large increase in Region 6 is in part a reflection of the small use of oil in the 1973 base year. The interior regions of the country (4, 5, 6, 7 and 8) all show greater oil use in 1978 compared to 1973. Regions in the Northeast (1, 2 and 3) and in the West (9 and 10) used less oil in 1978 than in 1973.

End use patterns vary by region for a number of reasons. The most obvious is weather conditions (Table III-2 shows heating degree days by region for the 1970-1978 period and a thirty-five year average). Space heating energy use accounted for 48 percent of total energy use in the five coldest regions in 1978 and accounted for 33 percent of total energy use in the warmest regions. The relationship between heating degree days and energy use required to provide space heating is indicated in Figure III-11. While the expected relationship between heating degree days and space heating energy use requirements is obvious, considerable variation in this ratio occurs across regions. Again, however, these variations are explainable. Region 10, which appears to be the greatest outlier reflects a higher space heating energy use requirement because so much more electricity is used for space heating (34.1 percent) compared to the average (6.7 percent) that the inefficiency of electricity (when measured at its source value) inflates Region 10's space heating energy use.

Air conditioning loads also vary according to summer climate factors; however, this relationship is somewhat less dramatic because a large portion of air conditioning demand is generated by internal loads. Air conditioning loads in the five warmest regions use 36 percent of total energy while the five coldest regions use only 26 percent of total energy in cooling.

Lighting, water heating and other end uses reflect similar energy demands across regions. Their importance, mesured as a percent of total

FIGURE III-11
SPACE HEATING ENERGY USE INTENSITY AND
HEATING DEGREE DAYS, 1978



energy use, varies because of differences in space heating and cooling energy uses across regions.

In addition to the regional influences mentioned above, the impact of age of the building stock including growth of the stock since the embargo and regional variations in the building mix, can influence regional end use/fuel/building type energy use characteristics. A detailed analysis of these influences is obviously beyond the scope of this section.

A detailed end use and fuel use picture of regional energy use characteristics for the 1970-1978 period is presented in Tables III-13 through III-22. Energy use by building type with fuel and end use detail for each region is given in Appendix A.

TABLE III-13

REGION 1 COMMERCIAL ENERGY USE BY END USE AND FUEL, 1970-1978

(10^{15} Btu)

	1970	1971	1972	1973	1974	1975	1976	1977	1978
HEAT									
ELEC	0.0124	0.0135	0.0162	0.0157	0.0151	0.0198	0.0233	0.0233	0.0268
GAS	0.0210	0.0225	0.0233	0.0222	0.0212	0.0223	0.0223	0.0238	0.0269
OIL	0.2810	0.2936	0.3142	0.3118	0.2494	0.2137	0.2505	0.2213	0.2148
OTHR	0.0032	0.0033	0.0034	0.0036	0.0036	0.0034	0.0036	0.0037	0.0046
TOTAL	0.3175	0.3329	0.3571	0.3533	0.2894	0.2592	0.2997	0.2721	0.2731
COOL									
ELEC	0.0546	0.0618	0.0742	0.0782	0.0724	0.0949	0.1061	0.1079	0.1079
GAS	0.0022	0.0023	0.0022	0.0024	0.0024	0.0023	0.0022	0.0023	0.0023
OIL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTHR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.0569	0.0641	0.0764	0.0805	0.0748	0.0971	0.1083	0.1102	0.1101
WATR									
ELEC	0.0057	0.0060	0.0059	0.0065	0.0065	0.0062	0.0063	0.0067	0.0078
GAS	0.0047	0.0048	0.0047	0.0051	0.0053	0.0050	0.0048	0.0050	0.0056
OIL	0.0683	0.0640	0.0638	0.0629	0.0535	0.0514	0.0507	0.0502	0.0504
OTHR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.0787	0.0748	0.0744	0.0745	0.0653	0.0626	0.0618	0.0620	0.0638
LGHT									
ELEC	0.0984	0.1072	0.1117	0.1262	0.1231	0.1178	0.1174	0.1210	0.1235
GAS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OIL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTHR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.0984	0.1072	0.1117	0.1262	0.1231	0.1178	0.1174	0.1210	0.1235
OTHR									
ELEC	0.0270	0.0294	0.0305	0.0342	0.0349	0.0349	0.0362	0.0388	0.0411
GAS	0.0077	0.0079	0.0077	0.0081	0.0082	0.0077	0.0074	0.0074	0.0075
OIL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTHR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.0347	0.0374	0.0382	0.0423	0.0432	0.0425	0.0436	0.0462	0.0486

TABLE III-14

REGION 2 COMMERCIAL ENERGY USE BY END USE AND FUEL, 1970-1978

(10^{15} Btu)

	1970	1971	1972	1973	1974	1975	1976	1977	1978
HEAT									
ELEC	0.0090	0.0087	0.0101	0.0096	0.0126	0.0096	0.0100	0.0095	0.0108
GAS	0.1098	0.1162	0.1207	0.1144	0.1057	0.0978	0.0991	0.0999	0.1019
OIL	0.6098	0.5996	0.6114	0.6146	0.5356	0.4928	0.5829	0.5691	0.5424
OTHR	0.0071	0.0075	0.0078	0.0074	0.0076	0.0073	0.0078	0.0086	0.0102
TOTAL	0.7357	0.7320	0.7500	0.7459	0.6614	0.6074	0.6999	0.6871	0.6653
COOL									
ELEC	0.1877	0.1919	0.2160	0.2258	0.3002	0.2300	0.2384	0.2315	0.2439
GAS	0.0088	0.0091	0.0088	0.0090	0.0093	0.0088	0.0086	0.0089	0.0090
OIL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTHR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.1965	0.2010	0.2248	0.2348	0.3095	0.2388	0.2470	0.2404	0.2529
WATR									
ELEC	0.0025	0.0026	0.0025	0.0027	0.0027	0.0026	0.0027	0.0029	0.0034
GAS	0.0099	0.0103	0.0099	0.0102	0.0109	0.0103	0.0101	0.0104	0.0111
OIL	0.0650	0.0641	0.0641	0.0615	0.0532	0.0519	0.0517	0.0518	0.0509
OTHR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.0775	0.0769	0.0765	0.0744	0.0668	0.0648	0.0645	0.0651	0.0653
LGHT									
ELEC	0.2421	0.2590	0.2651	0.2866	0.2803	0.2719	0.2727	0.2834	0.2937
GAS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OIL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTHR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.2421	0.2590	0.2651	0.2866	0.2803	0.2719	0.2727	0.2834	0.2937
OTHR									
ELEC	0.0673	0.0720	0.0732	0.0780	0.0796	0.0804	0.0836	0.0900	0.0968
GAS	0.0194	0.0201	0.0193	0.0198	0.0205	0.0192	0.0187	0.0191	0.0192
OIL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTHR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.0867	0.0921	0.0925	0.0978	0.1002	0.0996	0.1023	0.1091	0.1160

TABLE III-15

REGION 3 COMMERCIAL ENERGY USE BY END USE AND FUEL, 1970-1978

(10^{15} Btu)

	1970	1971	1972	1973	1974	1975	1976	1977	1978
HEAT									
ELEC	0.0194	0.0196	0.0215	0.0204	0.0183	0.0243	0.0268	0.0278	0.0375
GAS	0.1514	0.1699	0.1878	0.1793	0.1608	0.1533	0.1799	0.1659	0.1723
OIL	0.2875	0.2849	0.2851	0.2903	0.2382	0.2071	0.2248	0.2125	0.1931
OTHR	0.0239	0.0227	0.0233	0.0210	0.0195	0.0186	0.0186	0.0185	0.0156
TOTAL	0.4823	0.4970	0.5177	0.5110	0.4368	0.4033	0.4500	0.4247	0.4186
COOL									
ELEC	0.1937	0.2056	0.2238	0.2348	0.2143	0.2788	0.3033	0.3124	0.3997
GAS	0.0094	0.0097	0.0096	0.0103	0.0109	0.0099	0.0099	0.0096	0.0099
OIL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTHR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.2031	0.2153	0.2334	0.2451	0.2252	0.2887	0.3132	0.3220	0.4096
WATR									
ELEC	0.0044	0.0044	0.0043	0.0044	0.0044	0.0041	0.0040	0.0040	0.0036
GAS	0.0078	0.0080	0.0080	0.0086	0.0093	0.0084	0.0085	0.0081	0.0087
OIL	0.0172	0.0170	0.0173	0.0167	0.0152	0.0145	0.0143	0.0142	0.0140
OTHR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.0294	0.0294	0.0296	0.0298	0.0289	0.0270	0.0268	0.0263	0.0264
LGHT									
ELEC	0.1746	0.1883	0.1998	0.2273	0.2330	0.2166	0.2169	0.2208	0.2240
GAS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OIL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTHR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.1746	0.1883	0.1998	0.2273	0.2330	0.2166	0.2169	0.2208	0.2240
OTHR									
ELEC	0.0481	0.0520	0.0548	0.0618	0.0664	0.0644	0.0672	0.0711	0.0748
GAS	0.0139	0.0144	0.0142	0.0154	0.0164	0.0147	0.0145	0.0138	0.0141
OIL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTHR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.0620	0.0664	0.0690	0.0771	0.0828	0.0791	0.0817	0.0849	0.0889

TABLE III-16

REGION 4 COMMERCIAL ENERGY USE BY END USE AND FUEL, 1970-1978

(10^{15} Btu)

	1970	1971	1972	1973	1974	1975	1976	1977	1978
HEAT									
ELEC	0.0556	0.0576	0.0498	0.0573	0.0504	0.0539	0.0633	0.0711	0.0745
GAS	0.1669	0.1749	0.1655	0.1658	0.1539	0.1631	0.1927	0.1882	0.1717
OIL	0.1138	0.1169	0.1349	0.1473	0.1498	0.1456	0.2155	0.2113	0.1933
OTHR	0.0311	0.0290	0.0308	0.0293	0.0263	0.0256	0.0270	0.0262	0.0218
TOTAL	0.3675	0.3784	0.3810	0.3996	0.3804	0.3881	0.4985	0.4969	0.4613
COOL									
ELEC	0.2535	0.2789	0.2622	0.3039	0.2829	0.2937	0.3247	0.3661	0.3666
GAS	0.0143	0.0146	0.0179	0.0179	0.0198	0.0188	0.0183	0.0184	0.0187
OIL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTHR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.2678	0.2936	0.2801	0.3218	0.3027	0.3125	0.3430	0.3845	0.3853
WATR									
ELEC	0.0083	0.0084	0.0096	0.0095	0.0100	0.0095	0.0093	0.0094	0.0092
GAS	0.0089	0.0091	0.0110	0.0109	0.0121	0.0117	0.0112	0.0111	0.0112
OIL	0.0076	0.0078	0.0099	0.0095	0.0092	0.0088	0.0087	0.0087	0.0088
OTHR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.0248	0.0253	0.0305	0.0300	0.0314	0.0300	0.0292	0.0293	0.0292
LGHT									
ELEC	0.2206	0.2417	0.3149	0.3360	0.3673	0.3453	0.3429	0.3558	0.3644
GAS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OIL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTHR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.2206	0.2417	0.3149	0.3360	0.3673	0.3453	0.3429	0.3558	0.3644
OTHR									
ELEC	0.0606	0.0666	0.0862	0.0913	0.1048	0.1031	0.1069	0.1155	0.1227
GAS	0.0178	0.0184	0.0223	0.0224	0.0250	0.0229	0.0223	0.0221	0.0220
OIL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTHR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.0784	0.0849	0.1085	0.1137	0.1297	0.1260	0.1292	0.1376	0.1448

TABLE III-17

REGION 5 COMMERCIAL ENERGY USE BY END USE AND FUEL,,1970-1978

(10^{15} Btu)

	1970	1971	1972	1973	1974	1975	1976	1977	1978
HEAT									
ELEC	0.0211	0.0204	0.0227	0.0210	0.0176	0.0208	0.0237	0.0243	0.0250
GAS	0.5994	0.6256	0.6746	0.6711	0.6877	0.6584	0.6711	0.5836	0.6498
OIL	0.3879	0.3665	0.3900	0.3743	0.3789	0.3956	0.4480	0.4371	0.4393
OTHR	0.1023	0.0972	0.1015	0.0871	0.0823	0.0784	0.0791	0.0779	0.0601
TOTAL	1.1107	1.1097	1.1888	1.1535	1.1665	1.1532	1.2219	1.1228	1.1742
COOL									
ELEC	0.3227	0.3313	0.3553	0.3739	0.3170	0.3675	0.4056	0.4140	0.4044
GAS	0.0427	0.0438	0.0434	0.0453	0.0490	0.0456	0.0445	0.0461	0.0470
OIL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTHR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.3654	0.3750	0.3987	0.4192	0.3660	0.4131	0.4501	0.4601	0.4514
WATR									
ELEC	0.0066	0.0066	0.0064	0.0064	0.0064	0.0060	0.0058	0.0057	0.0047
GAS	0.0154	0.0158	0.0156	0.0162	0.0176	0.0164	0.0159	0.0161	0.0165
OIL	0.0114	0.0116	0.0117	0.0119	0.0110	0.0106	0.0104	0.0106	0.0108
OTHR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.0334	0.0340	0.0337	0.0345	0.0350	0.0330	0.0322	0.0324	0.0321
LGHT									
ELEC	0.3586	0.3912	0.4132	0.4602	0.4978	0.4674	0.4671	0.4902	0.5018
GAS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OIL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTHR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.3586	0.3912	0.4132	0.4602	0.4978	0.4674	0.4671	0.4902	0.5018
OTHR									
ELEC	0.0984	0.1077	0.1130	0.1250	0.1421	0.1398	0.1459	0.1595	0.1698
GAS	0.0310	0.0321	0.0316	0.0330	0.0361	0.0332	0.0320	0.0326	0.0329
OIL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTHR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.1294	0.1397	0.1446	0.1580	0.1782	0.1729	0.1780	0.1921	0.2027

TABLE III-18

REGION 6 COMMERCIAL ENERGY USE BY END USE AND FUEL, 1970-1978

(10^{15} Btu)

	1970	1971	1972	1973	1974	1975	1976	1977	1978
HEAT									
ELEC	0.0045	0.0045	0.0057	0.0051	0.0047	0.0057	0.0058	0.0070	0.0088
GAS	0.2078	0.1950	0.1942	0.1873	0.1685	0.1547	0.1706	0.1867	0.2059
OIL	0.0278	0.0280	0.0462	0.0554	0.0770	0.0866	0.1013	0.1312	0.1411
OTHR	0.0144	0.0134	0.0151	0.0142	0.0126	0.0121	0.0129	0.0121	0.0105
TOTAL	0.2545	0.2409	0.2612	0.2620	0.2628	0.2592	0.2905	0.3369	0.3663
COOL									
ELEC	0.2313	0.2535	0.2919	0.2906	0.2811	0.3275	0.3259	0.3891	0.4248
GAS	0.0175	0.0179	0.0178	0.0195	0.0206	0.0184	0.0200	0.0188	0.0186
OIL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTHR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.2487	0.2714	0.3097	0.3101	0.3017	0.3459	0.3459	0.4078	0.4434
WATR									
ELEC	0.0011	0.0012	0.0011	0.0012	0.0012	0.0011	0.0012	0.0011	0.0010
GAS	0.0064	0.0065	0.0065	0.0070	0.0073	0.0065	0.0068	0.0063	0.0062
OIL	0.0010	0.0011	0.0011	0.0012	0.0011	0.0010	0.0012	0.0011	0.0012
OTHR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.0086	0.0088	0.0087	0.0094	0.0096	0.0087	0.0092	0.0086	0.0084
LGHT									
ELEC	0.1477	0.1623	0.1724	0.2031	0.2172	0.1999	0.2211	0.2113	0.2129
GAS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OIL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTHR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.1477	0.1623	0.1724	0.2031	0.2172	0.1999	0.2211	0.2113	0.2129
OTHR									
ELEC	0.0405	0.0446	0.0471	0.0551	0.0620	0.0597	0.0690	0.0685	0.0717
GAS	0.0124	0.0129	0.0127	0.0140	0.0148	0.0130	0.0138	0.0127	0.0125
OIL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTHR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.0530	0.0575	0.0598	0.0691	0.0767	0.0727	0.0827	0.0813	0.0843

TABLE III-19

REGION 7 COMMERCIAL ENERGY USE BY END USE AND FUEL, 1970-1978

(10^{15} Btu)

	1970	1971	1972	1973	1974	1975	1976	1977	1978
HEAT									
ELEC	0.0021	0.0021	0.0022	0.0020	0.0015	0.0022	0.0029	0.0032	0.0039
GAS	0.1708	0.1765	0.1867	0.1677	0.1687	0.1731	0.1861	0.1744	0.1726
OIL	0.0594	0.0534	0.0586	0.0585	0.0553	0.0567	0.0676	0.0671	0.0746
OTHR	0.0128	0.0123	0.0128	0.0117	0.0114	0.0109	0.0109	0.0104	0.0086
TOTAL	0.2451	0.2443	0.2604	0.2399	0.2368	0.2428	0.2676	0.2550	0.2597
COOL									
ELEC	0.1173	0.1230	0.1290	0.1256	0.0991	0.1380	0.1842	0.2004	0.2130
GAS	0.0118	0.0121	0.0120	0.0130	0.0147	0.0130	0.0131	0.0125	0.0126
OIL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTHR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.1291	0.1351	0.1410	0.1386	0.1137	0.1510	0.1973	0.2129	0.2257
WATR									
ELEC	0.0007	0.0007	0.0007	0.0007	0.0008	0.0007	0.0007	0.0007	0.0005
GAS	0.0037	0.0038	0.0038	0.0040	0.0045	0.0040	0.0040	0.0038	0.0038
OIL	0.0017	0.0017	0.0018	0.0018	0.0017	0.0016	0.0016	0.0016	0.0016
OTHR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.0062	0.0063	0.0062	0.0065	0.0070	0.0063	0.0063	0.0060	0.0060
LGHT									
ELEC	0.0861	0.0934	0.0994	0.1149	0.1305	0.1169	0.1197	0.1187	0.1187
GAS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OIL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTHR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.0861	0.0934	0.0994	0.1149	0.1305	0.1169	0.1197	0.1187	0.1187
OTHR									
ELEC	0.0236	0.0257	0.0272	0.0313	0.0373	0.0350	0.0375	0.0388	0.0403
GAS	0.0074	0.0076	0.0075	0.0081	0.0094	0.0082	0.0082	0.0077	0.0077
OIL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTHR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.0310	0.0334	0.0347	0.0394	0.0467	0.0432	0.0456	0.0464	0.0480

TABLE III-20

REGION 8 COMMERCIAL ENERGY USE BY END USE AND FUEL, 1970-1978

(10^{15} Btu)

	1970	1971	1972	1973	1974	1975	1976	1977	1978
HEAT									
ELEC	0.0019	0.0019	0.0019	0.0017	0.0014	0.0017	0.0012	0.0015	0.0018
GAS	0.0874	0.0884	0.0921	0.0928	0.0875	0.0956	0.1006	0.0929	0.0900
OIL	0.0387	0.0406	0.0439	0.0498	0.0613	0.0659	0.0714	0.0624	0.0742
OTHR	0.0109	0.0108	0.0107	0.0104	0.0095	0.0093	0.0088	0.0082	0.0068
TOTAL	0.1389	0.1416	0.1486	0.1547	0.1597	0.1725	0.1820	0.1649	0.1729
COOL									
ELEC	0.0591	0.0620	0.0661	0.0671	0.0588	0.0670	0.0542	0.0648	0.0734
GAS	0.0071	0.0073	0.0077	0.0082	0.0094	0.0083	0.0094	0.0087	0.0087
OIL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTHR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.0662	0.0693	0.0738	0.0753	0.0682	0.0753	0.0636	0.0736	0.0821
WATR									
ELEC	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0004
GAS	0.0016	0.0017	0.0017	0.0018	0.0021	0.0018	0.0020	0.0019	0.0018
OIL	0.0009	0.0009	0.0009	0.0010	0.0010	0.0009	0.0010	0.0010	0.0010
OTHR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.0029	0.0030	0.0031	0.0033	0.0036	0.0032	0.0035	0.0033	0.0032
LGHT									
ELEC	0.0407	0.0446	0.0501	0.0577	0.0681	0.0604	0.0684	0.0656	0.0657
GAS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OIL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTHR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.0407	0.0446	0.0501	0.0577	0.0681	0.0604	0.0684	0.0656	0.0657
OTHR									
ELEC	0.0112	0.0123	0.0137	0.0157	0.0195	0.0181	0.0214	0.0214	0.0223
GAS	0.0032	0.0034	0.0035	0.0038	0.0044	0.0038	0.0043	0.0039	0.0038
OIL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTHR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.0144	0.0157	0.0172	0.0195	0.0239	0.0219	0.0257	0.0254	0.0262

TABLE III-21

REGION 9 COMMERCIAL ENERGY USE BY END USE AND FUEL, 1970-1978

(10^{15} Btu)

	1970	1971	1972	1973	1974	1975	1976	1977	1978
HEAT									
ELEC	0.0207	0.0224	0.0249	0.0240	0.0203	0.0322	0.0289	0.0312	0.0314
GAS	0.2222	0.2118	0.2075	0.2079	0.2054	0.2211	0.2075	0.2130	0.2026
OIL	0.0389	0.0522	0.0753	0.0977	0.0785	0.0579	0.0672	0.0727	0.0845
OTHR	0.0062	0.0073	0.0066	0.0074	0.0069	0.0070	0.0060	0.0064	0.0064
TOTAL	0.2880	0.2936	0.3143	0.3370	0.3111	0.3182	0.3097	0.3233	0.3250
COOL									
ELEC	0.3129	0.3201	0.3809	0.3721	0.3303	0.4906	0.5194	0.5347	0.5459
GAS	0.0178	0.0185	0.0181	0.0197	0.0204	0.0189	0.0192	0.0185	0.0185
OIL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTHR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.3306	0.3386	0.3990	0.3918	0.3507	0.5095	0.5386	0.5532	0.5644
WATR									
ELEC	0.0020	0.0020	0.0020	0.0021	0.0021	0.0020	0.0021	0.0020	0.0019
GAS	0.0093	0.0096	0.0094	0.0101	0.0105	0.0097	0.0096	0.0091	0.0090
OIL	0.0015	0.0015	0.0015	0.0016	0.0015	0.0014	0.0014	0.0014	0.0015
OTHR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.0127	0.0132	0.0129	0.0139	0.0141	0.0131	0.0131	0.0125	0.0124
LGHT									
ELEC	0.2065	0.2278	0.2357	0.2710	0.2752	0.2619	0.2693	0.2602	0.2559
GAS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OIL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTHR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.2065	0.2278	0.2357	0.2710	0.2752	0.2619	0.2693	0.2602	0.2559
OTHR									
ELEC	0.0568	0.0628	0.0645	0.0736	0.0783	0.0778	0.0832	0.0832	0.0845
GAS	0.0169	0.0178	0.0172	0.0188	0.0196	0.0178	0.0178	0.0168	0.0165
OIL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTHR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.0736	0.0805	0.0817	0.0924	0.0978	0.0955	0.1010	0.1000	0.1010

TABLE III-22

REGION 10 COMMERCIAL ENERGY USE BY END USE AND FUEL, 1970-1978

(10^{15} Btu)

	1970	1971	1972	1973	1974	1975	1976	1977	1978
HEAT									
ELEC	0.0437	0.0465	0.0592	0.0567	0.0512	0.0589	0.0569	0.0625	0.0659
GAS	0.0746	0.0890	0.1022	0.1053	0.1049	0.1163	0.1050	0.0975	0.0872
OIL	0.0618	0.0673	0.0733	0.0624	0.0565	0.0428	0.0313	0.0346	0.0367
OTHR	0.0040	0.0043	0.0042	0.0042	0.0040	0.0041	0.0039	0.0039	0.0037
TOTAL	0.1841	0.2071	0.2390	0.2286	0.2166	0.2221	0.1971	0.1985	0.1935
COOL									
ELEC	0.0636	0.0691	0.0894	0.0951	0.0919	0.1015	0.1067	0.1135	0.1217
GAS	0.0028	0.0029	0.0029	0.0031	0.0034	0.0033	0.0034	0.0032	0.0032
OIL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTHR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.0664	0.0720	0.0923	0.0982	0.0952	0.1048	0.1101	0.1166	0.1248
WATR									
ELEC	0.0048	0.0048	0.0047	0.0050	0.0053	0.0053	0.0055	0.0053	0.0053
GAS	0.0020	0.0021	0.0021	0.0024	0.0027	0.0027	0.0029	0.0027	0.0029
OIL	0.0042	0.0043	0.0043	0.0043	0.0038	0.0037	0.0037	0.0035	0.0034
OTHR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.0109	0.0112	0.0111	0.0116	0.0118	0.0117	0.0121	0.0115	0.0115
LGHT									
ELEC	0.0487	0.0534	0.0561	0.0650	0.0715	0.0702	0.0745	0.0713	0.0719
GAS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OIL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTHR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.0487	0.0534	0.0561	0.0650	0.0715	0.0702	0.0745	0.0713	0.0719
OTHR									
ELEC	0.0134	0.0147	0.0154	0.0177	0.0204	0.0211	0.0234	0.0234	0.0246
GAS	0.0041	0.0043	0.0042	0.0046	0.0051	0.0048	0.0049	0.0046	0.0045
OIL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTHR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.0175	0.0190	0.0195	0.0223	0.0255	0.0259	0.0283	0.0280	0.0291

IV. CONSERVATION AND SOLAR TECHNOLOGIES IN COMMERCIAL BUILDINGS

A tremendous potential for energy conservation exists both in new and existing commercial buildings. No comprehensive data base exists to statistically substantiate this potential or its size; however, a growing number of case studies and engineering analyses clearly indicate a large potential. For instance, a sample of retrofit conservation programs developed by Ross (1980) shows an average savings of 16 percent and maximum savings of up to 75 percent resulting from a variety of conservation measures taken for the twenty case studies reported. Hirst (1980) found average savings of 28 percent in electricity use for forty-one buildings audited in Minnesota. Savings of 51 percent were reported for fossil fuels. EBASCO Services, Incorporated (1980) provides retrofits to commercial buildings with guaranteed savings. Information on seven retrofit cases showed guaranteed energy savings of 44 percent for fossil fuel use and 21 percent for electricity.

A number of conservation measures requiring limited capital investment can be implemented in both new and existing commercial buildings. None of these measures requries a deterioration of space conditioning characteristics during occupied hours. These measures include[1/]

Thermostat Setback (night and weekend shutdown).

Many heating, ventilating and air conditioning (HVAC) systems operate continuously as temperatures in building zones vary between upper and lower set limits. When the temperature reaches or exceeds the maximum temperature, maximum cooling occurs and when the temperature drops below the minimum set point, maximum heating occurs. A linear variation of heating or cooling occurs between the high and low temperature settings. An on-off control implemented at night and weekends, however, can prohibit heating or cooling as long as the zone temperature is within preset limits. The only restriction on the on-off thermostat set points requires a lower set point that precludes freezing temperatures in any zone.

[1/] This discussion is based on Johnson and Pierce (1980).

Reduced Lighting.

The Handbook of the Illuminating Engineering Society (1966) has for many years suggested lighting levels that provide from two to three times the illumination levels now recognized as sufficient. Removal of lamps and replacement by lower wattage bulbs can reduce lighting energy use significantly. Reduction by as much as 20 percent can be implemented with no perceptable change in illumination levels in most areas of commercial buildings. While reduced lighting levels require somewhat more space heating because of loss of heat, savings in air conditioning energy use more than offset this increase in heating energy use.

Reduced Ventilation.

The level of ventilation has a significant impact on HVAC energy use since outside air temperatures must be increased or reduced to meet desired temperatures of inside air. Ventilation levels are typically greatly in excess of the minimum required ventilation rate.

Other Measures.

Other measures which typically provide smaller savings (after the three measures described above are taken into account) include internal shading of windows with curtains or blinds, an economizer cycle which uses outside air that is more suitable for use in the HVAC system than internal air from return air ducts, and reseting of deck temperatures on the HVAC system.

In addition to the conservation measures listed above, new buildings offer additional opportunities for reducing the level of energy use through the use of more efficient building shell desing. An analysis of the ASHRAE 90/75 standard by Arthur D. Little (1976) indicates that savings in HVAC systems costs more than offsets increased cost of new structures. By reducing energy use requirements of the building, a smaller less expensive HVAC system can be installed. Total cost savings were estimated to be up to 2 percent of total building cost.

An analysis of energy savings for four prototype buildings (hospital,

office, educational and retail) was recently completed by Johnson and Pierce (1980). Each of the energy conserving features described above was evaluated using an engineering buildings energy use simulation program called NECAP (1975). Figures IV-1 through IV-8 show savings resulting from conservation programs for both existing buildings and buildings which approximate those suggested by the ASHRAE 90/75 recommendations. Cummulative savings resulting from thermostat setback and reduced ventilation and lighting levels range from 30 percent for hospitals to 49 percent in offices for existing buildings. Savings for new buildings range from 32 to 56 percent for hospitals and office buildings respectively.

Table IV-1 shows base case conventional energy use requirements for the four buildings as well as energy use after implementation of these conservation measures in both existing and new buildings. Savings resulting from both a change in construction practices and an implementation of the conservation measures reflect reduction in energy use from 36 to 63 percent. Incorporation of these conservation measures is extremely cost effective. Payback periods of well under one year are achieved from these measures for most regions in the country. The reason for these rapid paybacks is the large energy savings and the very limited cost of HVAC controls and modification to ventilation and lighting system. While many buildings have obviously undertaken these measures as indicated in Section II by the reduced energy intensity figures and by the case studies cited earlier in this section; much of the potential is unrealized because of the slowness in changing old patterns of operation and because of the lack of awareness of the extent of energy savings achieveable by undertaking such conservation measures.

In addition to these low cost operations-related conservation measures, considerable conservation potential exists for improving the efficiency of equipment used in commercial buildings. A recent study by Lyman (1978) of HVAC systems indicates retrofit savings in older buildings (i.e., pre embargo) of up to 49 percent by installing reset controls, double bundle heat exchangers and exhaust air heat recovery. These investments reflect payback periods of three years or less. In newer HVAC systems, the addition of double bundle exchangers and exhaust air heat recovery provided savings of about 15 percent; the payback for these investments is considerably longer, however. Lyman's analysis was also conducted with the NECAP buildings energy

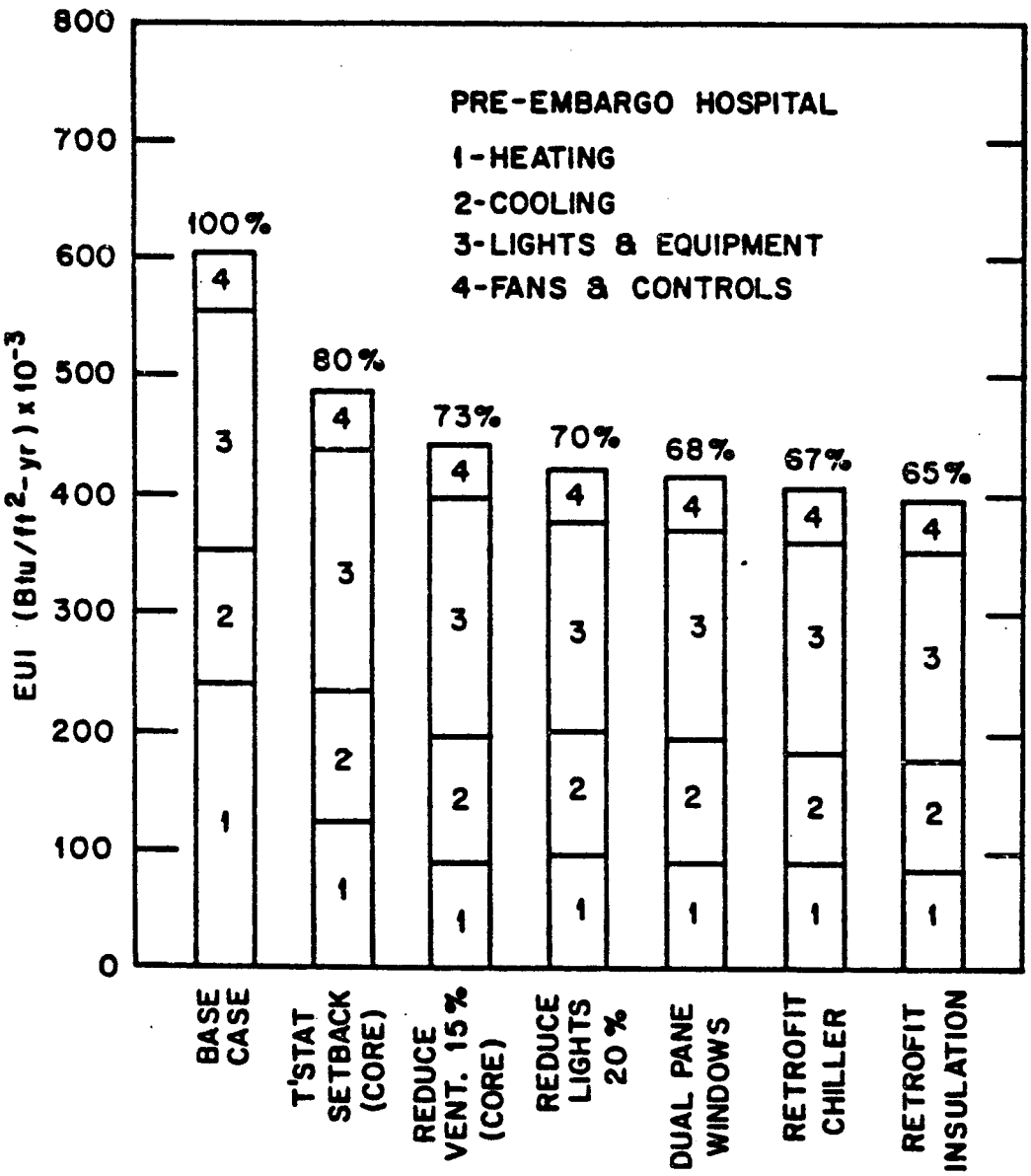


FIGURE IV-1. ENERGY USE IMPACTS OF CONSERVATION MEASURES -- PRE-EMBARGO HOSPITAL

Source: Johnson and Pierce (1980)

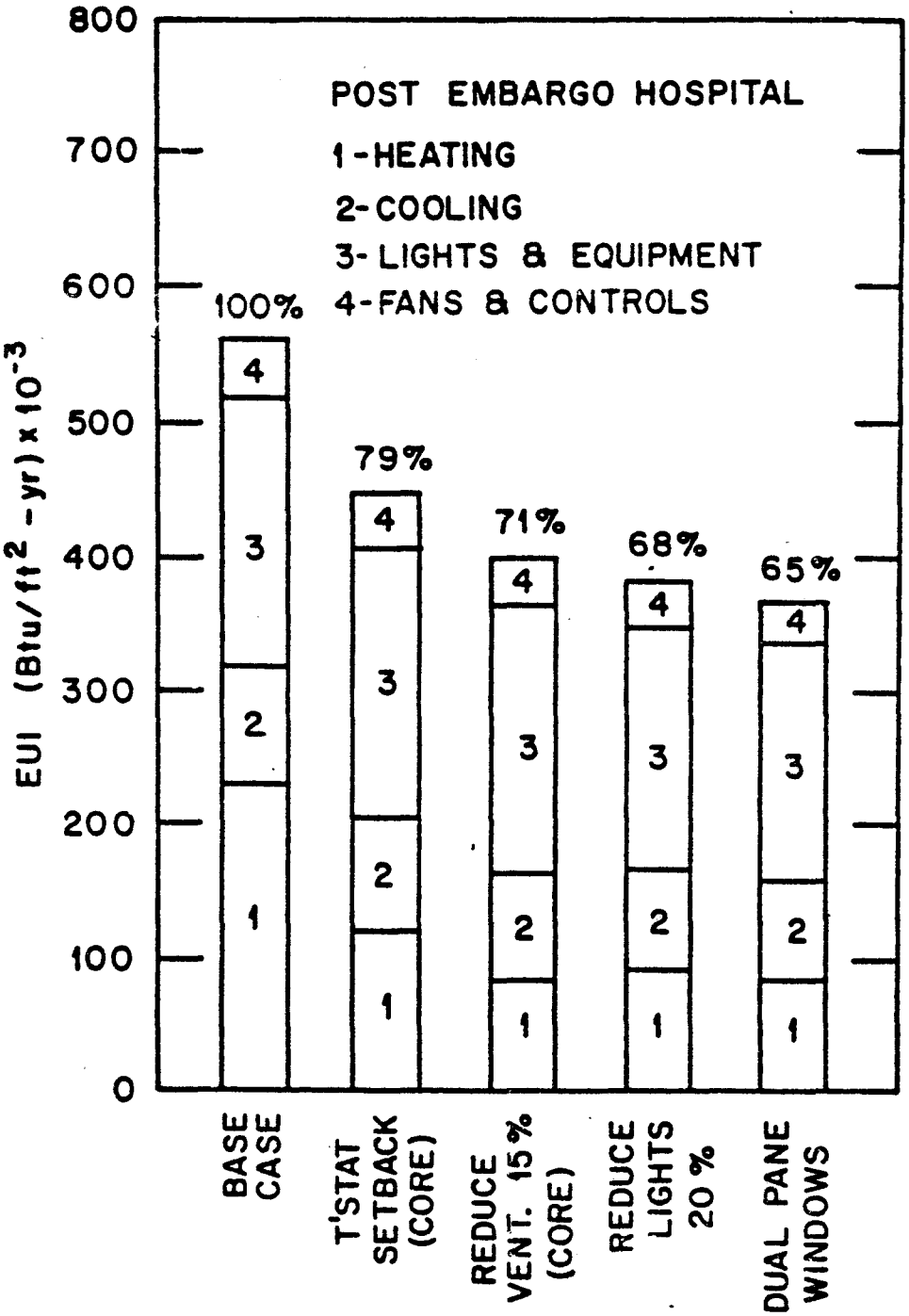


FIGURE IV-2. ENERGY USE IMPACTS OF CONSERVATION MEASURES -- POST-EMBARGO HOSPITAL

Source: Johnson and Pierce (1980)

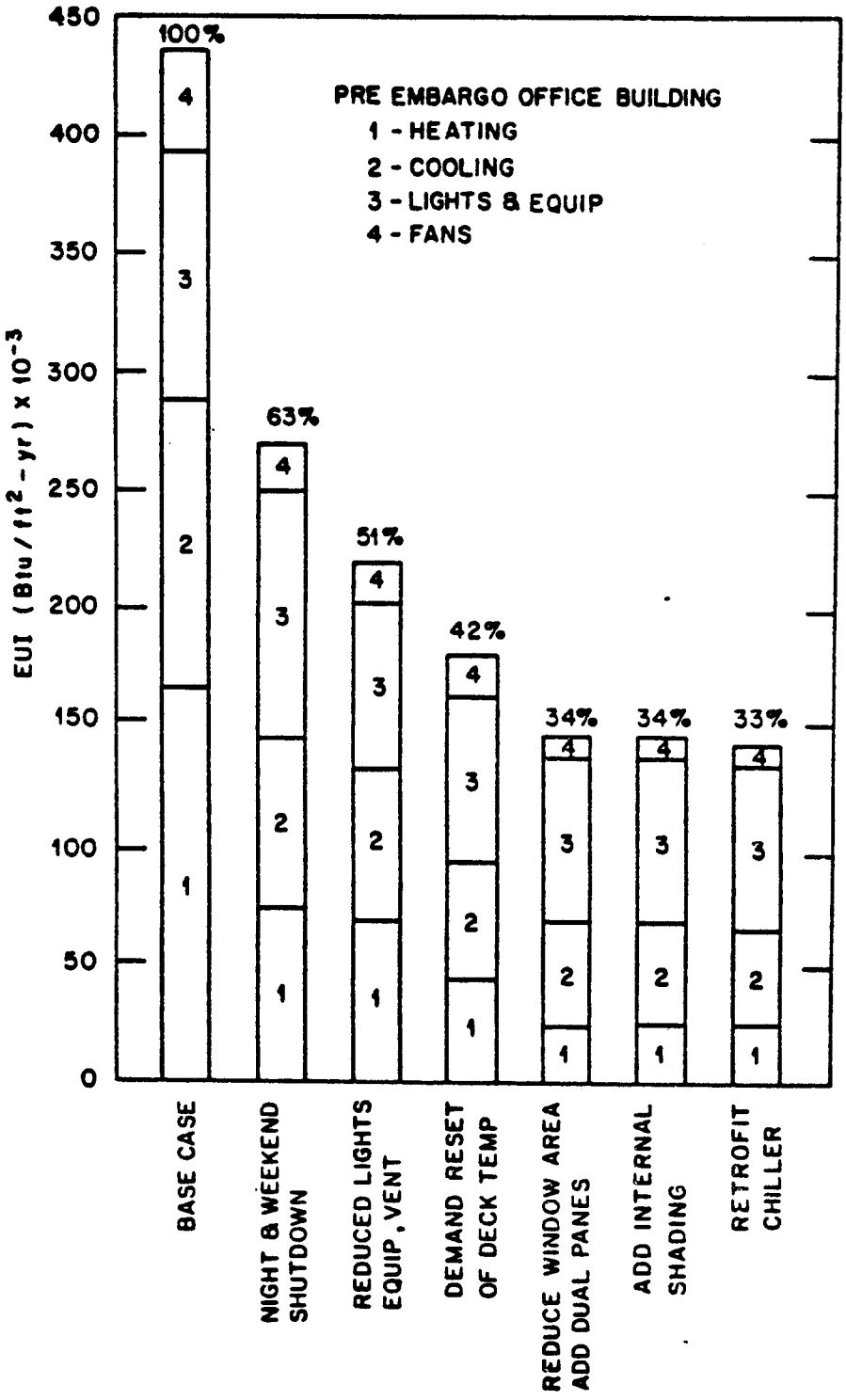


FIGURE IV-3. RESULTS OF CONSERVATION MEASURES -- PRE-EMBARGO OFFICE BUILDING

Source: Johnson and Pierce (1980)

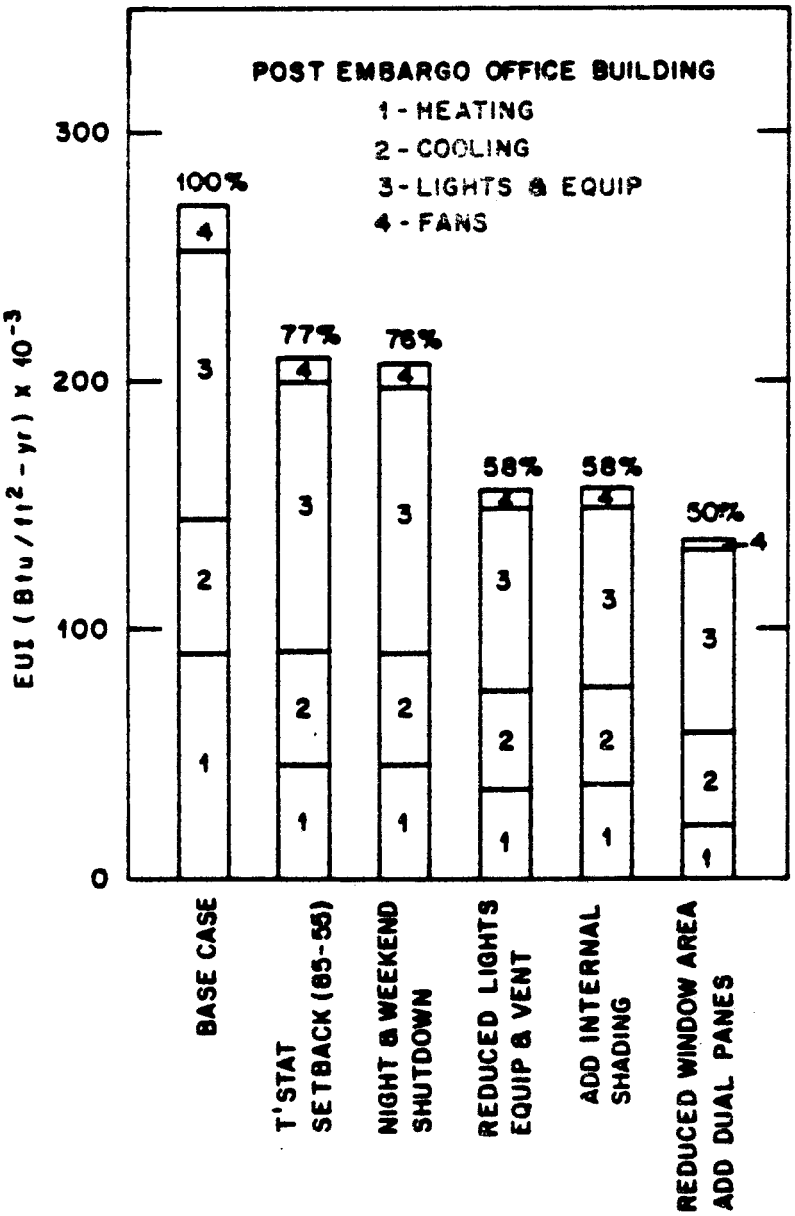


FIGURE IV-4. RESULTS OF CONSERVATION MEASURES -- POST-EMBARGO OFFICE BUILDING

Source: Johnson and Pierce (1980)

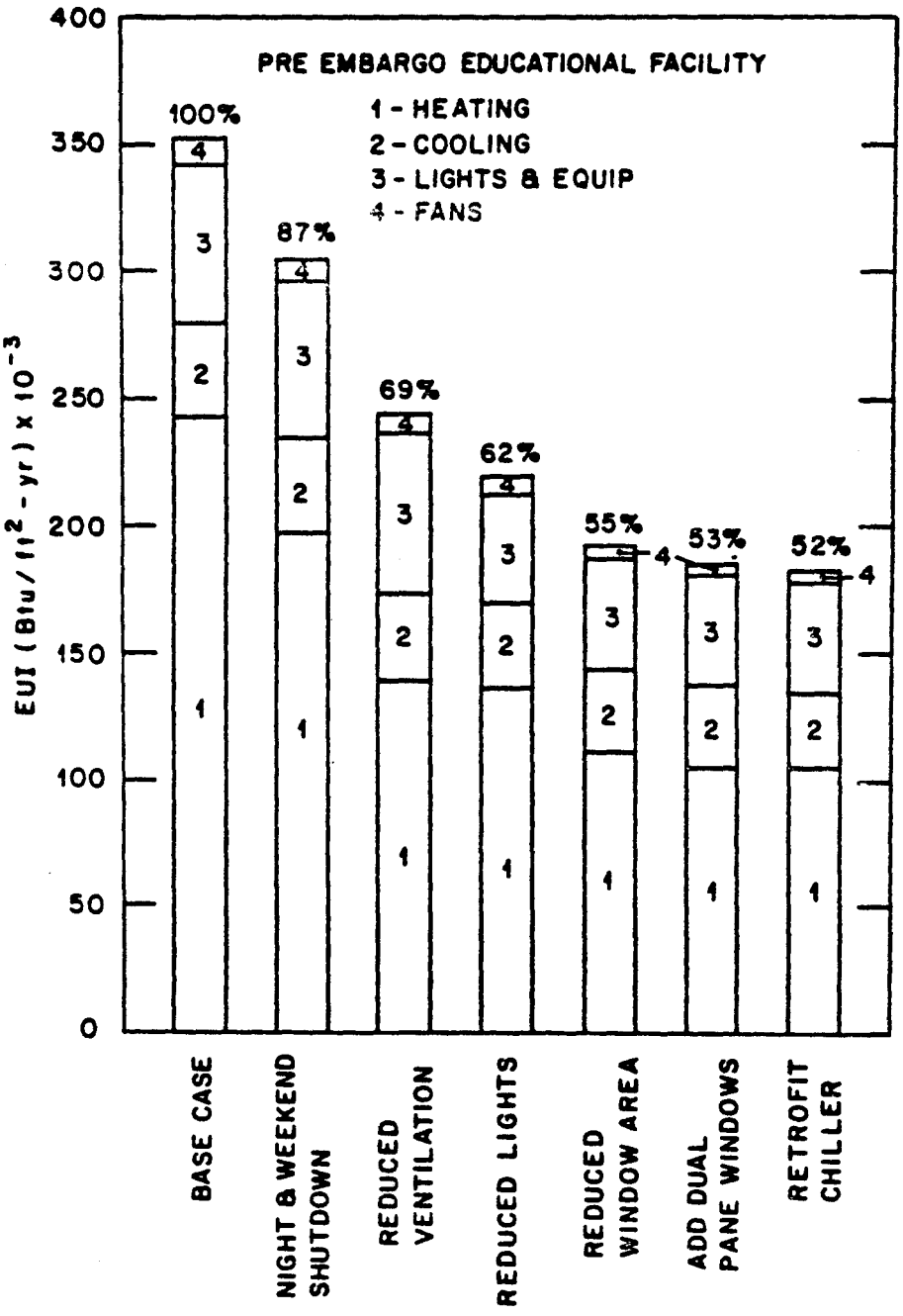


FIGURE IV-5. RESULTS OF CONSERVATION MEASURES -- PRE-EMBARGO EDUCATIONAL FACILITY

Source: Johnson and Pierce (1980)

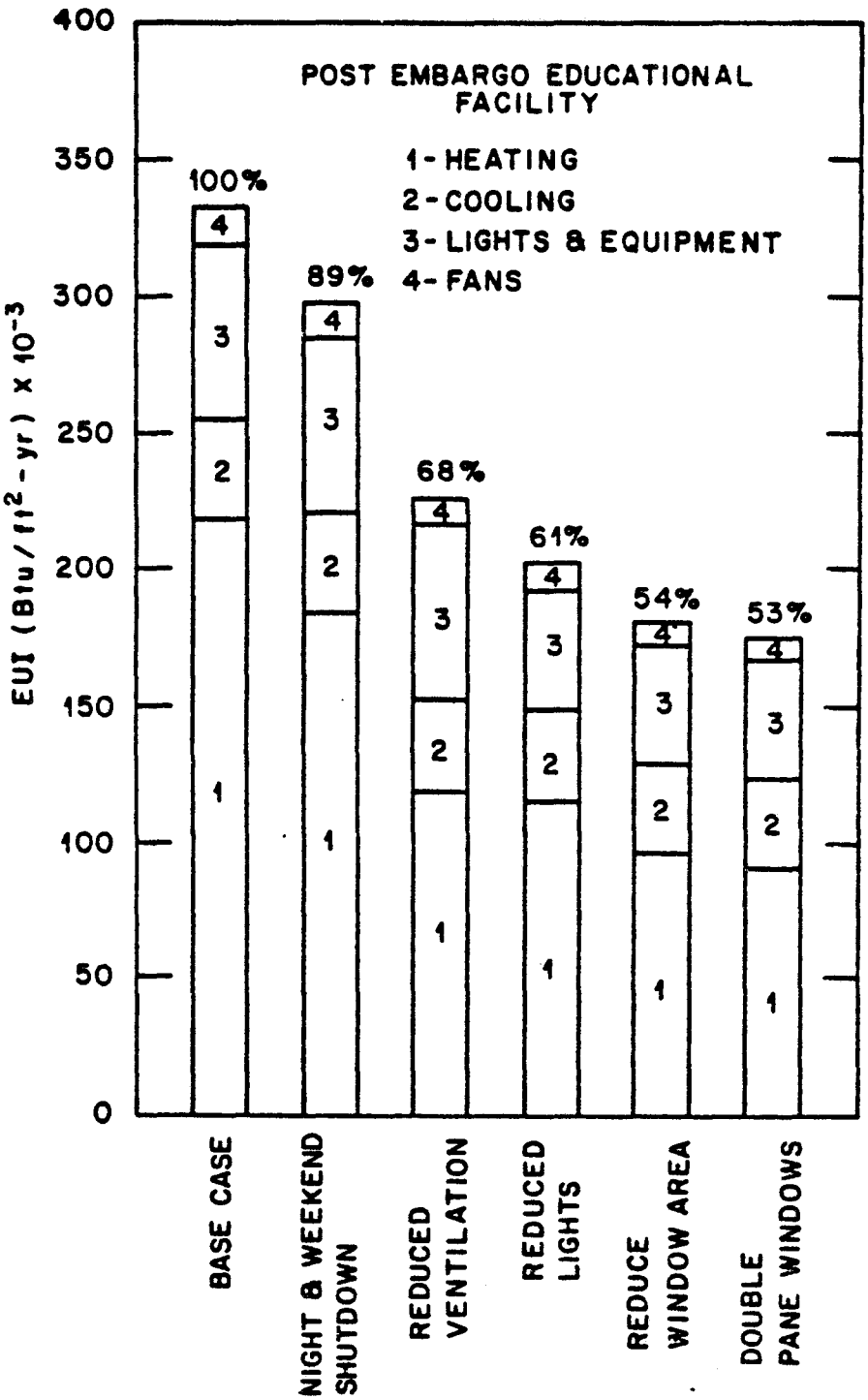


FIGURE IV-6. RESULTS OF CONSERVATION MEASURES -- POST-EMBARGO EDUCATIONAL FACILITY

Source: Johnson and Pierce (1980)

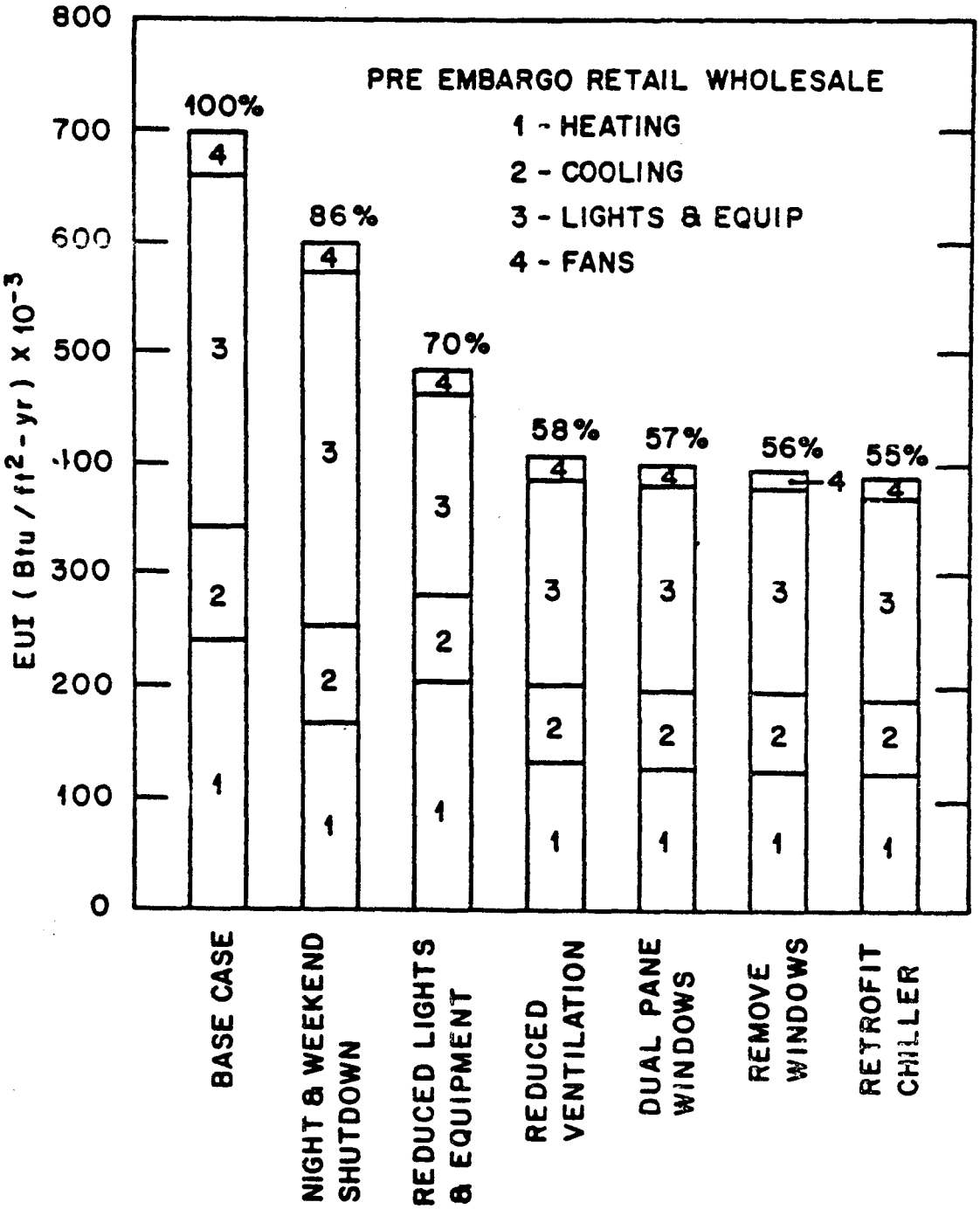


FIGURE IV-7. RESULTS OF CONSERVATION MEASURES -- PRE-EMBARGO RETAIL BUILDING

Source: Johnson and Pierce (1980)

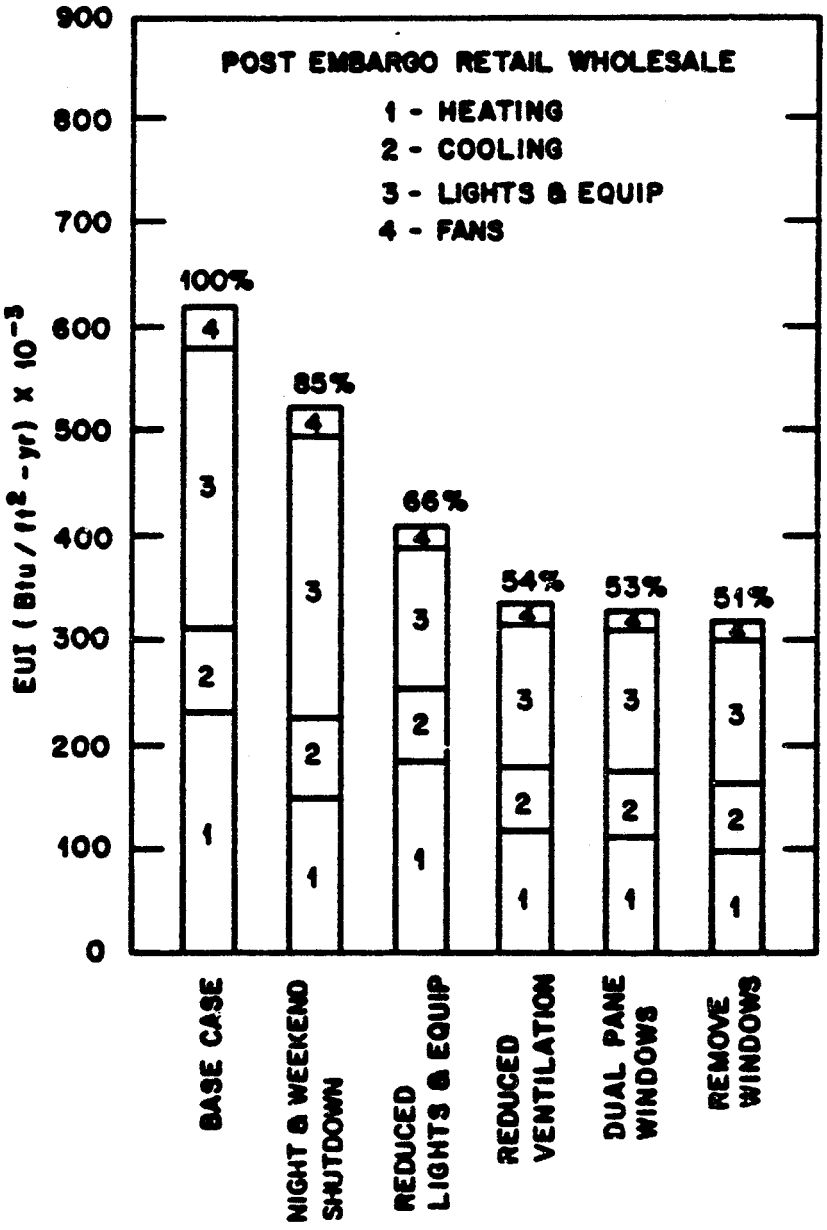


FIGURE IV-8. RESULTS OF CONSERVATION MEASURES -- POST-EMBARGO RETAIL BUILDING

Source: Johnson and Pierce (1980)

Table IV-1
Impacts of Conservation on
Energy Use in Commercial Buildings

Building Type	Base Case Energy Use	10^3 Btu/ft^2/yr. Existing Retrofit	New Retrofit
Hospital	600	400	380
Office	436	183	157
School	357	221	203
Retail	700	406	336

*Source: Johnson and Pierce (1980), numbers estimated from Figures

use simulation program. Representative results are shown for offices in Figure IV-9.

The studies cited here concerning conservation potential in building construction practices, operations-related measures and equipment efficiency increases indicate a tremendous overall potential for conservation in the commercial sector. Case studies and observations on the relationship between aggregate energy use and floor space confirm that some of the potential has been achieved. These studies as well as our analysis of alternative commercial energy futures in a later section suggest that only a small part of the potential is currently realized.

Another means of conserving energy relies on care in designing commercial buildings to maximize solar energy absorbed in the winter and to minimize absorbed energy in the summer. Building orientation, overhangs which permit winter sunlight but block summer sun, window shading with blinds or shutters, and use of massive construction materials are the most common characteristics of buildings incorporating passive solar design. The skillful use of these passive solar techniques can, under the right conditions, reduce space heating and cooling requirements close to zero.

Active solar systems include components that are not integral parts of the building structure. Most active solar systems utilize solar collectors which use solar energy to heat a fluid such as water or air. When the working fluid is air, bins of rocks are used to store excess heat for use when sunlight is not available. If water is the working fluid large water tanks are used to store excess thermal energy. Active systems use pumps or fans to move the heated fluid from the collection area to the storage area. A heat exchanger is used to heat air for space heating or water for water heating. In the case of air conditioning, the thermal energy of the working fluid is used directly in an absorption air conditioning unit. Depending on the system, a varying amount of heat from other fuels must be added to reach temperatures required in the absorption cycle.

To provide energy for end uses other than space heating, water heating and cooling, solar electric systems are required.[1/] Electricity can be

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[1/] Solar energy in the form of natural lighting can also be used to reduce use of electricity in providing lighting in buildings.

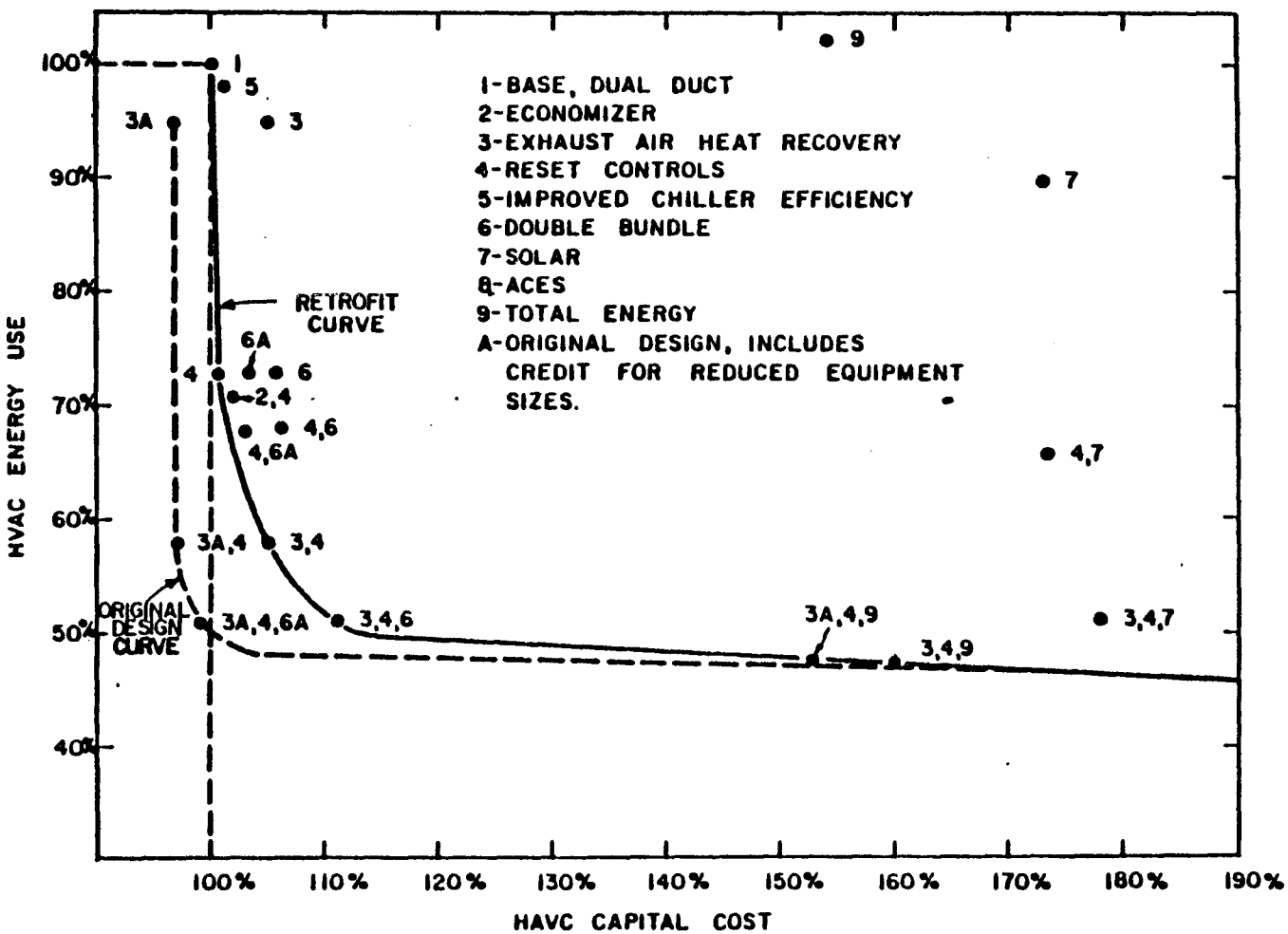

FIGURE IV-9. HVAC ENERGY USE VS. CAPITAL COST FOR GAS HEAT AND ELECTRIC COOLING IN OFFICE WITH DUAL DUCT

generated from heated fluids that operate heat engines (such as steam turbines) to generate electricity, or from photovoltic cells. Photovoltic cells convert sunlight directly to electricity. At present, both of these approaches are so expensive that they are not practical if electricity can be purchased directly from a utility.

While the statements above describe several generic approaches to utilizing solar energy in providing end use services, the opportunity for variations in design are almost unlimited. This heterogeneity of designs along with the present negligible use of active solar systems in commercial buildings makes it extremely difficult to evaluate the cost and energy use of prototype commercial active solar systems.[2/] Nevertheless, a numbr of studies have been conducted to estimate the cost and performance of active solar systems in commercial buildings. We have used two such studies (Arthur D. Little (1976) and Mitre Corporation (Rebibo (1979); Taul and deJong (1980)) along with independent engineering analysis to develop cost estimates for three prototype solar systems including solar hot water, solar hot water and heating, solar hot water, heating and air conditioning. We chose prototype configuration similar to those in the Arthur D. Little study. The water heating system uses a small flat plate collector, piping, a pump, thermal storage tank and two heat exchangers. The water and space heating system is similar to the water heating system except that pipes and valves were added to connect the thermal storage to the conventional system. The combined water heating, space heating and air conditioning system utilizes an absorption air conditioning system and a more advanced collector system for generating the higher temperatures needed in the absorption cycle. System specifications were such that 50 percent of energy required to serve each end use was provided by solar. Table IV-2 shows the 1975 initial and life cycle cost of the hot water and heating and the hot water, heating and air conditioning systems for 1975 relative to the life cycle cost of conventional systems. The fuels used in the calculations were either oil or electricity, whichever provided the least costly system. We did not use gas prices in these calculations because gas prices were (and are now) artificially low, in large part

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[2/] Unlike the residential sector, so little use has been made of active solar systems that many if not most active systems currently in commercial buildings are best described as experimental.

because of price controls and the restrictions on hookups that existed at the time.[3/] Arthur D. Little's regional variations in cost were used to reflect cost differences arising from variations in the amount of solar energy reaching collectors across regions.

The figures in Table IV-2 show solar heating and water heating systems possessing life cycle costs in 1975 of from 18 percent to 89 percent greater than conventional systems. Solar systems combining all three end uses reflect life costs that range from 27 percent to 127 percent greater than the alternative conventional systems. The initial costs of these two solar systems varies from about two to five times the costs of conventional systems. Water heating systems reflected relative life cycle costs that varied little across regions from the 2.4 average. Initial costs for the solar water heating systems were close to five times the cost of a conventional system. A discount rate of 18 percent and annual maintenance costs of 2 percent of conventional and 3 percent of solar systems initial costs were used in calculating the life cycle costs.[4/] In addition, a real (i.e., inflation adjusted) fuel price increase of 4 percent per year was used to reflect escalating operating costs expected over the lifetime of the systems. Regional end use energy use requirements developed from end use energy use estimates (Appendix A) and regional floorspace stock estimates are used in calculating operating costs for the solar systems. Regional variations in the solar systems reflect both the attractiveness of the region in terms of solar radiation characteristics and price of the fuel displaced by the system. As indicated in Section VII of this report, fuel prices expected in the 1990's make solar systems much more competitive with conventional systems.

[3/] Relative life cycle cost would appear approximately the same using 1978 prices because of the modest increase (and in some cases, a decrease) experienced in most regions for electricity and oil.

[4/] An 18 percent discount rate is substantially greater than the opportunity cost of funds invested in solar systems. Information from industry sources suggests, however, that a greater discount rate is used in evaluating conservation options than in evaluating other investments. This observation is consistant with the fact that, for instance, a mild winter following the conservation investment may change a reasonable first year expected rate of return on the investment to a negligable return. In addition, investments in other areas frequently fulfill other objectives such as increasing share of the market.

Table IV-2

Initial and Life Cycle Costs of Solar Systems
Relative to Conventional Systems, 1975

Region	Space Heating/Water Heating		Cooling/ Space Heating/Water Heating	
	Initial Cost	Life Cycle Cost	Initial Cost	Life Cycle Cost
1	4.41	1.82	3.25	1.68
2	3.95	1.74	3.23	1.55
3	3.53	1.64	3.35	1.73
4	2.25	1.24	4.33	2.27
5	4.42	1.79	3.25	1.79
6	2.04	1.18	3.34	1.89
7	3.84	1.89	3.08	1.74
8	5.06	1.81	3.21	1.72
9	2.30	1.19	3.28	1.75
10	3.87	1.62	4.21	2.31

Note: Life cycle cost calculations on 18 percent discount rate, an annual maintenance cost of 2 percent of initial cost for conventional and 3 percent for solar and an expected real fuel price increase of 4 percent per year.

V. END USE HOURLY LOAD PROFILES IN COMMERCIAL BUILDINGS

Daily variations in energy use result in utility load curves that show a significant peak. To meet demand of their customers and to minimize costs, utilities employ large efficient baseload generating units to provide the non-peaking portion of load; older, less efficient units and special fossil fuel-fired peaking units are brought on line to cover peak period demands. The reduction of peak demand can significantly alter both the cost of producing electricity and the environmental externalities of higher production levels in two ways. First, to the extent that the daily and seasonal peaks can be reduced, electricity can be produced with more efficient, less costly and cleaner base load generating equipment. Second, to the extent that the historical growth of peak demand can be reduced, fewer new, more expensive, generating units must be added and used in the future.

The topics of the previous section can contribute in significant ways to reducing the current level and growth of peak demand. To understand the way in which these topics are related it is useful to examine end use load curves for several commercial buildings. While some limited information does exist on end use load patterns, available data were too scanty to provide real insight into this issue.[1/] Therefore, buildings simulation models were used to estimate end use load curves. Figures V-1 through V-3 show hourly load profiles for a 40,500 ft^2 office building in Knoxville, Phoenix, and Minneapolis.[2/] The curves are drawn in a commulative fashion so that, for instance, the curve marked summer, reflects summer demand resulting from lighting, other equipment and air conditioning. Several observations can be made concerning these office building hourly load profiles. First, the summer peak does not differ substantially across the three cities. The reason for this is the fact that air conditioning loads, which reflect the only weather sensitive component of the summer peak are determined primarily by internal load generated by lighting equipment and people in the building.

[1/] See Mathtech (1978) for a most comprehensive collection of load curve data and references.

[2/] This analysis was conducted by William J. Johnson using building characteristics described in Johnson and Pierce (1980).

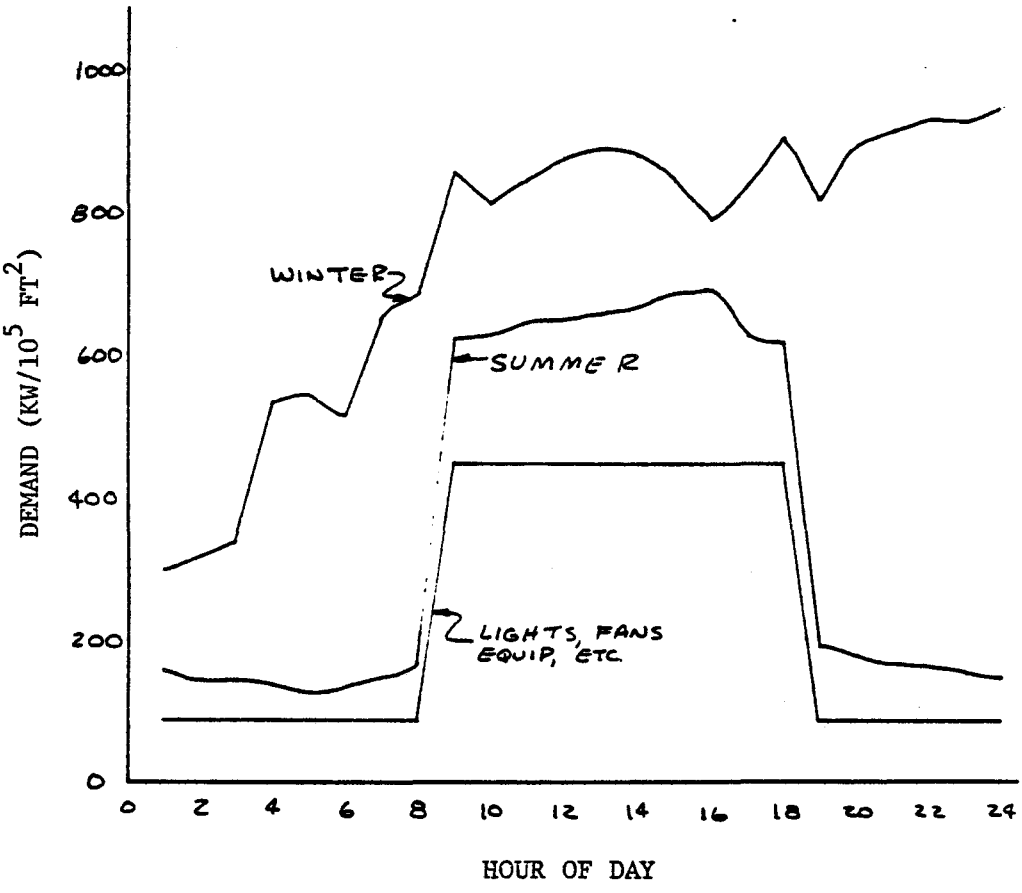


FIGURE V-1. HOURLY LOAD CURVES FOR
OFFICE BUILDING IN KNOXVILLE

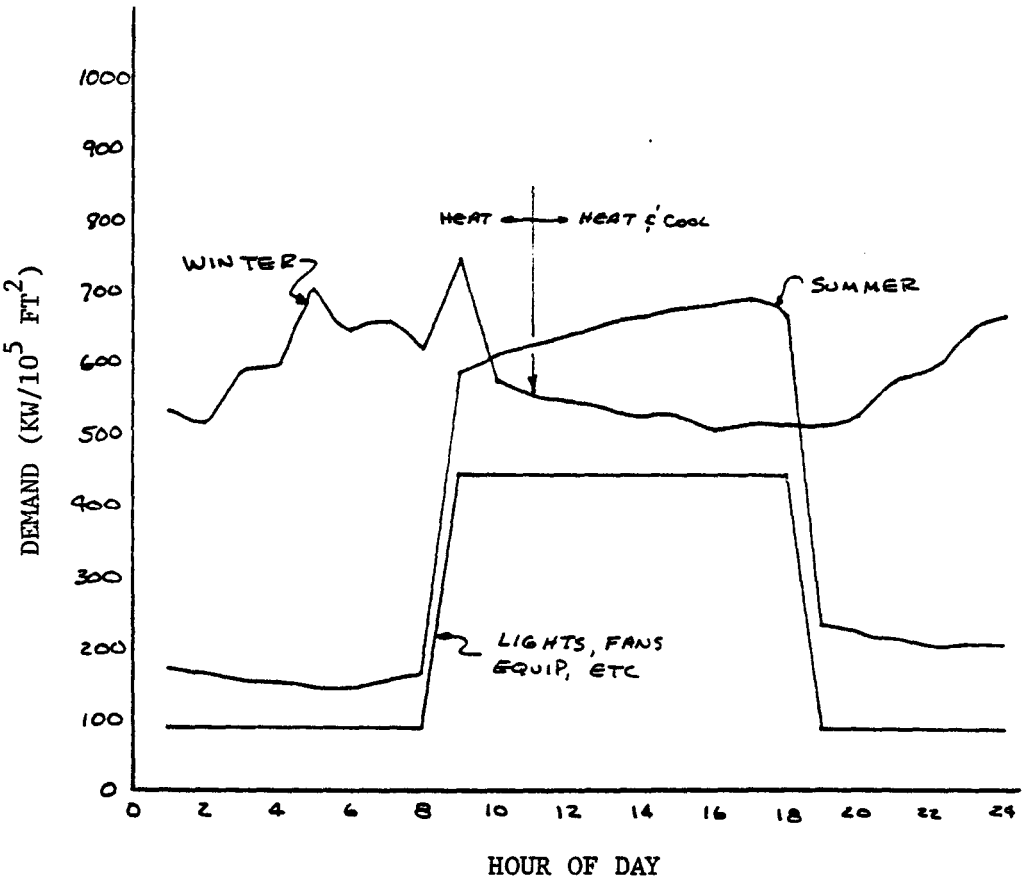


FIGURE V-2. HOURLY LOAD CURVES FOR
OFFICE BUILDING IN PHOENIX

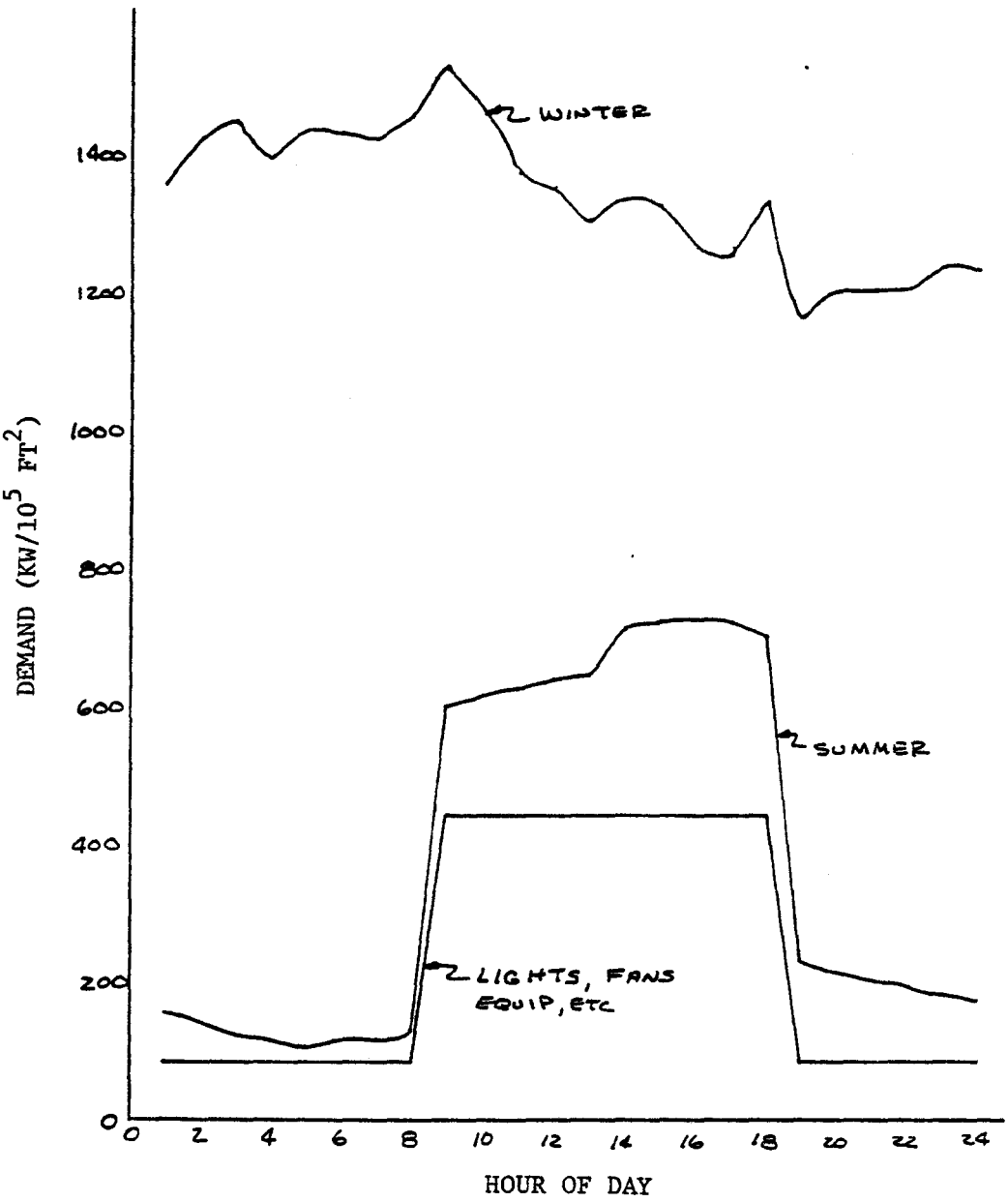


FIGURE V-3. HOURLY LOAD CURVES FOR OFFICE BUILDING IN MINNEAPOLIS

While outside temperature is a factor it is not nearly as important as internal loads. Secondly, lighting energy use, while not weather sensitive, contributes more to summer peak demand than air conditioning loads. Third, the ratio between summer peak demand and early morning or late night electricity demand is around four. Thus only 25 percent of peak demand is a baseline demand that cannot be reduced by changes in operation.

For electrically heated office buildings, the contribution to winter peak demand varies widely by region. Winter peak demand is 750, 900, and 1530 $KW/10^5$ ft^2 for office buildings in Pheonix, Knoxville and Minneapolis respectively. Figure V-4 shows that night shutdown of HVAC systems can considerably reduce energy use in the early morning and evening hours, but may increase peak demand slightly during unoccupied hours. This result is not too surprising since some space heating "catching up" is to be expected if the building is allowed to drift towards freezing over night.

Compared to offices, retail buildings (Figure V-5 to V-8) show much more spread out summer and winter peaking load curves, a greater contribution to system winter peak and less contribution to peak demand in the summer. Again, summer load curves for the end uses are quite similar accross regions while winter peak varies from about 1000 to 2200 $KW/10^5$ ft^2.

End use load curves exhibit similar temporal characteristics for hospitals and schools.

Considering our observations in the previous section on conservation and active solar systems, the contribution of the two areas in reduced peak demand and growth of peak are obvious. For winter peaking utilities, the conservation measures of the previous chapters would reduce each buildings contribution to peak significantly. Solar units can be used to reduce electric space heating systems demand. Even in extended periods of overcast skies, solar units could still play an important role in reducing peak by using electricity to store thermal energy in storage tanks or bins in off-peak hours for use the following day in peak periods.

Summer peaking utilities can realize considerable reduction in buildings contributions to peak by encouraging HVAC conservation and lighting level reductions. In addition, electricity and thermal storage of solar

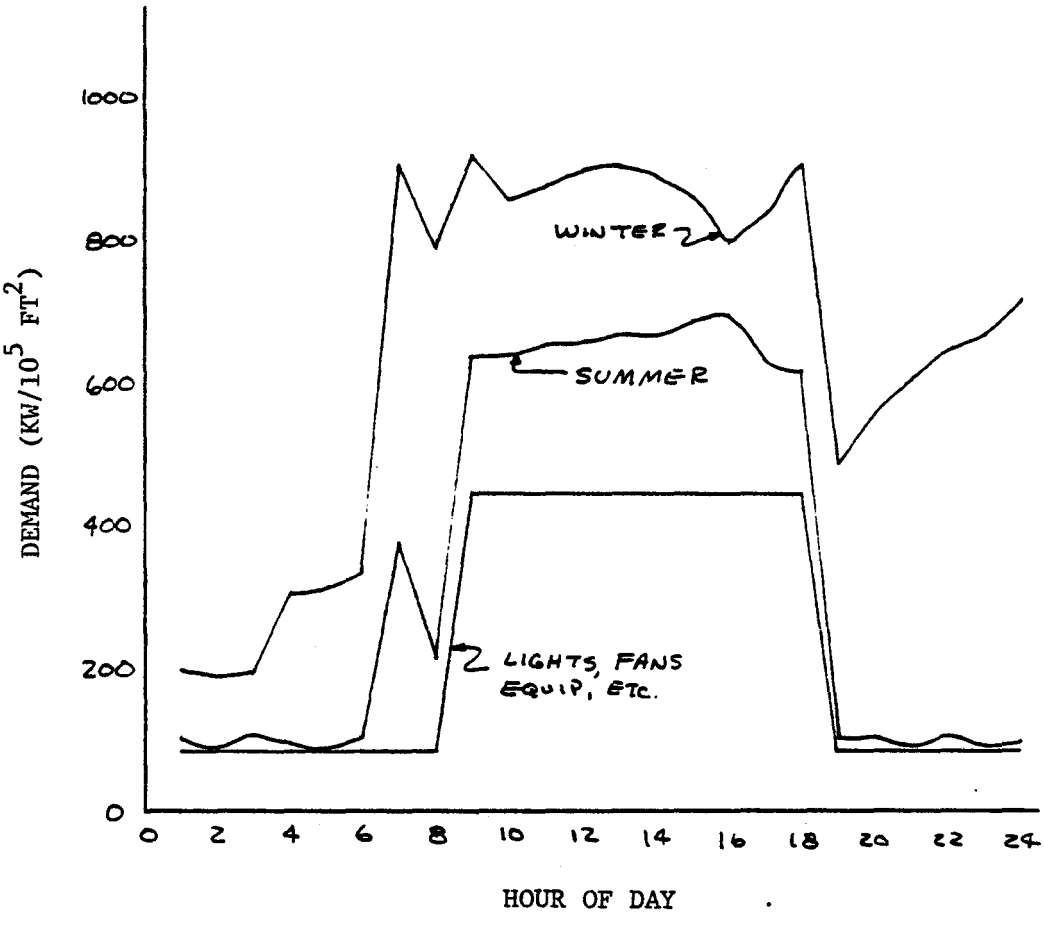


FIGURE V-4. HOURLY LOAD CURVE FOR OFFICE BUILDING IN KNOXVILLE WITH NIGHT SHUTDOWN

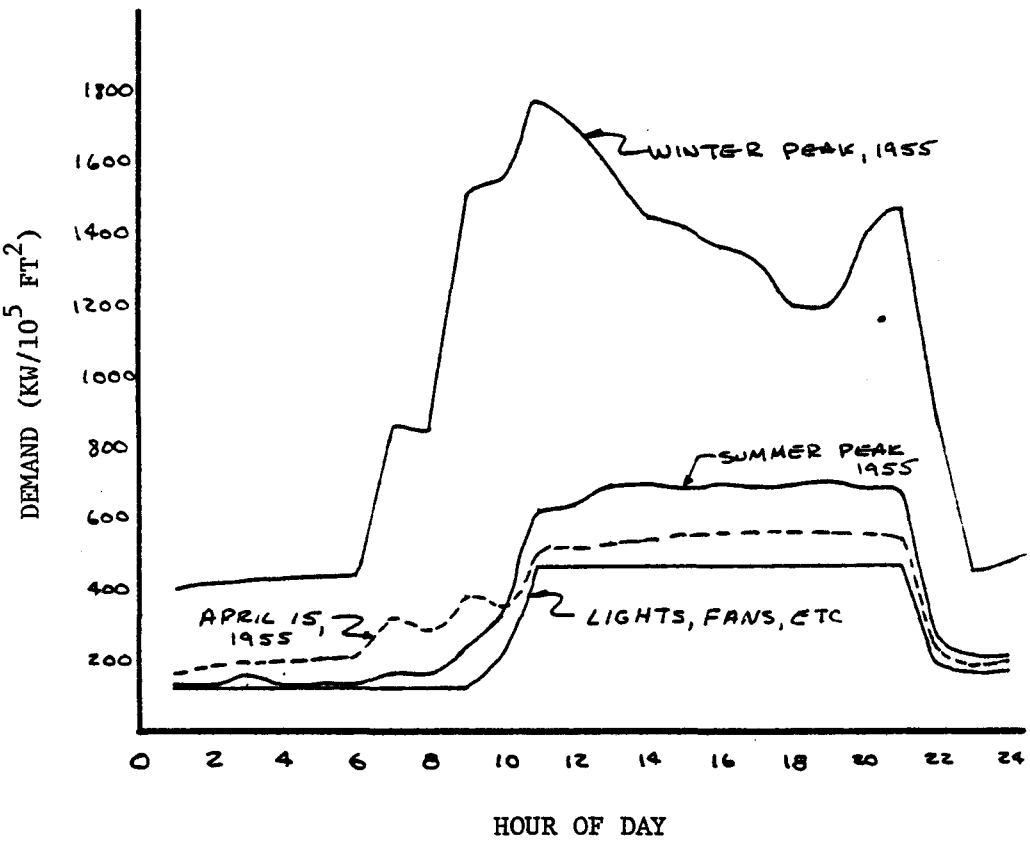


FIGURE V-5. HOURLY LOAD CURVE FOR RETAIL BUILDING IN KANSAS CITY

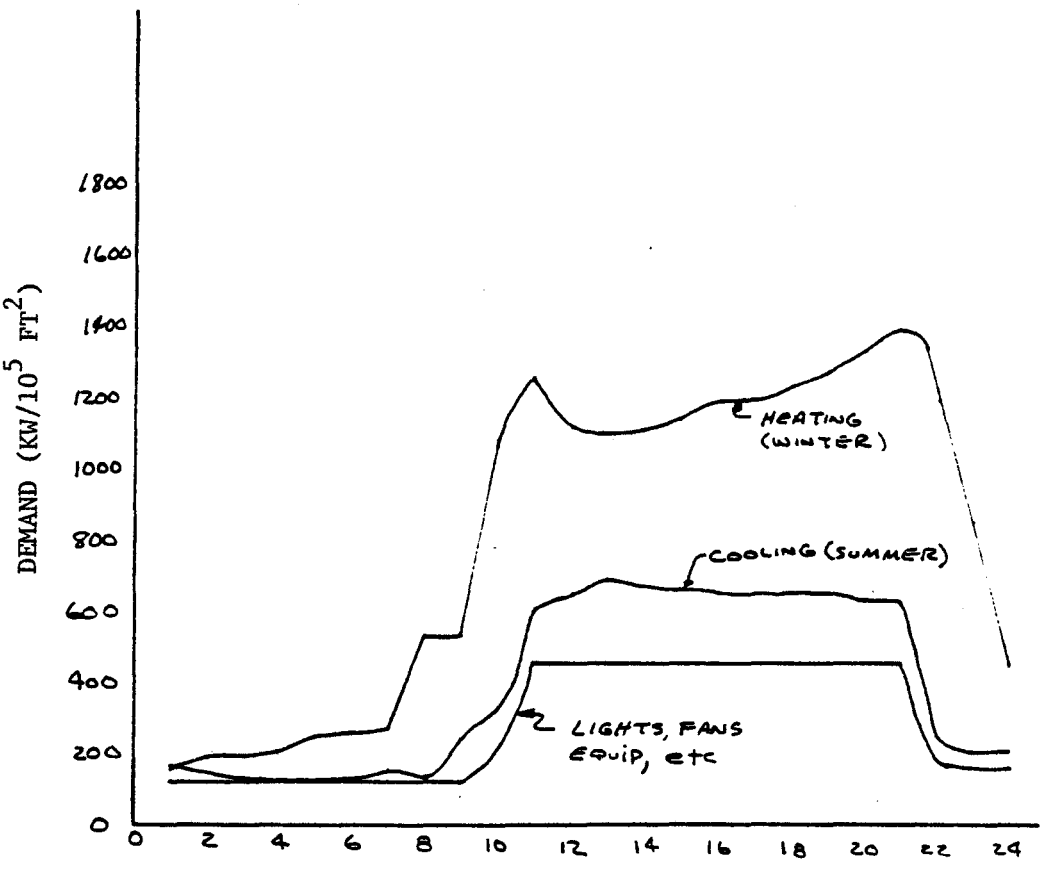


FIGURE V-6. HOURLY LOAD CURVES FOR RETAIL BUILDING IN KNOXVILLE

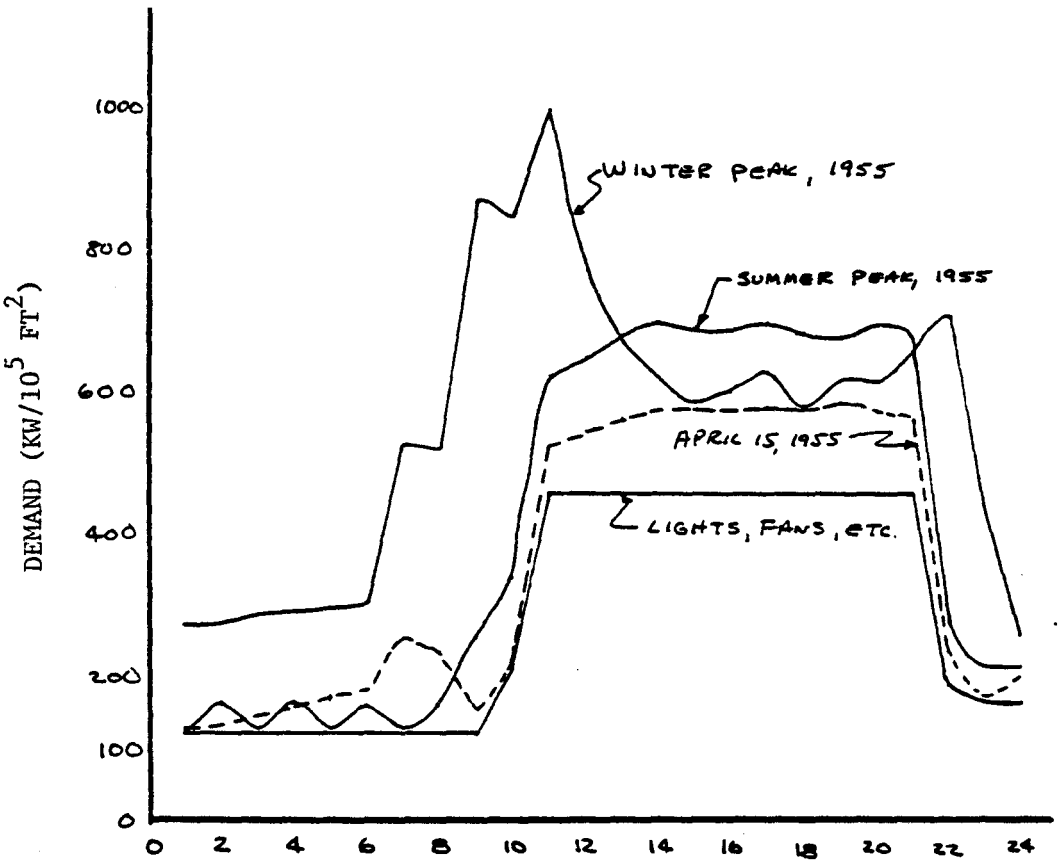


FIGURE V-7. HOURLY LOAD CURVES FOR RETAIL BUILDING IN PHOENIX

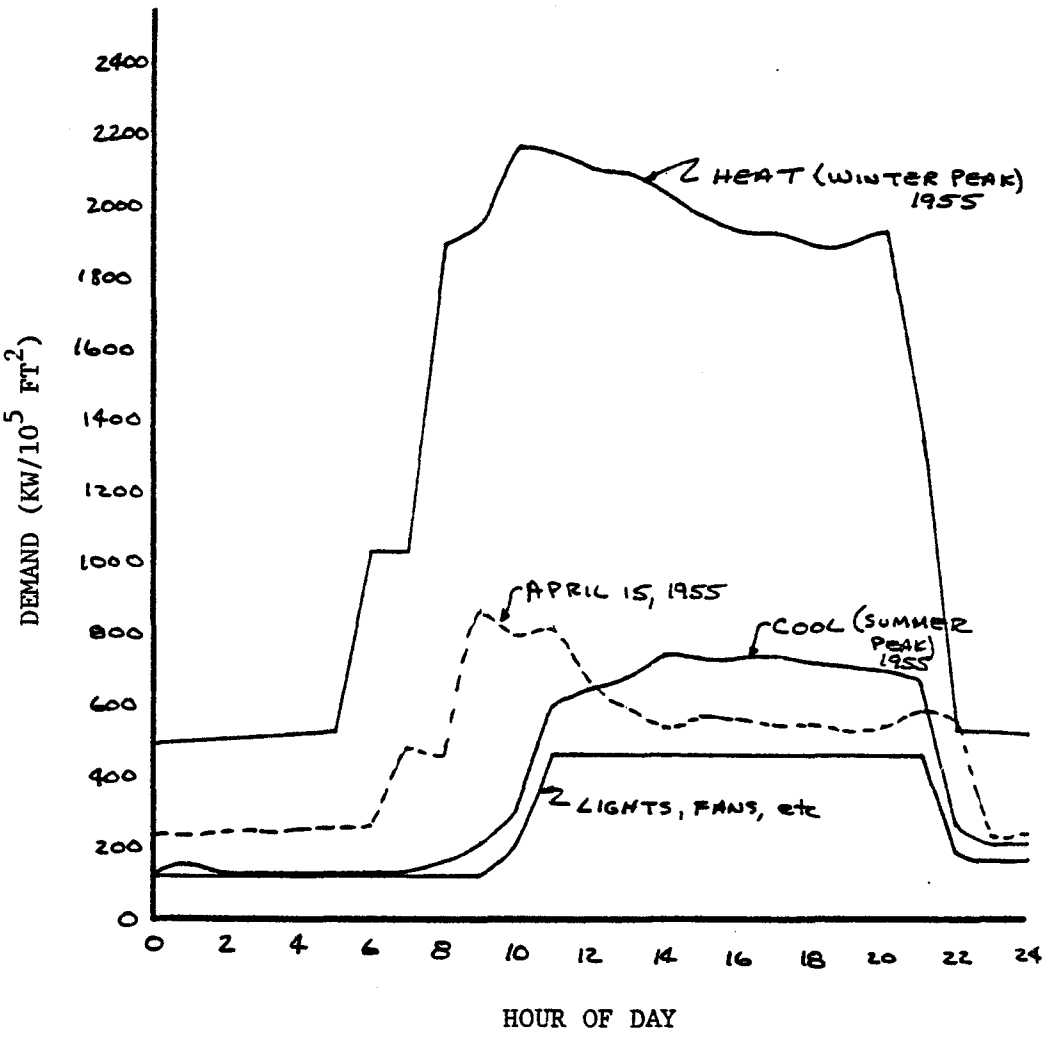


FIGURE V-8. HOURLY LOAD CURVES FOR RETAIL BUILDING IN MINNEAPOLIS

systems can also be used to generate a large part of the thermal energy for absorption air conditioning systems in off-peak periods.

While lack of a comprehensive data base on end use load curves detailed by building type and region preclude our estimation of the impacts that conservation and solar energy can make to reducing cost of electricity generation and environmental damage, the potential contribution is obviously quite sizable.

VI. COMMERCIAL SECTOR MODEL STRUCTURE

Historical energy use patterns by building type and end use were developed with an end use model. This model is also used in the next section to develop alternative future energy use scenarios for the commercial sector. The purpose of this section is to summarize the structure and general characteristics of this model. A more detailed technical description is provided in Appendix B.

The commercial energy demand model represents an extension of the capital-stock approach used in most econometric studies. This approach views energy demand as a product of two factors: the first is the stock of energy-using capital measured in terms of maximum potential energy requirements; and the second is a utilization factor that represents actual utilization of equipment relative to the maximum utilization possible. In the short run (i.e., that period in which the stock of capital is fixed), only the utilization factor can change in response to exogenous changes such as fuel price increases. In the long run the efficiency and fuel characteristics, as well as the utilization factor, of capital stock can change.

Changes in utilization are modeled using short-run econometric fuel price elasticities; fuel choice is forecast with an econometric fuel choice model, and changes in equipment efficiency are determined using engineering and cost information for space heating and cooling equipment and econometric estimates for the other end uses (lighting, water heating, and other).

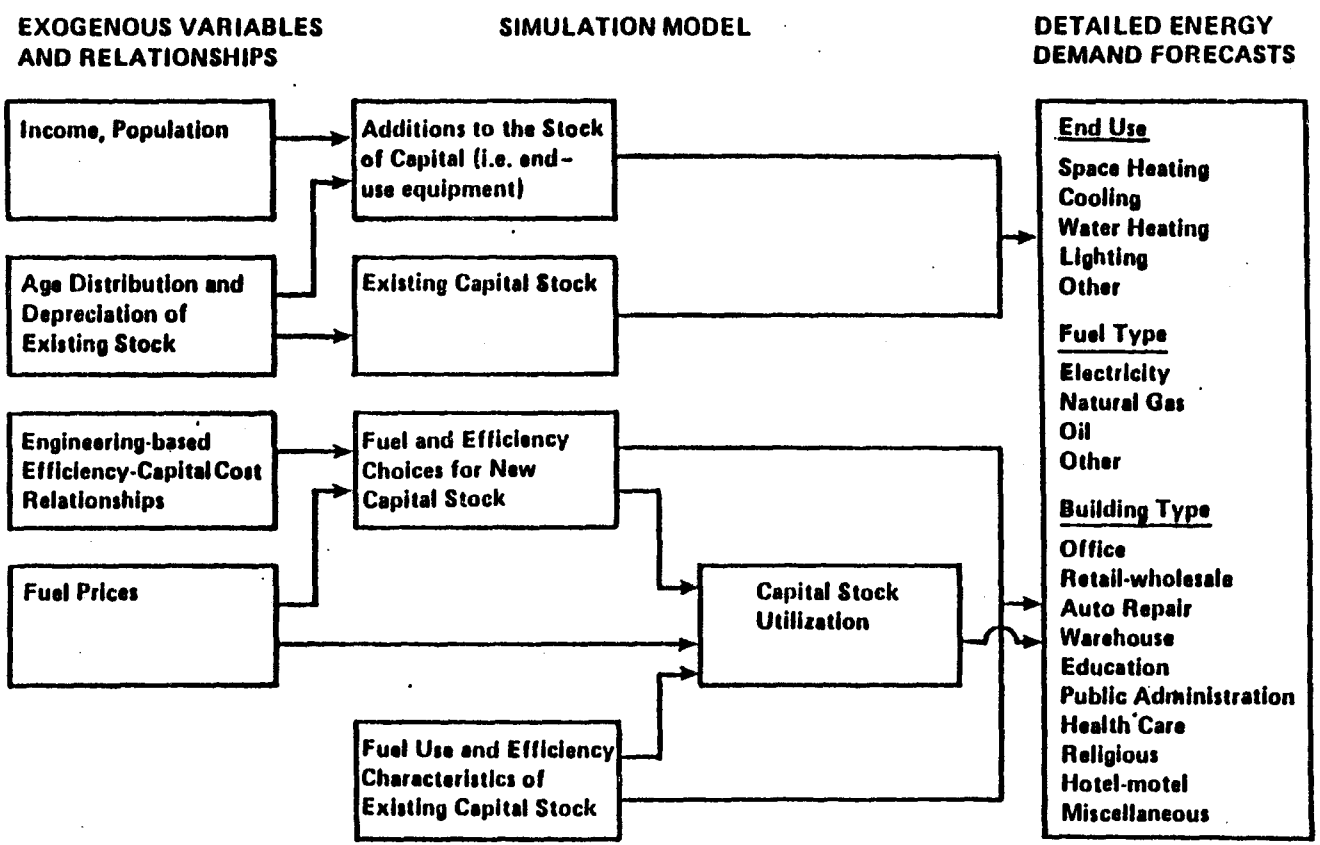
Three characterisitcs of this model distinguish it from traditional modeling approaches. First, our reliance on engineering relationships to determine future heating and cooling efficiency provides a more sound basis for forecasting long-run changes in space heating and cooling energy use requirements than can generally be supplied through econometric studies alone. Second, the simulation model uses a variety of engineering data on the energy-using characterisitcs of commercial buildings; and third, the model provides estimates of energy use detailed by five end uses, four fuel types, and eleven building types (see Figure VI-1).

Since detailed development of the model's structural representation is available in other publications, we provide only a summary of the model

FIGURE VI-1

SCHEMATIC REPRESENTATION OF THE

COMMERCIAL ENERGY DEMAND MODEL



structure in this report[1/]. Figure VI-1 is a schematic representation of the model structure. The stock of energy-using capital (i.e., end-use equipment) is measured in the model by the stock of commercial floor space. Floor space is a fairly accurate measure of energy-using capital since most commercial end-use systems are designed on the basis of floor space served. For instance, lighting systems are installed to provide minimum illumination levels per square foot of floor space; heating and cooling systems are also designed according to the area served.

Floor space stock is forecast using forecasting equations developed at Oak Ridge National Laboratory for each commercial subsector (Cohn, et.al., (1980)). Forecasts of future floor space along with estimates of the age distribution of existing floor space stock and estimated depreciation rates yield estimates of additions to floor space by building type. All of this new floor space requires new end-use systems. Estimates of the age distribution and depreciation rates of end-use systems allow us to estimate the replacement of end-use systems for existing commercial buildings.

Those end-use systems which are not installed in new buildings and are not replacements for existing systems retain efficiency and fuel use characteristics of the previous period. The efficiency of new systems is detemined endogenously in the model in one of two ways. For space heating and cooling systems, engineering relationships between operating cost (efficiency) and initial cost for alternative heating and cooling system designs are used along with estimated discount rates (which reflect commercial establishments' preference concerning trading of future fuel savings for increase in equipment costs) and fuel prices to determine choice of equipment in terms of cost and efficiency. This efficiency determination is equivalent to choice of efficiency using a minimum life cycle cost criterion.

Fuel price and efficiency elasticities are used to estimate the efficiency of the other end-use systems (water heating, lighting, and other end uses). These efficiency elasticities are econometrically determined from a pooled cross-section time series analysis of commercial energy demand. Short-run elasticities are netted out of long-run price eleasticities to

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[1/] See Jackson, et.al., (1978)

implicitly determine the price induced increase in efficiency. See Jackson (1979) for a more detailed discussion of the econometric estimates and the development of the efficiency elasticities, respectively.

Equipment utilization is dependent both on equipment efficiency and fuel price. Changes in utilization are modeled using fuel-specific short-run price elasticities. For equipment that has not been added or replaced in the previous year, utilization will change relative to utilization of the previous year only as a result of changes in fuel prices.

Since utilization of equipment actually depends on the price of producing the end-use service, fuel price changes must be weighted by efficiency changes in those cases where new or replacement equipment has been installed in the current year. For instance, if the price of oil increases by 10 percent but the new space heating equipment is 10 percent more efficient, one would not expect to observe a change in the space heating thermostat settings (i.e., a change in utilization), since the cost of providing space heating services has not changed. The implementation of these utilization impacts is described more fully in the previously referenced ORNL reports.

Fuel prices and efficiencies of new systems determine fuel choice characteristics of new space heating systems. Again, since the price of delivering the end-use service is the relevant price variable, fuel prices must be weighted by efficiencies. An econometrically estimated fuel choice model is used to estimate changes in space heating fuel choices. We assume that water heating fuel choices follow those of space heating. Some gas and steam are used for space cooling, but their use is not significant for these end uses. Thus, lighting and cooling are entirely fueled by electricity. The "other" end use, comprising mostly electromechanical uses, is fueled solely by electricity except for the retail/wholesale sector where we have included some gas use to represent laundry and restaurant gas uses.

As seen Figure VI-1, energy demand is estimated by each building type, fuel and end-use combination.

The detail available on end use consumption in the 1970-1978 period as well as in the forecast period is achieved in large part through the devlopment of detailed energy use parameters for each fuel-end use-building type-

region combination (e.g., electric space heating requirements in office buildings in region 5) as well as estimates by region of the stock of individual buildings by category and the fraction of that stock served by each fuel.

Since data preparation for the model is quite involved, we will describe our general approach and refer detailed questions to references indicated above. Regional floor space stock data were developed using data from General Electric (1978) (building stock estimates by BEA area and building type) to allocate our national floor space stock estimates accross regions. Energy use requirements estimates were developed using buildings simulations estimates on a variety of prototype commercial buildings for air conditioning, lighting, water heating, and "other" end uses.

Energy use requirements for fossil fuel space heating were developed by utilizing information on relative efficiencies of oil and gas space heating systems, relative space heating energy use requirements accross building types based on engineering analysis, floor space stock estimates by building types and total gas and oil use by state. This insured that energy use requirements for oil and gas space heating are consistant with interbuilding differences in energy use, total floor space stock and total fuel use.

While these data parameters fall short of what might be developed if detailed data existed on a national basis, they do represent a reasonably accurate picture of end use and building type energy use. These data also represent the only existing sources of such information relating to detailed regional energy use in the commercial sector.

VII. ALTERNATIVE COMMERCIAL ENERGY USE SCENARIOS

Our analysis of future commercial energy use includes the following five scenarios:

1. Baseline Scenario. This forecast uses assumptions on fuel prices and income increases provided in the Energy Information Administration's (EIA) Medium Price Scenario in the 1979 Annual Report to Congress (1980). These price and income series are used in the next two scenarios as well. A buildings energy use conservation program consistent with the ASHRAE 90/75 standards is the only conservation program assumed to be in place.

2. Baseline Scenario with Solar Technologies. This scenario incorporates the impact of solar water heating, space heating and water heating, and space heating, water heating and cooling systems.

3. Conservation Scenario. This forecast includes the solar technologies described in the previous scenario and more stringent conservation programs. These programs include an improved buildings energy performance standard as well as the schools, hospitals and local government program and the Federal Energy Management program.

4. High Fuel Price Scenario. The fourth scenario incorporates all solar and conservation program assumptions of the previous case with higher fuel price trajectories.

5. Low Consumption Scenario. This final scenario incorporates the high fuel prices and solar technologies of the preceeding scenario and a representation of a stringent conservation program.

The purpose of this section is to describe in more detail the assumptions underlying each scenario and to present the resulting energy use forecasts.

BASELINE SCENARIO

EIA fuel price assumptions are shown in Tables VII-1 through VII-3 for electricity, natural gas and oil. Rates of electricity price increase from 1978-2000 vary from .7 percent to 2.3 percent per year with a national average of 1.2 percent per year. Considerable variation exists accross regions in year 2000 electricity price. Region 2, which payed the highest price for electricity in 1978 retains that distinction in 2000 while Region 10's electricity price is lowest of all regions over the entire forecast horizon.

Table VII-1
DOE Electricity Price Assumptions

Region	1970	1975 $/10^6 Btu 1978	1985	1990	1995	2000a	Average Annual Rate of Price Increase, 1978-2000
1	2.99	3.51	5.10	5.13	4.37	4.37	1.0
2	3.02	4.08	4.94	4.80	4.71	4.71	.7
3	2.38	3.15	3.76	3.90	3.89	3.89	1.0
4	2.27	2.63	3.01	3.29	3.39	3.49	1.3
5	2.63	2.99	3.47	3.67	3.62	3.62	.9
6	2.06	2.41	3.68	4.04	3.96	3.96	2.3
7	2.50	2.72	3.70	3.57	3.61	3.65	1.3
8	2.27	2.18	3.64	3.14	2.71	2.71	1.0
9	2.00	3.31	4.29	4.42	4.03	4.03	.9
10	1.48	1.31	1.45	1.76	1.83	1.90	1.7
U.S.	2.40	2.93	3.70	3.86	3.76	3.77	1.2

[a]Fuel prices were taken from the 1979 Annual Report to Congress; price estimates are not provided for the year 2000. Rates of increase from 1990-1995 are used to estimate 2000 prices except when such an approach would reduce electric price; in that case, prices in 2000 are set equal to those in 1995.

Table VII-2
DOE Natural Gas Price Assumptions

Region	1970	1978	1985	1990	1995	2000a	Average Annual Rate of Price Increase, 1978-2000 %
		1975 $/10^6$ Btu					
1	1.93	2.85	3.21	4.08	4.42	4.79	2.4
2	1.69	2.51	2.91	3.78	4.16	4.58	2.8
3	1.28	2.01	2.61	3.19	3.54	3.93	3.1
4	.96	1.64	2.21	2.69	3.12	3.62	3.7
5	1.05	1.77	2.41	2.96	3.30	3.68	3.4
6	.61	1.52	2.37	3.25	3.61	4.01	4.5
7	.90	1.53	2.31	3.03	3.53	4.11	4.6
8	.76	1.35	2.58	3.35	3.70	4.09	9.0
9	.97	1.80	2.93	3.43	3.30	3.30	5.7
10	1.37	2.05	3.70	4.00	4.41	4.86	5.9
U.S.	1.03	1.79	2.56	3.22	3.53	3.97	3.7

[a]Fuel prices were taken from the 1979 Annual Report to Congress; price estimates are not provided for the year 2000. Rates of increase from 1990-1995 are used to estimate 2000 prices.

Table VII-3
DOE Oil Price Assumptions

Region	1970	1975 $/10^6 Btu 1978	1985	1990	1995	2000a	Average Annual Rate of Price Increase, 1978-2000 %
1	.88	2.18	4.43	5.00	5.46	5.95	4.7
2	1.11	2.14	4.50	5.06	5.52	6.02	4.8
3	1.07	2.35	4.76	5.36	5.83	6.34	4.6
4	1.32	2.45	4.73	5.35	5.85	6.40	4.5
5	1.35	2.58	4.59	5.21	5.71	6.26	4.1
6	1.36	2.58	4.75	5.39	5.89	6.44	4.2
7	1.38	2.55	4.61	5.23	5.75	6.32	4.2
8	1.50	2.23	4.48	5.04	5.54	6.09	4.7
9	1.45	2.45	4.44	5.08	5.54	6.04	4.2
10	1.30	2.15	4.17	4.78	5.27	5.81	4.6
U.S.	1.16	2.35				6.18	4.5

[a]Fuel prices were taken from the 1979 Annual Report to Congress; price estimates are not provided for the year 2000. Rates of increase from 1990-1995 are used to estimate 2000 prices.

Natural gas prices increased at annual rates that vary from 2.4 to 9 percent between 1978 and 2000. While regional variation in natural gas prices is not as great in 2000 as it was in 1978 in percentage terms, the difference between the highest gas price region (region 10) and the lowest gas price region (region 9) is a sizable $\$1.49/10^6$ Btu.

Oil prices increase much more rapidly in most regions than natural gas prices; the price of oil in 2000 is always greater on a Btu basis than gas for each region. Oil prices vary much less regionally than either gas or electricity. The spread between maximum and minimum regional oil price is only $\$.63/10^6$ Btu in the year 2000.

Population and income assumption used for all scenario are given in Table IV-4. The income forecast were developed by EIA for the 1979 Annual Report to Congress (ARC). The ARC average annual income growth rate is 2.17 percent. This rate reflects a growth in economic activity that is moderate from an historical point of view. For instance, real per capita personal disposable income grew at annual rates of 1.23, 2.98, 2.52 and 1.69 over the 1950's, 1960's, from 1970-1978, and from 1973-1978. Considering low productivity growth expected in the future along with the inflationary impacts of sustained use of high priced exported oil the income growth rate of 2.17 percent appears reasonable.

Population estimates were taken from the Bureau of the Census Series II projection (1979). The average annual growth rate of .90 percent is lower than population growth rates in the 1950's and 1960's (1.73 and 1.29 percent respectively) and marginally higher than the .84 percent expected for the 1970's (Bureau of the Census (1978)).

The final set of input specifications required for the baseline scenario reflect a building construction standard equivalent to the standards put forth by ASHRAE 90/75 (American Society of Heating, Refrigeration and Air Conditioning Engineers (1975)). Table VII-5 indicates energy use required in new buildings relative to energy use in buildings constructed in 1970. A variety of sources were used to estimate these energy savings including ADL's assesment (Arthur D. Little (1976)) and analysis by Johnson and Pierce (1980). These standards were assumed to take effect in 1981. The estimates

Table VII-4
Growth Rate of Population & Income By Region
Baseline Scenario

	Avg. Annual Growth Rates (percent)	
Region	Population	Per Capita Income
1	0.73	2.02
2	0.41	1.86
3	0.76	2.23
4	1.29	2.87
5	0.56	2.17
6	1.31	2.37
7	0.41	2.11
8	1.15	2.16
9	1.17	1.73
10	1.24	1.87
U.S.	.90	2.17

Table VII-5
Expected Average Impact of the Construction Standards:
Energy Use Relative to 1970 By Building Type and End Use

	Heating	Cooling	Water Heat	Lighting
Office, Public, Federal	0.29	0.69	0.69	0.78
Retail/Wholesale	0.50	0.89	0.76	0.75
Garage, Warehouse, Religious, Misc.	0.48	0.66	0.66	0.77
Educational Services	0.42	0.69	0.69	0.78
Health Services	0.30	0.79	0.77	0.78
Hotel/Motel	0.58	0.47	0.47	0.88

in Table VII-5 reflect somewhat smaller efficiency increases than suggested by most analyses of the impacts of ASHRAE 90/75. An adjustment was used in this study to reflect less than 100 percent compliance; consequently the space heating efficiency increses in Table VII-5 reflect about 80 percent and other end uses reflect about 90 percent of the levels that would be achieved by complete adherence to ASHRAE 90/75 standards.

The energy savings figures in Table VII-5 provide insight on opportunities for energy conservation accross the different building types. These estimates indicate that new buildings constructed according to standards similar to the ASHRAE 90/75 recommendations can save from 42 to 71 percent of the space hetaing energy use compared to conventional pre embargo building practices. Savings in cooling and water heating vary from 11 to 53 percent, while savings in lighting range from 12 to 23 percent. One interesting aspect of the analysis that has arisen from the 90/75 recommendation is that the increased expenditures for building shell and other components required are often more than offset by savings in equipment cost that result from smaller heating and cooling loads. (Arthur D. Little (1976)).

The regional population and per capita disposable personal income presented in Table VII-4 determine floor space stock over the 1979-2000 forecast period. Floor space forecasts and growth rates over the 1978-2000 period are provided in Table VII-6 for each region and for the nation. Rates of floor space growth range from 2.01 in Region 2 (NY & NJ) to 3.86 (Southeast). Floor space in the sunbelt regions (IV & VI) and the northwest regions (VIII and X) grows more rapidly than the nation as a whole while all other regions grow more slowly. 1978 and 2000 regional commercial floor space stock are illustrated in Figure VII-1. It is evident from this figure that regions IV and V are the predominant regions in 2000, in terms of floor space stock. Forty-one percent of the nation's stock of floor space in 2000 is located in those two regions.

National floor space stock by building type is presented in Table VII-7 for the forecast period. As indicated in Table VII-8 growth of the subsectors varies considerbly. The fastest growing building type is office buildings (4.2 percent per year) while the slowest growing are federal and other public buildings (.9 percent per year for each). Retail/wholesale and

Table VII-6
Commercial Floor Space Stock by Region
1978 & 2000 Base Case Forecast

(Million Sq. Ft.)

Region	Commercial Floor Space 1978	1978	Avg. Annual Growth Rate (Percent)
1	1572.8	2673.2	2.44
2	4033.1	6250.2	2.01
3	2990.9	5306.0	2.64
4	4719.3	10860.3	3.86
5	6475.1	11026.6	2.45
6	2722.4	5705.9	3.42
7	1417.2	2279.5	2.18
8	769.7	1479.7	3.02
9	3578.7	6416.4	2.69
10	879.4	1634.3	2.86
Total U.S.	29158.6	53632.2	2.80

FIGURE VII-1

COMMERCIAL FLOORSPACE STOCK BY REGION

1978 & 2000, BASELINE SCENARIO

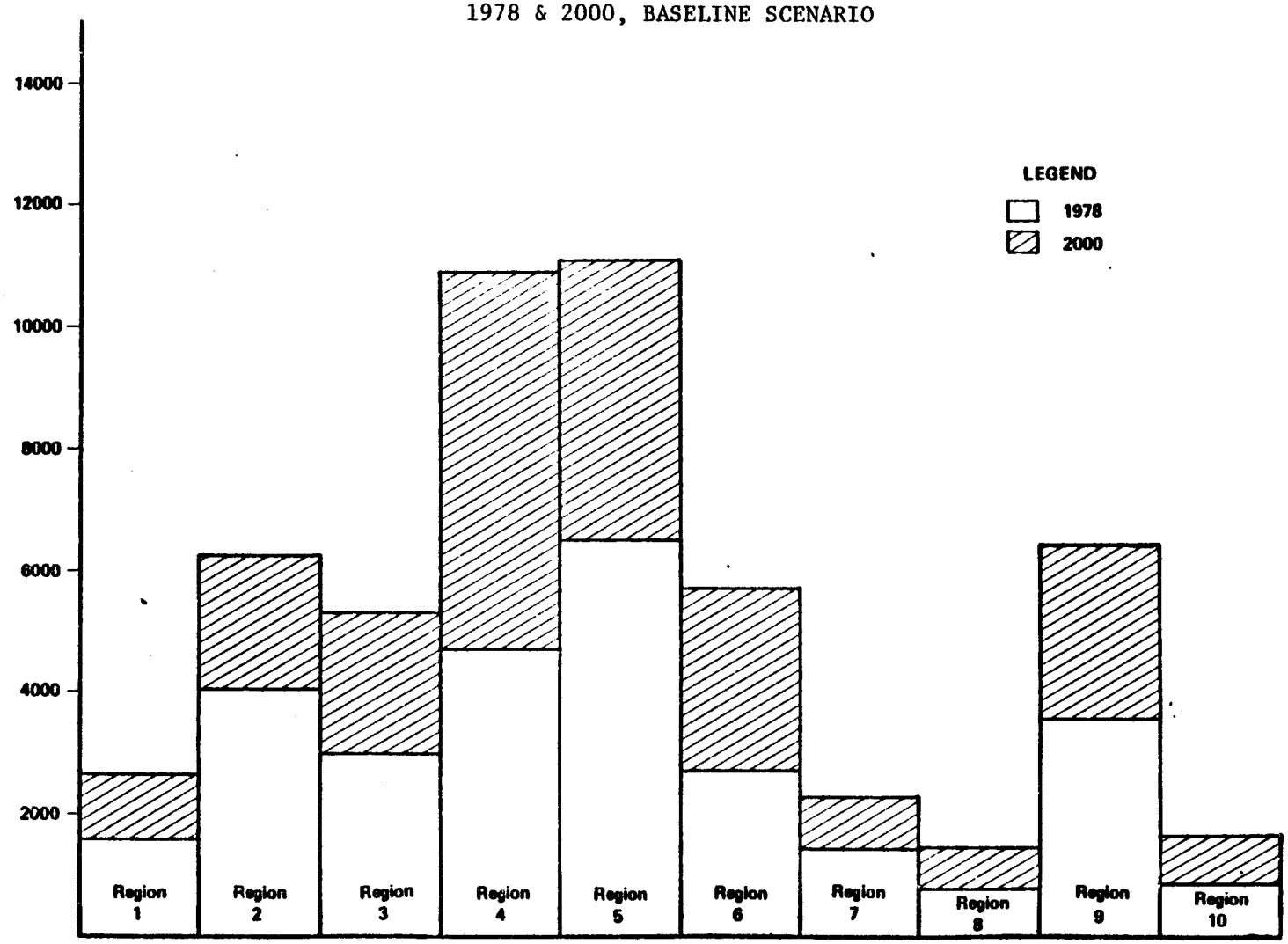


TABLE VII-7. NATIONAL FLOOR SPACE STOCK ESTIMATES

	10^6 FT^2						
	1978	1979	1980	1985	1990	1995	2000
OFFICE	4497.	4614.	4732.	6201.	7750.	9230.	11004.
RETL-WHL	5017.	5114.	5211.	6345.	7476.	8525.	9725.
AUTO SLP	581.	586.	590.	622.	654.	689.	726.
WAREHSE	2298.	2353.	2409.	3079.	3769.	4426.	5202.
FIND SER	6926.	7017.	7108.	8050.	8951.	9783.	10696.
PUB BLDG	750.	755.	761.	797.	835.	874.	916.
FED BLDG	337.	340.	342.	359.	376.	395.	414.
HEALTH	1988.	2016.	2044.	2339.	2623.	2884.	3173.
REL SERV	1514.	1532.	1550.	1730.	1901.	2060.	2234.
HOTL&LDG	1624.	1650.	1675.	1962.	2244.	2506.	2800.
MISC	3624.	3690.	3754.	4514.	5268.	5959.	6744.
TOTAL	29159.	29667.	30178.	35999.	41846.	47331.	53632.

Table VII-8
Relative Importance of Building Types

Building Type	Percent of Total Floor Space 1978	2000	Average Annual Rate of Floor Space Growth, 1978-2000 %
Office	15.4	20.5	4.2
Retail/Wholesale	17.2	18.1	3.1
Auto Repair	2.0	1.4	1.0
Warehouse	7.9	9.7	3.8
Education	23.8	19.9	2.0
Public	2.6	1.7	.9
Federal	1.2	.8	.9
Health	6.8	5.9	2.2
Religious	5.2	4.2	1.8
Hotel/motel	5.6	5.2	2.5
Miscellaneous	12.4	12.6	2.9
Total	100.0	100.0	2.81

warehouse also grow at rates considerably greater than the national average (3.1 and 3.8 percent respectively) while miscellaneous buildings grow at approximately the national average (2.9 percent).

The floor space forecasts in Table VII-7 are identical for all scenarios evaluated in this sector.

The commercial end use model was simulated with the inputs described above to develop baseline scenario forecasts. A summary of the national baseline commercial energy use forecasts is presented in Table VII-9 and Figures VII-2, 3 and 4. Electricity use increases at 2.65 percent per year over the forecast period while gas use grows at less than 1 percent per year and oil and other fuels actually decline. Total energy use is forecast to increase at 1.80 percent in this time period.

The relative importance of fuels is indicated in Figure VII-3. Electricity's predominate role in determining the trend in total commercial energy use is quite evident. As Figure VII-3 indicates, electricity's share of the energy market increases from 58 percent in 1978 to 69 percent in 2000. Gas' share diminishes from 21 to 17 percent in the twenty-two years shown in Figure VII-3. Oil use also declines; from 20 percent in 1978 to 13 percent in 2000.

Relative energy use shares by end use are shown in Figure VII-4. The reduction in heating's share is substantial; from 40 to 29 percent between 1978 and 2000. Cooling energy increased from 28 to 37 percent of the total almost exactly offsetting space heating's share reduction. In terms of relative energy use shares, water heating, lighting and other energy uses varied by within 1 percent between 1978 and 2000.

Cooling energy use increased at a slightly faster rate (2.98 percent per year) than floor space. Both standards and price induced conservation effects are more than offset by the increasing penetration of cooling systems in existing buildings and the virtually 100% air conditioning penetration in new commercial buildings. Water heating and lighting energy use both increased at slower rates than floor space growth (.95 and 2.12 percent per year). The rate of growth of water heating is lower than lighting because the price of fuels used in water heating (primarily gas and oil) increased at two to three times the rate of the electricity prices (which influence

Table VII-9
National Commercial Energy Use by Fuel and End Use,
1978 and 2000 Baseline Scenario

	Energy Use, 10^{15} Btu		Average Annual
	1978	2000	Growth Rate (%)
Fuel			
Elecricity	6.19	11.04	2.65
Gas	2.26	2.75	.92
Oil	2.15	2.08	- .13
Other	1.57	.05	-5.25
End Use			
Heating	4.31	4.65	.35
Cooling	3.05	5.85	2.98
Water Heating	.26	.32	.95
Lighting	2.23	3.54	2.12
Other	.90	1.57	2.56
Total	10.76	15.91	1.80

FIGURE VII-2

NATIONAL COMMERCIAL ENERGY USE 1978-2000

BASELINE FORECAST

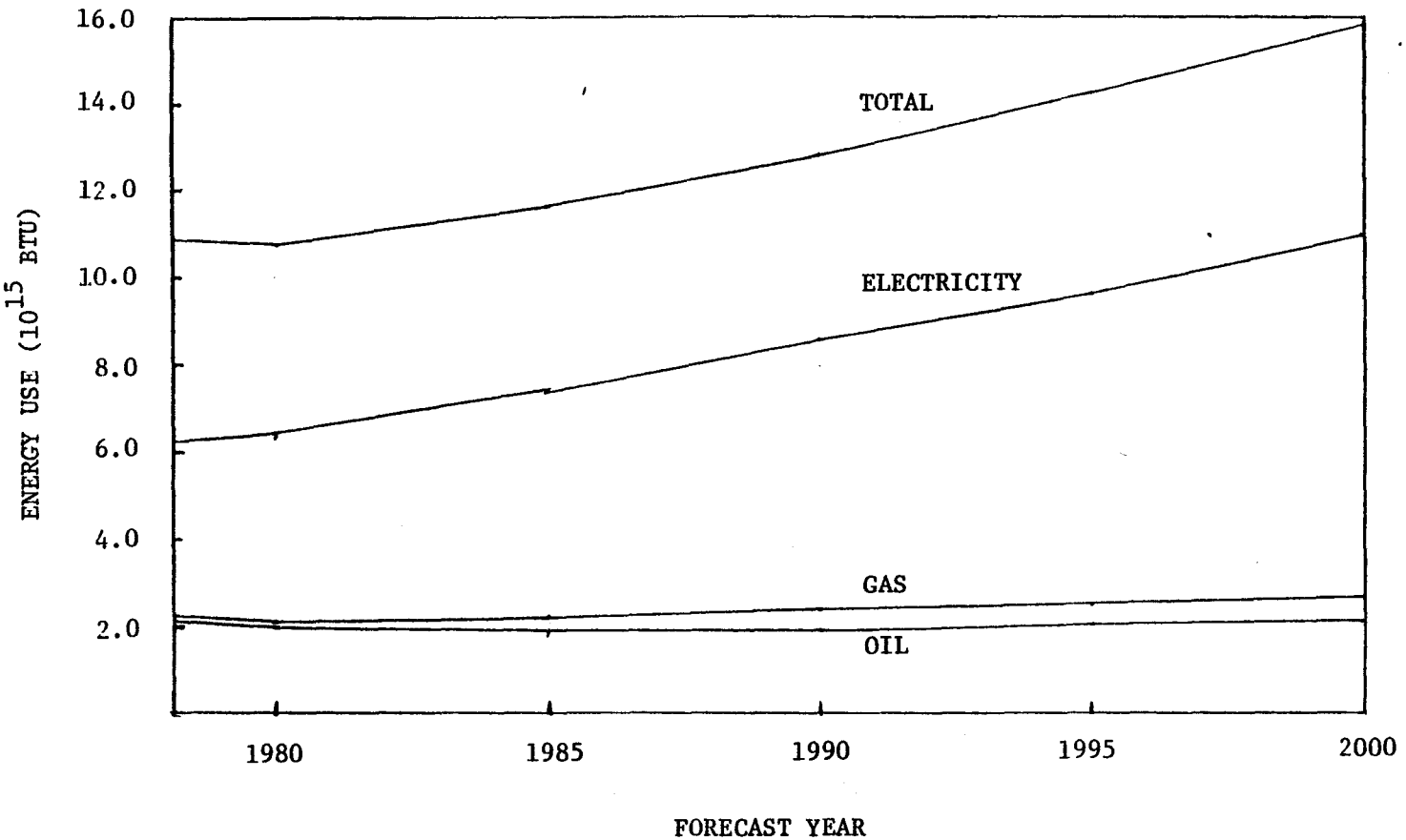


FIGURE VII-3

NATIONAL COMMERCIAL ENERGY USE BY FUELS
1980-2000, BASELINE FORECAST

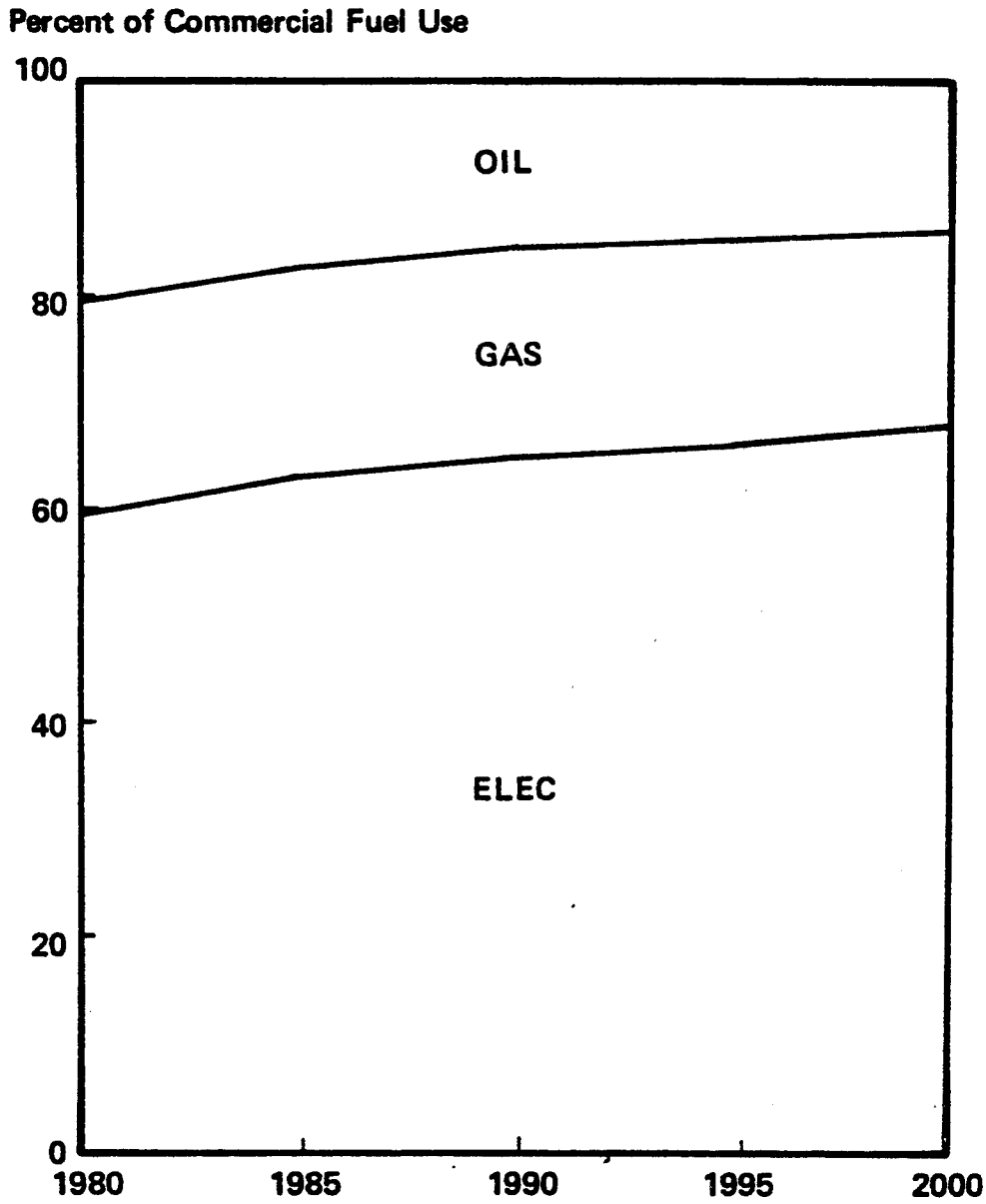
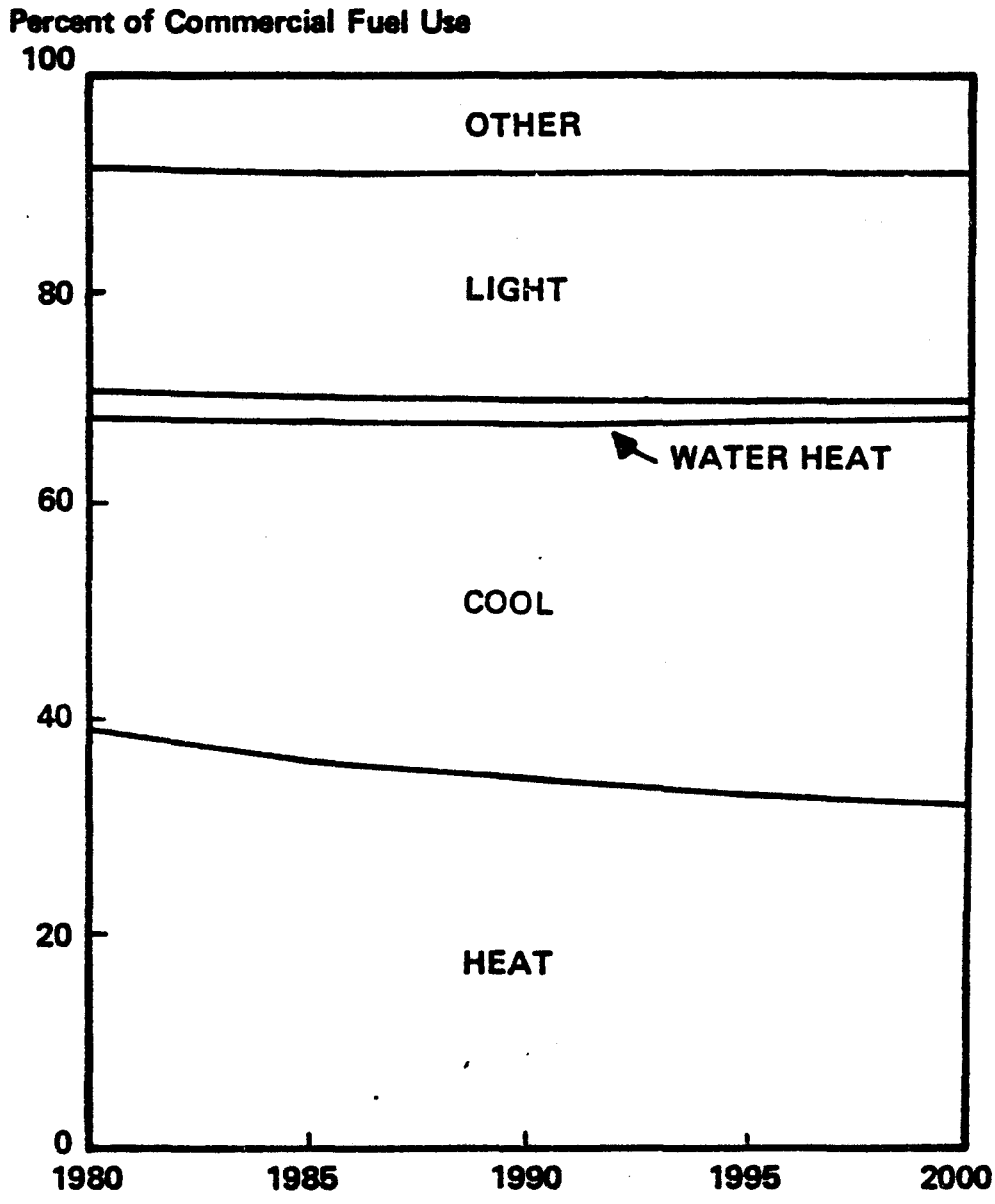


FIGURE VII-4

NATIONAL COMMERCIAL ENERGY USE BY END USE
1980-2000, BASELINE FORECAST



lighting utilization and efficiency increases). Finally, energy used in the other end use reflects primarily electromechanical uses (88% of the other category in 2000) which are assumed to increase substantially over this period.

The reasons for the variation in fuel use growth rates is determined largely by trends in end use energy use over this period. Energy required for space heating grows at the slowest rate of all end uses for two reasons. First, as indicated above, the construction standards impact space heating to the greatest extent and, second, large increases in gas and oil price over this period and the large conservation potential indicated in section IV result in a large price induced conservation effect in space heating. Oil's predominant use in space heating along with some fuel switching explains the three percent reduction in oil use between 1978 and 2000 in the face of an 84 percent increase in floor space over the same period. For gas, space heating conservation resulting from both the construction standards and price are offset to some extent by fuel switching; gas use increases by 22 percent over this period. In terms of end use breakdown by fuel (Table VII-10) only space heating forecasts provide any significant changes over historical trends. In 1980, electricity's share of the space heating market is forecast to be 6.9 percent. By 2000 electricity provides 10.6 percent of space heating services. Gas' importance in space heating increases from 43.6 to 47.2 percent of space heating energy use while oil declines from 46.3 to 41.3 and other fuels decline from 3 to less than 1 percent of space heating energy use.

Regional Energy use totals are presented in Table VII-11 and Figure VII-5 for 1978 and 2000. Regions 4, 6, 8 and 10, all of which have floor space stock growth greater than the national average (Table VII-6) reflect energy use growth greater than the average 1.8 percent. Variations in energy use accross regions correspond closely to variations in floor space growth; however, variations in fuel price tend to modify those relationships over the 22 year forecast period. For instance, Region 10 floor space growth is only 2 percent greater than the national average but Region 10's energy use is 17 percent greater than the average primarily because the price of electricity in Region 10 remains at about one half of the average electric price throughout this period.

Region forecasts detailed by fuel and end use are presented in Appendix C.

TABLE VII-10

BASELINE ENERGY USE BY END USE AND FUEL

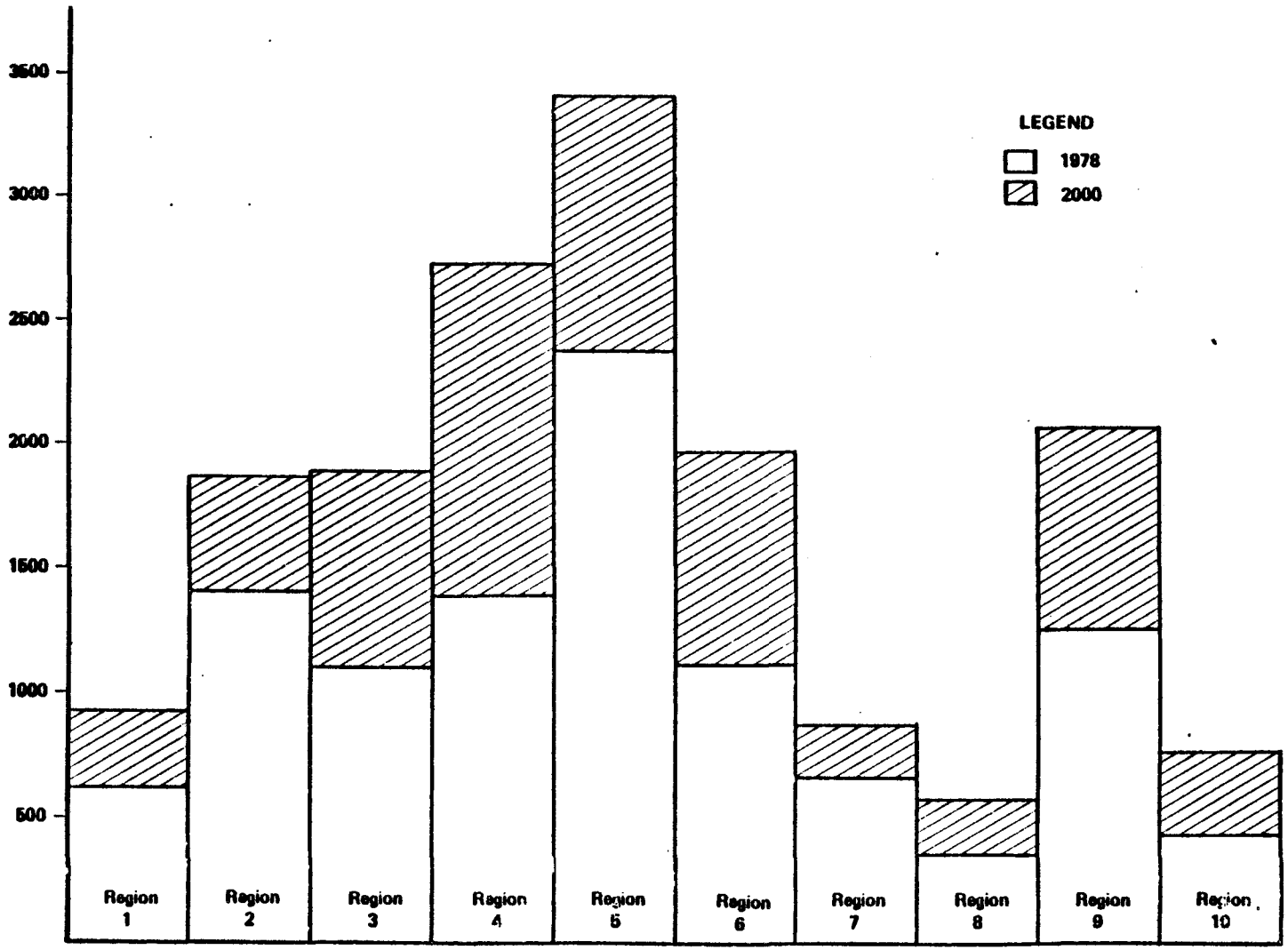
	1980	1985	1990	1995	2000
HEAT					
ELEC	0.2801	0.3091	0.3565	0.4058	0.4916
GAS	1.7671	1.8522	1.9674	2.0560	2.1963
OIL	1.8740	1.7490	1.7804	1.8561	1.9201
OTHR	0.1270	0.0926	0.0686	0.0588	0.0453
TOTAL	4.0482	4.0029	4.1729	4.3767	4.6533
COOL					
ELEC	3.0203	3.5246	4.1349	4.8130	5.5816
GAS	0.1521	0.1722	0.1937	0.2161	0.2414
OIL	0.0	0.0	0.0	0.0	0.0
OTHR	0.0	0.0	0.0	0.0	0.0
TOTAL	3.1724	3.6968	4.3286	5.0291	5.8230
WATR					
ELEC	0.0373	0.0380	0.0400	0.0439	0.0515
GAS	0.0762	0.0856	0.0959	0.1051	0.1176
OIL	0.1424	0.1341	0.1387	0.1468	0.1551
OTHR	0.0	0.0	0.0	0.0	0.0
TOTAL	0.2559	0.2577	0.2746	0.2959	0.3242
LGHT					
ELEC	2.2861	2.5479	2.8573	3.1758	3.5438
GAS	0.0	0.0	0.0	0.0	0.0
OIL	0.0	0.0	0.0	0.0	0.0
OTHR	0.0	0.0	0.0	0.0	0.0
TOTAL	2.2861	2.5479	2.8573	3.1758	3.5438
OTHR					
ELEC	0.8133	0.9821	1.0917	1.2131	1.3731
GAS	0.1376	0.1484	0.1599	0.1751	0.1947
OIL	0.0	0.0	0.0	0.0	0.0
OTHR	0.0	0.0	0.0	0.0	0.0
TOTAL	0.9509	1.1305	1.2517	1.3882	1.5678

Table VII-11
Commercial Energy Use By Region
1978 & 2000 Baseline Forecast

Region	(10^{12} Btu) 1978	2000	Avg. Annual Growth Rate (Percent)
1	.62	.87	1.54
2	1.39	1.77	1.10
3	1.17	1.76	1.87
4	1.39	2.51	2.72
5	2.36	3.14	1.31
6	1.12	1.86	2.33
7	.66	.82	.99
8	.35	.54	1.99
9	1.26	1.96	2.02
10	.43	.68	2.10
Total U. S.	10.74	15.91	1.80

FIGURE VII-5

COMMERCIAL ENERGY USE BY REGION
1978-2000, BASELINE FORECAST



BASELINE SCENARIO WITH SOLAR TECHNOLOGIES

The baseline forecast presented in the preceeding subsection did not reflect the use of solar technologies in providing commercial end use services. The commercial sector model had not been formally extended to represent choice of solar technologies prior to this study. Modeling solar penetration in the commercial sector is an extremely complex undertaking which cannot be provided in great detail until a better understanding of existing commercial building characteristics is developed. It is possible, of course to model solar penetration using an Heuristic approach. Such an approach has been used by Arthur D. Little (1976) and Mitre Corporation (e.g., Taul and deJong (1980)) in the past.

Unfortunately, the anlaysis developed in these studies is not very useful for our purposes since details such as building stock growth by subsector were not available to interpret the results for application in this work. Therefore, we had no option but to incorporate the choice of solar technologies explicitly by extending the commercial model. While recognizing that our analysis must be considered somewhat simplistic, in our opinion it represents an improvement over existing approaches to modeling the market penetration and energy using impacts of solar technologies.

Three primary factors determine the rate at which solar technologies diffuse in the commercial sector: The risk adjusted life cycle cost of solar technologies relative to the cost of existing technologies, the rate of growth of the building stock, and the rate of turnover of existing equipment. The last two of these factors are already explicitly represented in the model for each end use equipment category. The impact of the relative life cyle cost of solar technologies on equipment choice is represented using a judgmentally determined equipment choice probability density function. We assume that the life cycle cost of solar and conventional technologies are the primary determinants of solar choice. Since life cycle cost includes the discount rate used in equipment purchase decisions, price expectations, expected maintenance cost, a risk premium and so on, we can rely on this single index to reflect the most important determinants of solar choice.

We also assume that the solar industry becomes established and that

sufficient demonstration projects have been provided to reduce the risk premium to an insignificant level by 1985.

Given some "standard" assumptions on future prices, discount rates, and maintenance expenditures, one can develop a variable R which is the life cycle cost of the solar technology divided by the life cycle cost of the conventional technology. For a single firm, assuming the values of the variables above hold, the solar technology will be purchased only when R<1, the conventional technology will be purchased when R>1 and a random choice will ensue representing indifference between technology choices when R=1.

For firms where the life cycle cost assumptions do not hold these relationships with R will not hold. For example, a firm that expects greater maintenance cost of a solar unit than assumed in the "standard" life cycle cost calculations will chose solar units only when R is enough less then 1 to make up this difference in expected solar expenditure. Thus, the perceived value of R varies within the population of commercial firms. If we assume that one half of the commercial firm population would perceive the solar technology as being more attractive in a cost sense when the value of R based on our "standard" assumptions is 1, and if we further assume that perceived values of the cost attractiveness for a fixed set of assumptions is distributed approximately normally, then we can represent the fraction of firms likely to purchase the solar technology by the area under the probability density in Figure VII-6 given any value of R. For instance R* represents a solar life cycle cost that is less than the conventional cost; therefore, more than half of the population of commercial firms considering new equipment purchases would perceive solar as the most cost advantageous choice. These firms are assumed install solar systems. The fraction of firms making equipment purchases who actually chose solar in this case equals

$$\int_{R^*}^{\infty} f(R)dR$$

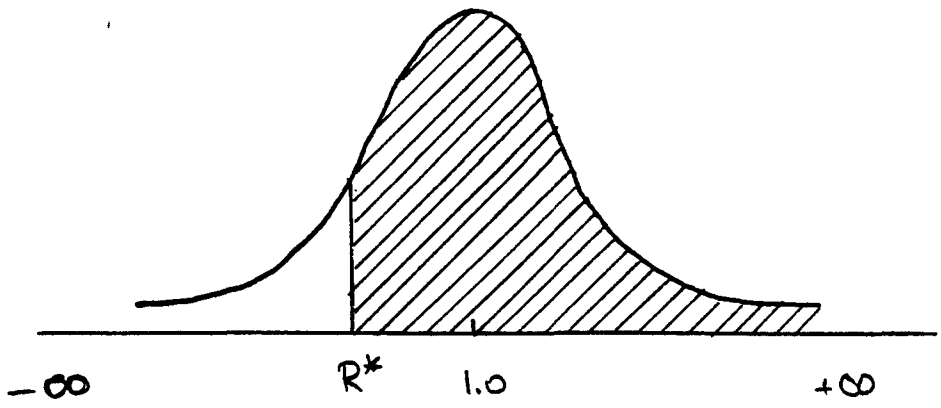
As an approximation to the cumulative normal distribution ($\int f(R)dR$) we use

$$F(R) = (1.0 + \text{Exp}[(R-1)]5.88)]^{-1} \qquad (1)$$

To implement this representation of solar equipment choice we have

FIGURE VII-6

DISTRIBUTION OF PERCEIVED COSTS OF
SOLAR RELATIVE TO CONVENTIONAL TECHNOLOGIES



developed a "standard" estimate of the relative life cycle cost of solar relative to conventional systems for the three generic solar systems described in Section IV. Equation (1) defines the parameters of the distribution such that F(1.5) = .05 and F(.5)= .95. Relative life cylce costs for the baseline scenario are given in Table VII-12 for the three systems for each region. We assumed that the initial cost of replacement systems would be 20 percent greater than on new installations.

Relative costs for hot water systems were nearly identical accross regions: 2.35 and 1.45 for 1975 and 2000 respectively. Except in Region 6 (Southwest), and Region 9 (California, Arizona, Nevada), solar heating systems are not very attractive at 1975 fuel prices. By the year 2000; however, relative costs of solar heating/water heating systems for new buildings are with 20 percent of the cost of conventional systems. While the solar heating/cooling/water heating (HCWH) systems are in some cases more attractive relative to the space heating/water heating systems, the relative attractiveness does not increase very rapidly. Only one region exhibits conditions in 2000 that put the cost of the solar HCWH system within 20 percent of the conventional systems.

The cost estimates in Table VII-12 are used along with the methodology described earlier to model the penetration of solar technologies in the commercial sector. The primary energy replaced by the solar heating/hot water system is presented in Table VII-13. The .36 Quads of primary energy replaced by this solar system represents 7.6 percent of space heating energy use by 2000. The rate at which these systems penetrate depends not only on the relative cost but also on the growth of the commercial sector. The cost advantage in incorporating solar systems in new buildings is quite significant as demonstrated by Region 3 which is the fastest growing region in terms of floor space.

The primary energy replaced by the combination heating/cooling/water heating system is about one third that of the heating/water heating system (Table VII-14). This system does not become particularly attractive except in Region 2 (NY & NJ) where high electricity prices significantly increase the value of a system that can provide 50 percent of its electricity needs for air conditioning.

Finally, single solar water heating systems appear as the least attrac-

Table VII-12
Life Cycle Cost of New Solar Systems
Relative to Conventional Systems

Region	Space Heat/Water Heat		Cooling/Space Heat/ Water Heat	
	1975	2000	1975	2000
1	1.82	1.15	1.68	1.32
2	1.74	1.10	1.55	1.17
3	1.64	1.13	1.73	1.59
4	1.24	.96	2.27	1.96
5	1.79	1.25	1.79	1.49
6	1.18	.88	1.89	1.43
7	1.89	1.39	1.74	1.54
8	1.81	1.52	1.72	1.62
9	1.19	.92	1.75	1.46
10	1.62	1.64	2.31	2.14

Note: Life cycle cost calculations use on 18 percent discount rate, an annual maintenance cost of 2 percent of initial cost for conventional and 3 percent for solar and expected fuel price increases of 4 percent per year. See Section IV for a more detailed discussion of the calculation of these costs.

Table VII-13
Primary Energy Replace by Solar
Space Heating/Water Heating System

Region	1985	1990	1995	2000
		10^{12} Btu		
1	0.1	1.1	4.0	14.2
2	0.0	0.0	1.9	13.1
3	0.4	5.0	11.9	30.2
4	2.5	34.7	71.4	131.9
5	0.3	3.4	10.7	30.5
6	1.7	1.7	36.1	64.9
7	0.0	0.4	.9	1.7
8	0.0	0.5	1.7	5.0
9	2.5	19.5	37.5	62.8
10	0.0	.2	.5	1.0
U.S.	7.5	66.5	173.0	355.3

Table VII-14
Primary Energy Replaced by Solar
Space Heating/Cooling/Water Heating System

Region	1985	1990	1995	2000
		10^{12} Btu		
1	0.3	3.2	07.2	15.6
2	7.0	14.1	31.3	66.7
3	0.0	1.1	2.5	5.5
4	0.0	0.2	0.4	1.0
5	0.3	3.4	8.5	19.4
6	0.2	2.2	6.0	14.1
7	0.0	0.7	1.6	3.4
8	0.0	0.3	0.6	1.3
9	0.3	2.6	5.8	11.5
10	0.0	0.0	0.0	0.0
U.S.	.028	27.8	63.9	138.5

tive systems because of the high initial cost (Table VII-15). Differences in primary energy displaced reflect primarily difference accross regions in water heating, energy use intensities and the stock of commercial buildings. By the year 2000, solar water heating has replaced 1.4 percent of the baseline water heating energy use.

The impact of solar technologies are represented graphically in Figure VII-7.

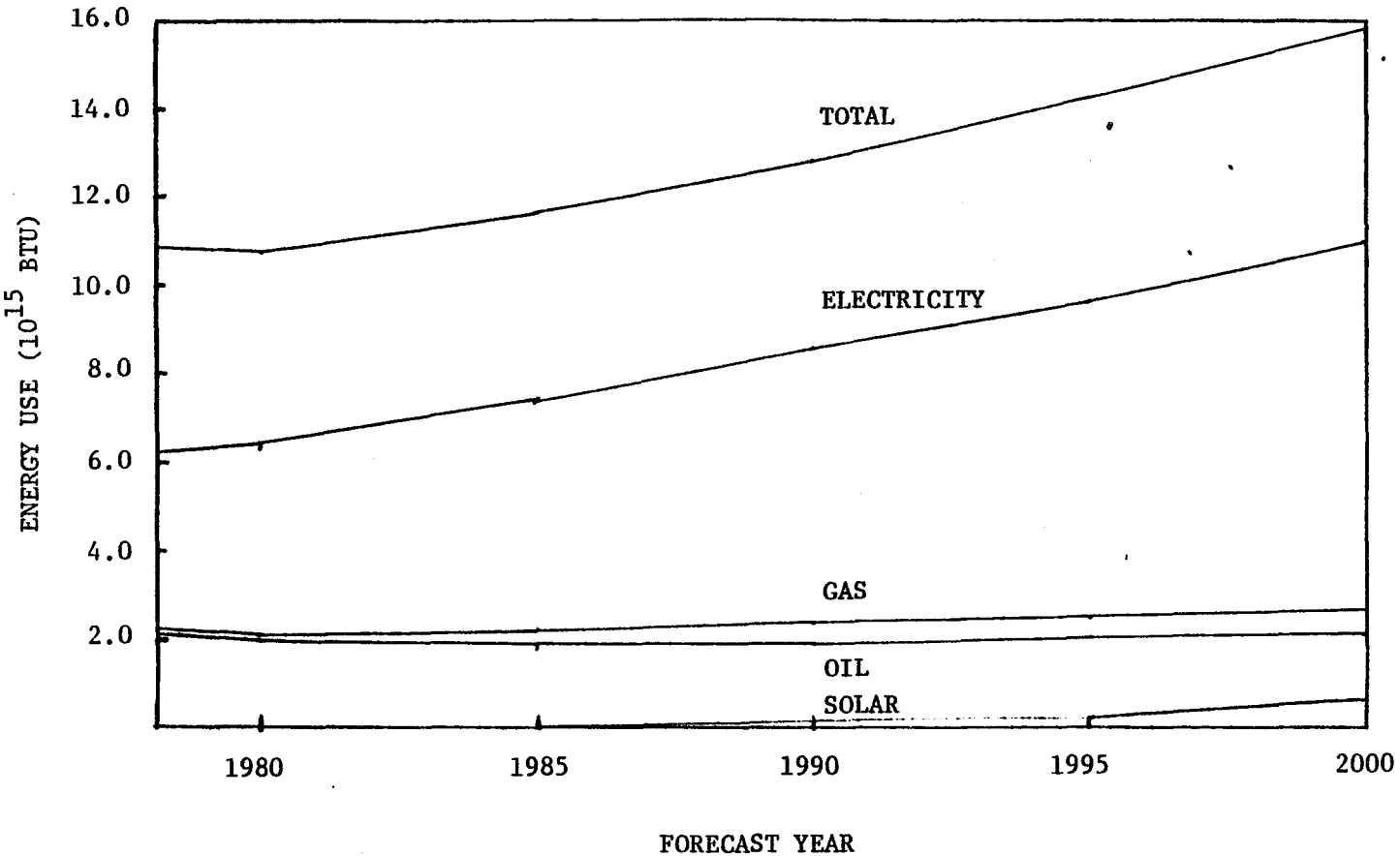
Table VII-15
Primary Energy Replaced by Solar
Water Heating System

Region	1990	10^{12} Btu 1995	2000
1	.16	.37	1.21
2	.17	.35	1.09
3	.07	.15	.45
4	.09	.20	.70
5	.08	.18	.55
6	.02	.05	.18
7	.014	.03	.10
8	.008	.019	.05
9	.033	.074	.25
10	____	____	____
	.647	1.423	4.59

FIGURE VII-7

NATIONAL COMMERCIAL ENERGY USE 1978-2000

BASELINE FORECAST INCLUDING SOLAR TECHNOLOGIES



CONSERVATION SCENARIO

The conservation scenario forecast incorporates population, income and price assumptions of the previous scenarios as well as the solar penetration model described above. This scenario also includes a more strengent conservation effort including construction standards, an investment tax credit program, a schools, hospitals, and local government grants program and the Federal Energy Management program. The construction standards imposed in the model are designed to represent the forthcoming Department of Energy Buildings Energy Performance Standard (BEPS). This standards program is part of the National Energy Act (U.S. Congress, (1977)) promulgated in the Energy Conservation and Production Act (U.S. Congress, (1976)). The Department of Housing and Urban Development was originally in charge of this program which was to provide performance standards for adoption in the individual states by 1980. The Department of Energy now has responsibility for issuance of the standards; we have assumed an implementation date of 1981. Table VII-16 shows our representation of the BEPS standard. Since these standards have

Table VII-16
AVERAGE IMPACT OF IMPROVED CONSTRUCTION STANDARDS:
ENERGY USE RELATIVE TO 1970 BY BUILDING TYPE AND END USE

	Heating	Cooling	Water Heat	Lighting
Office, Public, Federal	0.22	0.57	0.57	0.64
Retail/Wholesale	0.38	0.80	0.62	0.61
Garage, Warehouse, Religious, Misc.	0.36	0.54	0.54	0.63
Educational Services	0.32	0.57	0.57	0.64
Health Services	0.23	0.65	0.63	0.64
Hotel/Motel	0.43	0.39	0.39	0.72

not yet been finalized for commercial buildings, Table VII-16 was developed by increasing energy savings indicated for the ASHRAE standards by about 10 percent.

The Federal Energy Management Program sets target savings of 20 percent/ft^2 for existing federal buildings and 45 percent/ft^2 for new federal buildings relative to 1975 energy use (Department of Energy (1980)). The grants program is a three year federal program of matching grants to states for energy conservation improvements to schools, hospitals and government buildings (Department of Energy (1980)). A total of 1.8 billion dollars can be spent under this program. Estimates of program participation provide an estimated retrofit expenditure (e.g., $\$34/ft^2$ and $\$.67/ft^2$ if one half the schools and hospitals in the stock are assumed to participate in the program). These expenditure estimates are used directly in the model to estimate energy saving impacts of the program. See Jackson (1979) for detailed discussion of the representation of these programs.

The more stringent conservation programs in this scenario reduce total energy use by .85 Quadrillion Btu (QBtu) relative to the baseline scenario (Table VII-17 and Figure VII-8). Electricity growth rate falls by .21 percent while gas and oil growth rates fall by .82 and .80 percent, respectively. Solar energy use is .47 QBtu in this scenario in the year 2000 compared to .50 QBtu in the baseline scenario. The contribution of solar declines under stricter conservation programs because conventional systems replaced by solar systems use less energy than before. Primary energy replaced by solar systems also tends to be reduced by higher conventional fuel prices as conventional systems become more efficient. At the same time, higher conventional fuel prices increase solar system penetration, more than offsetting the increased conventional system efficiency impact. The conservation programs have the greatest impact on space heating where the rate of increase in energy use over the 1978 to 2000 period declines from .35 to -.10 percent per year. Of all the end uses, only cooling energy use grows at a faster rate than floor space (2.83 percent versus 2.80 percent). Total energy use increases in this scenario at an annual rate of 1.54 percent.

In terms of relative importance of the fuels and end uses, the conservation program scenario does not change the relative importance of any fuel or end use in 2000 by more than 2 percent over the baseline. Thus, the

Table VII-17
NATIONAL COMMERCIAL ENERGY USE BY FUEL AND END USE,
1978 AND 2000 CONSERVATIONS SCENARIO

	Energy Use, 10^{15} Btu		Average Annual
	1978	2000	Growth Rate (%)
Fuel			
Electricity	6.19	10.53	2.44
Gas	2.26	2.31	0.10
Oil	2.15	1.75	-0.93
Solar		.47	
End Use			
Heating	4.31	4.22	-0.10
Cooling	3.05	5.64	2.83
Water Heating	.26	.29	0.50
Lighting	2.23	3.35	1.87
Other	.90	1.57	1.57
Total	10.76	15.06	1.54

stricter conservation program has not significantly altered the relative fuel and end use patterns established by the baseline scenario.

Table VII-18 shows 1978 and 2000 energy use by region. Total regional energy use is reduced by from 5 to 7 percent relative to the baseline scenario as a result of the more stringent conservation programs. Figure VII-9 shows 1978 and 2000 total regional energy use graphically. A comparison with the similar graph for the baseline scenario (Figure VII-5) shows no perceptable change in relative regional importance in terms of total energy use.

Regional energy use by fuel and end use are given in Appendix Tables C-10 through C-18.

Figure VII-8

National Commercial Energy Use 1978-2000
Conservation Scenario

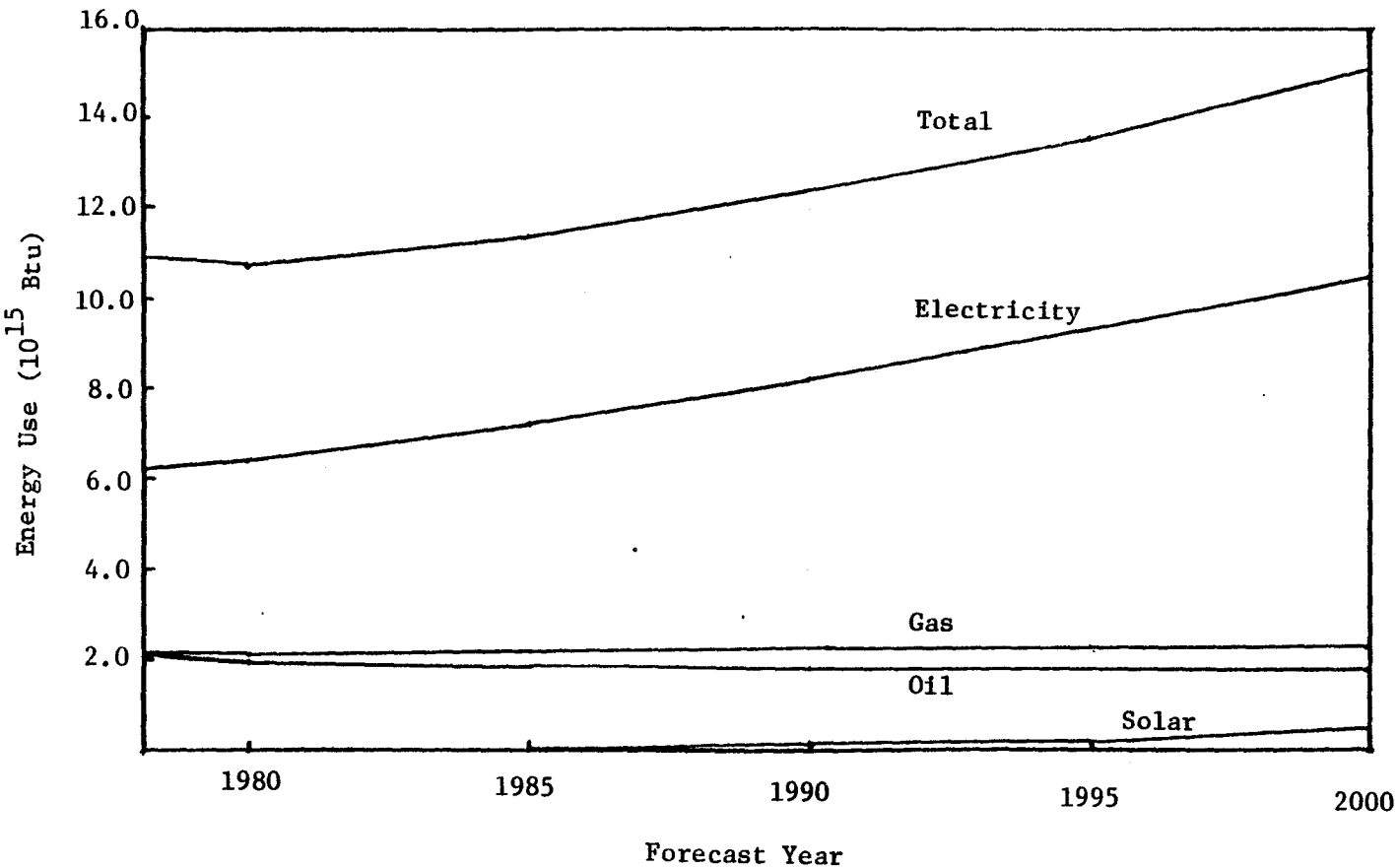
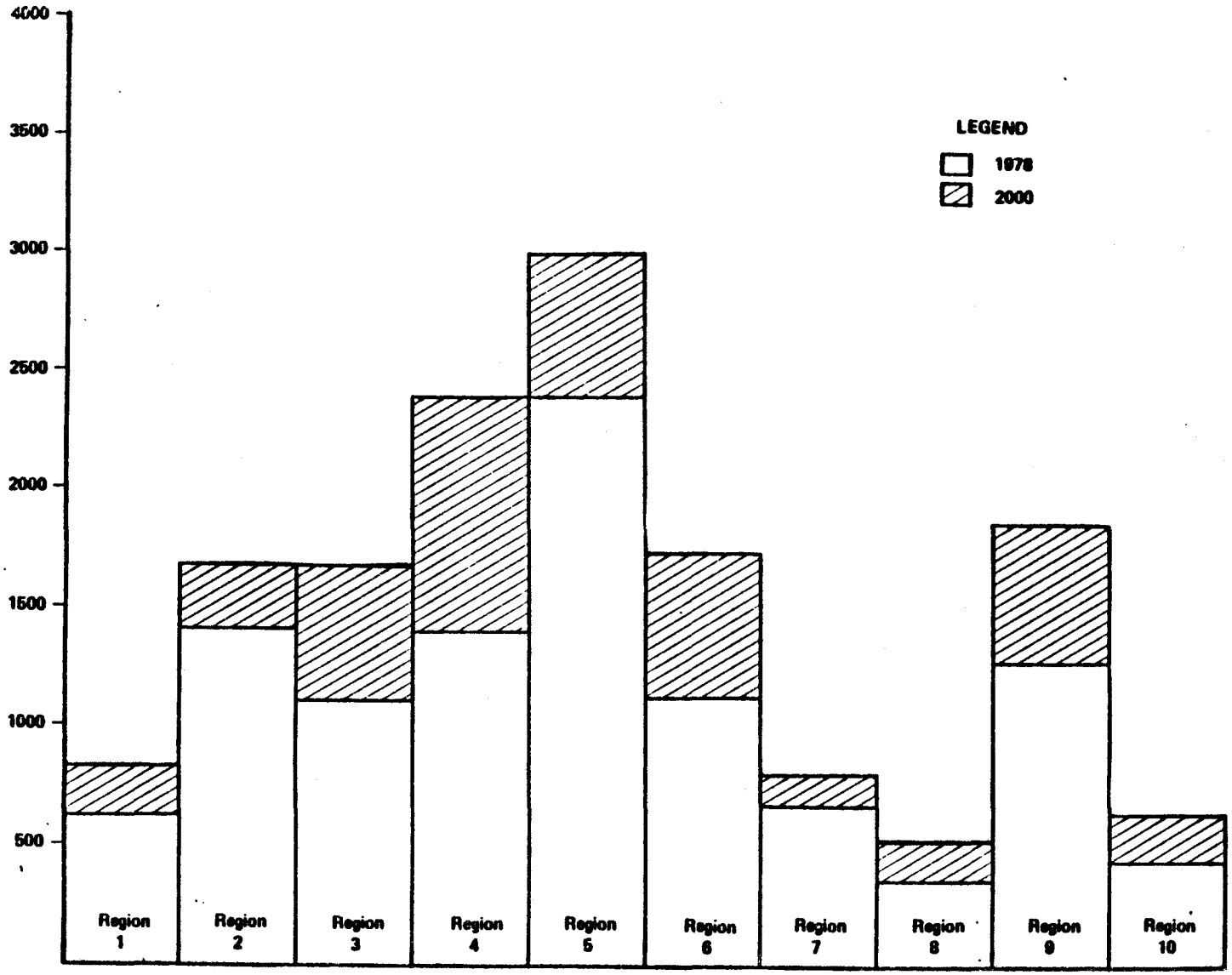


Table VII-18
COMMERCIAL ENERGY USE BY REGION
1978 AND 2000 CONSERVATION SCENARIO

Region	(10^{12}Btu) 1978	2000	Average Annual Growth Rate (%)
1	.62	.82	1.28
2	1.39	1.69	0.89
3	1.17	1.67	1.63
4	1.39	2.39	2.49
5	2.36	2.98	1.07
6	1.12	1.74	1.02
7	.66	.78	0.76
8	.35	.51	1.73
9	1.26	1.86	1.79
10	.43	.63	1.75
Total U.S.	10.76	15.06	1.54

Figure VII-9

Commercial Energy Use by Region
1978-2000, Conservation Scenario



HIGH PRICE SCENARIO

The high fuel price scenario incorporates conservation, income, and population assumptions of the preceeding conservation scenario and incorporates significantly higher fuel price assumptions. Table VII-19 shows fuel prices used in this scenario on a national basis. A comparison with baseline prices shows an increase for year 2000 prices of 84, 105, and 60 percent for electricity gas and oil respectively. These prices were developed to reflect the social cost of supplying the various fuels. These prices in Table VII-19 reflect externalities not presently captured in prices paid for energy.

Table VII-20 and Figure VII-10 show energy use by fuel and end use for the high fuel price scenario. The reduction in energy use is significant, especially for natural gas and oil. Use of these two fossil fuels declines at 1.16 and 1.26 percent annually. Electricity increases at 1.81 percent annually as a result of increased air conditioning and the other end use loads as well as increased use of electricity for space heating.

Table VII-19
HIGHER FUEL PRICE SCENARIO ASSUMPTIONS

	National Fuel Prices, 1975$			
	1985	1990	1995	2000
Electricty	6.57	6.71	6.83	6.94
Natural Gas	6.07	6.79	7.46	8.15
Oil	8.17	8.77	9.31	9.88

Source: Rosenfield (1980)

Solar energy use increases significantly from .47 QBtu of the preceeding scenario to .84 QBtu under high fuel prices. This increase in solar replacement of conventional fuel use is more significant than it appears at first since an average conventional efficiency increase of between 15 and 20 percent has occurred as a result of the higher fuel prices. The increased solar penetration is a result of a more attractive relative life cycle cost. In fact, the life cycle costs of solar heating/water heating systems relative to conventional systems under this new fule price scenario are less than conventional systems for all but two regions (Regions 7 and 8) in the year 2000.

Figure VII-10

National Commercial Energy Use 1978-2000
High Price Scenario

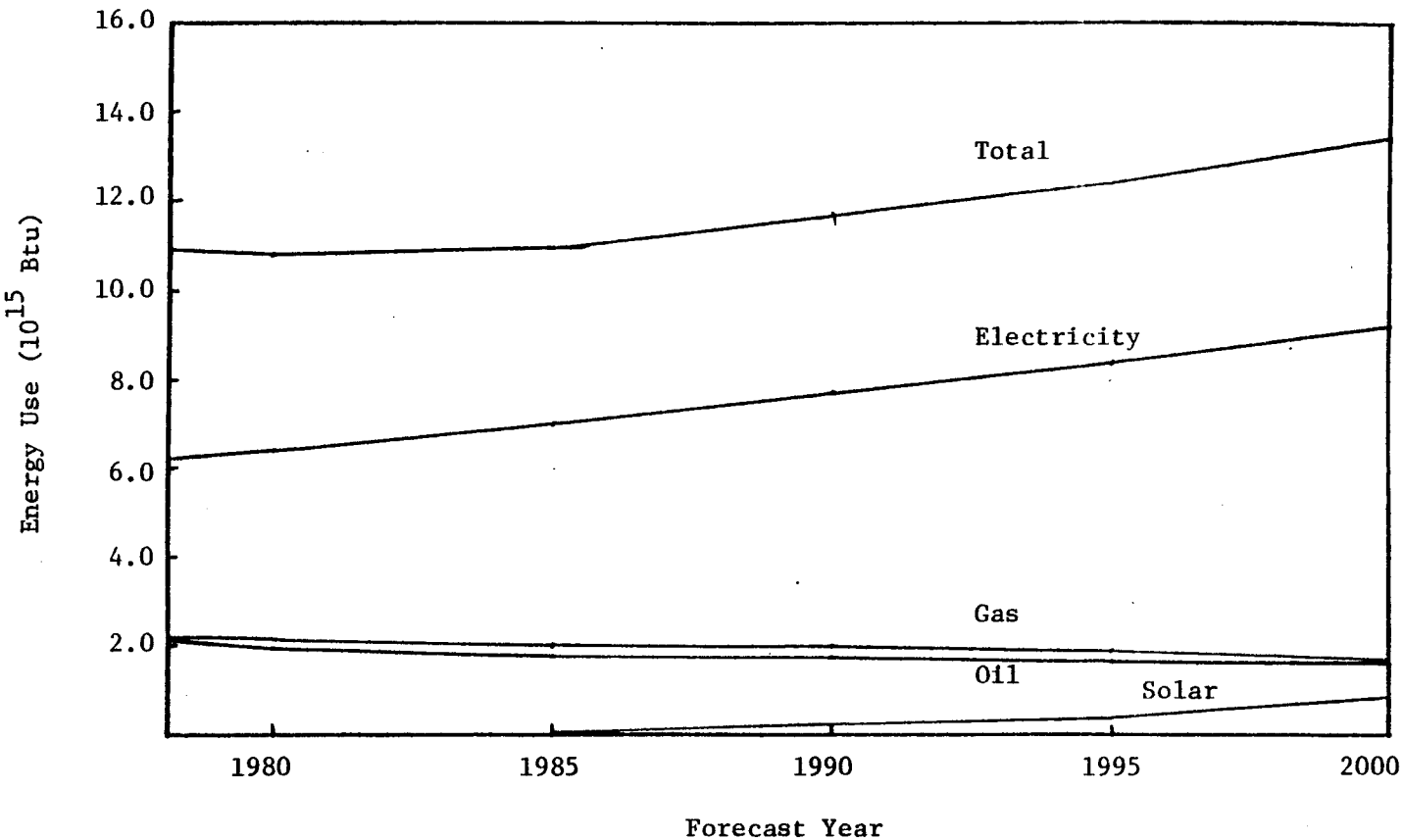


Table VII-20
NATIONAL COMMERCIAL ENERGY USE BY FUEL AND END USE,
1978 AND 2000, HIGH FUEL PRICE SCENARIO

	Energy Use, 10^{15} Btu		Average Annual
	1978	2000	Growth Rate (%)
Fuel			
Electricity	6.19	9.18	1.81
Gas	2.26	1.75	-1.16
Oil	2.15	1.63	-1.26
Solar		.84	
End Use			
Heating	4.31	3.70	-.69
Cooling	3.05	5.05	2.32
Water Heating	.26	.25	-.18
Lighting	2.23	3.01	1.37
Other	.90	1.39	2.00
Total	10.76	13.40	1.00

Both space and water heating energy use declines over this period while air conditioning, lighting and the other end use increase at 2.32, 1.37 and 2.00 percent respectively. Relative to year 2000 baseline forecasts, water heating and space heating reflect the greatest decline (22 and 20 percent), cooling and lighting are next at 15 percent each, and the other end use is 11 percent less than in the baseline case. These differences in energy use reduction accross end uses reflect primarily the predominant fuel used to provide the end use service and the conservation potential of the various end uses. Water and space heating are almost completely fossil fuel dependent and space heating shows greater conservation potential than the other end uses. Lighting, cooling and the other end use are fueled primarily by electricity which shows a less rapid rate of price increase than the fossil fuels. Total energy use increases at a rate of 1 percent from 1978 to 2000; this rate is 56 percent of the baseline growth rate and 36 percent of the floor space growth rate.

Again, the year 2000 importance of each fuel and end use energy use relative to total energy use is within 2 percent of that reflected in the baseline scenario (Figures VII-3 and VII-4). The stricter conservation programs and markedly higher fuel prices have apparently not altered the relative fuel use patterns established by the construction standards and fuel prices of the baseline scenario.

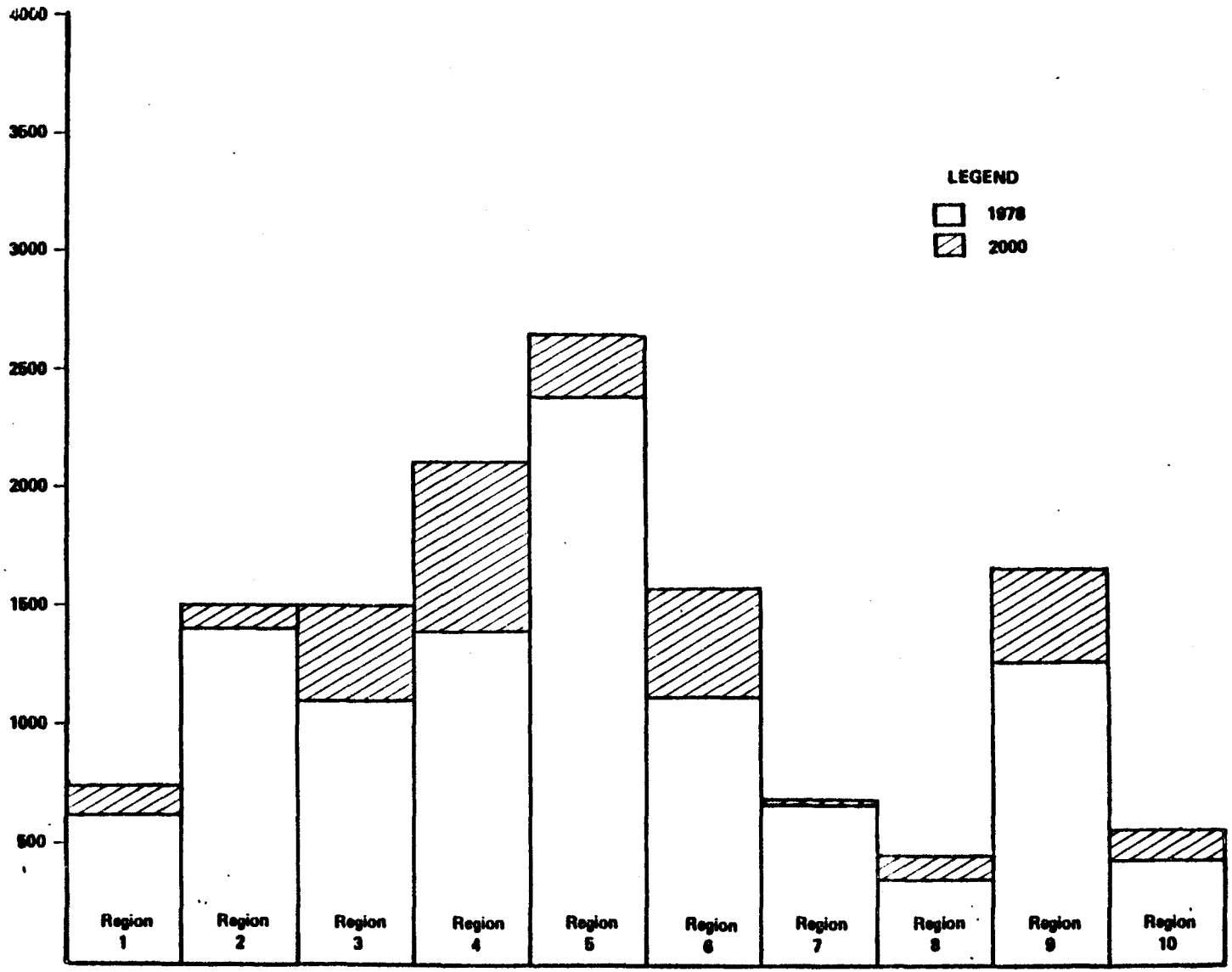
Total energy use by region is presented in Table VII-21 for 1978 and 2000. The impacts of the higher fuel prices do not vary significantly by region. Impacts range from a 15 to 18 percent reduction. As indicted clearly in Figure VII-11, a number of regions show only slightly more energy use in 2000 than 1978. Region 7 energy use grows at an annual rate of only .2 percent.

Table VII-21
COMMERCIAL ENERGY USE BY REGION
1978 AND 2000, HIGH FUEL PRICE SCENARIO

	(10^{12}Btu)		Average Annual
Region	1978	2000	Growth Rate (%)
1	.62	.73	0.75
2	1.39	1.49	0.32
3	1.17	1.48	1.07
4	1.39	2.14	1.98
5	2.36	2.62	0.48
6	1.12	1.57	1.55
7	.66	.69	0.20
8	.35	.45	1.15
9	1.26	1.67	1.29
10	.43	.56	1.21
Total U.S.	10.76	13.40	1.00

Figure VII-11

Commercial Energy Use by Region
1978-2000, High Price Scenario



LOW CONSUMPTION SCENARIO

Our final forecast scenario retains all the assumption of the previous scenario except that a verry stringent construction standard is imposed. Average impact of the new standard is shown in Table VII-22. Energy use in new buildings is reduced by well over fifty percent for almost all end uses and building types.

Future energy use under these assumptions is reduced considerably as indicated in Table VII-23 and Figure VII-12. Total energy use grows by only 1.3 QBtu over the forecast period; this translates into an average growth rate of .53 percent per year. Although electricity still reflects annual increases in this period, gas and oil use decline at 1.7 and 1.9 percent annually. Primary fuel replaced by solar systems is .76, somewhat less than the previous scenario.

Space heating energy use is exactly 1 QBtu less in 2000 than in 1978. Water heating energy use also declines in this period. Cooling and the other end use energy increase over this period, although the rates of increase (1.87 and 2.00 respectively) are a good deal less than the rate of floor space increase.

Table VII-22
EXPECTED AVERAGE IMPACT OF THE LOW CONSUMPTION CONSTRUCTION STANDARDS: ENERGY USE RELATIVE TO 1970 BY BUILDING TYPE AND END USE

	Heating	Cooling	Water Heat	Lighting
Office, Public, Federal	0.15	0.38	0.38	0.43
Retail/Wholesale	0.25	0.53	0.41	0.61
Garage, Warehouse, Religious, Misc.	0.29	0.40		
Educational Services	0.25	0.38	0.38	0.44
Health Services	0.18	0.47	0.46	0.44
Hotel/Motel	0.35	0.28	0.28	0.53

Regionally, (Table VII-24 and Figure VII-13), energy use declines in Regions 2 and 7 while increases in Regions 1 and 5 are close to zero. Regions 4 and 9 still show sizeable increases primarily because of large inceases in growth of floor space in those regions.

Table VII-23
NATIONAL COMMERCIAL ENERGY USE BY FUEL AND END USE,
1978 AND 2000 LOW CONSUMPTION SCENARIO

	Energy Use, 10^{15} Btu		Average Annual
	1978	2000	Growth Rate (%)
Fuel			
Electricity	6.19	8.39	1.39
Gas	2.26	1.55	-1.70
Oil	2.15	1.39	-1.97
Solar		.76	
End Use			
Heating	4.31	3.31	-1.19
Cooling	3.05	4.58	1.87
Water Heating	.26	.22	-0.76
Lighting	2.23	2.59	0.68
Other	.90	1.39	2.00
Total	10.76	12.09	0.53

Table VII-24
COMMERCIAL ENERGY USE BY REGION
1978 AND 2000 LOW CONSUMPTION SCENARIO

Region	(10^{12}Btu) 1978	2000	Average Annual Growth Rate (%)
1	.62	.67	0.35
2	1.39	1.36	-0.10
3	1.17	1.34	0.62
4	1.39	1.91	1.46
5	2.36	2.40	0.08
6	1.12	1.39	0.99
7	.66	.63	-0.21
8	.35	.41	0.72
9	1.26	1.49	0.77
10	.43	.50	0.69
Total U.S.	10.74	12.09	0.53

Figure VII-12

National Commercial Energy Use 1978-2000
Low Consumption Scenario

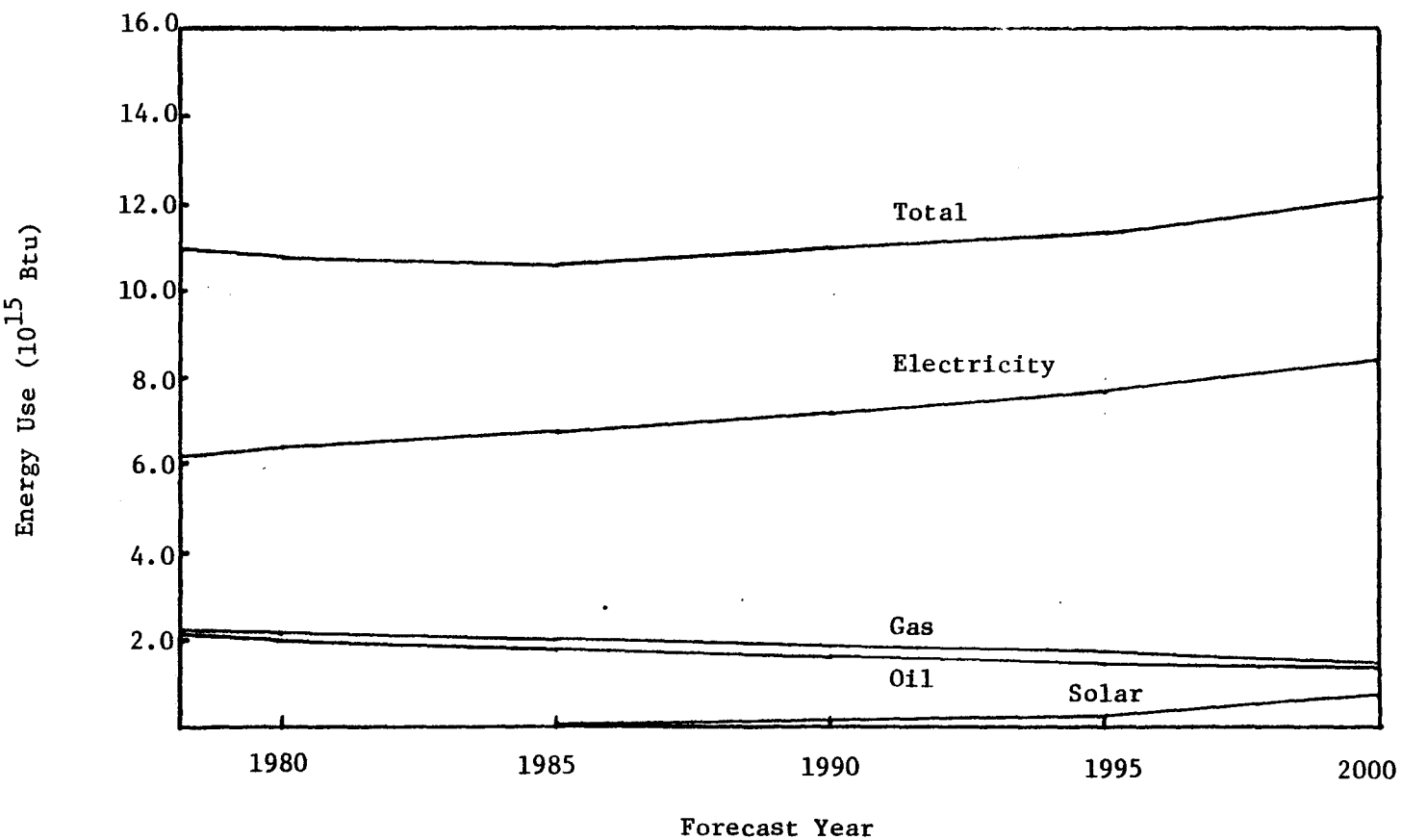
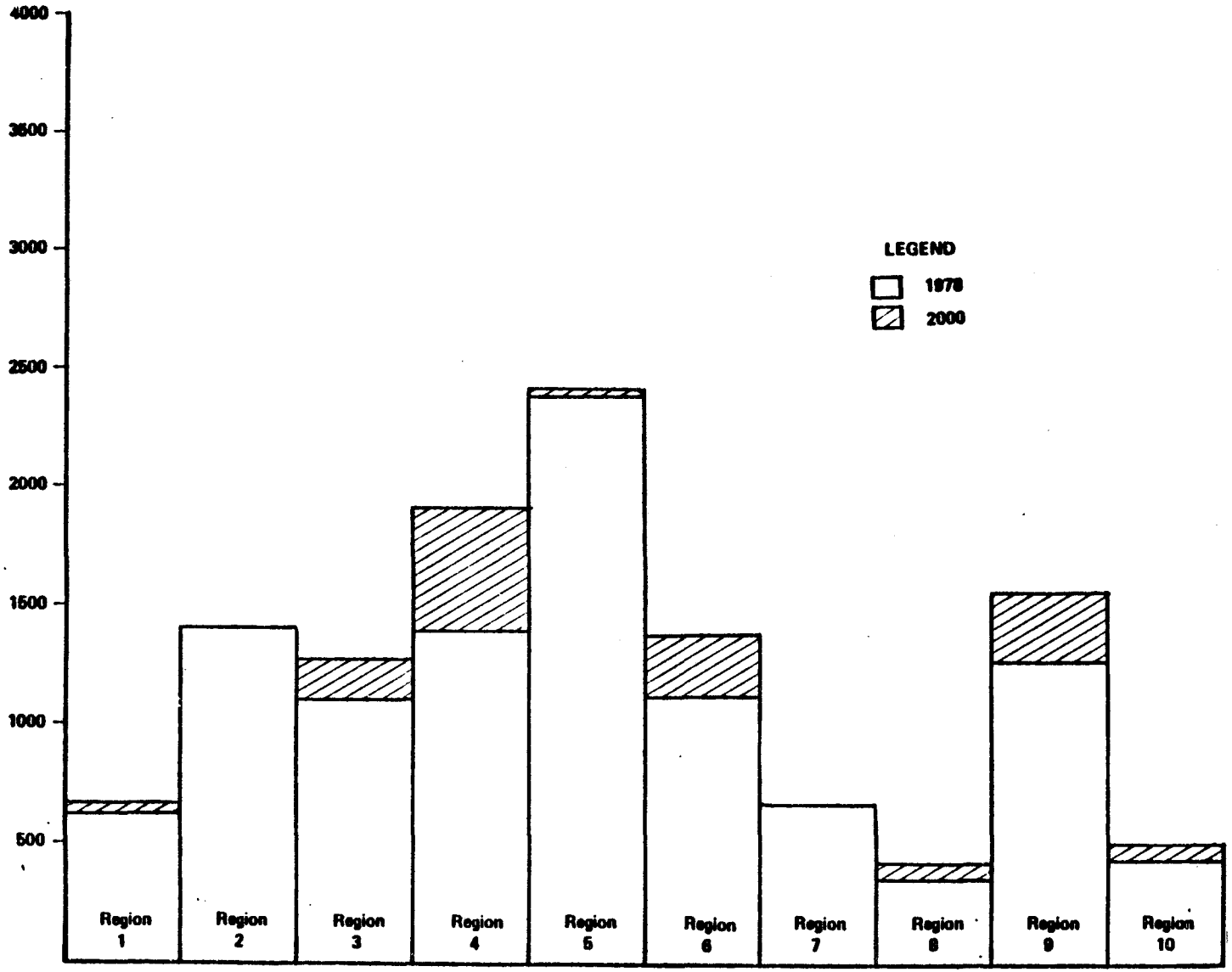


Figure VII-13

Commercial Energy Use by Region
1978-2000, Low Consumption Scenario



VIII. COMPARISON WITH OTHER FORECASTS

A comparison of our conservation scenario forecasts with the results of other commercial sector studies provides some insight on how others perceive the energy future of the commercial sector. We use the conservation scenario forecasts for comparison because the assumptions in that scenario are closest to aassumptions used by others in their forecasting exercises. We have also made an attempt to include in our comparative analysis only the results of relatively recent forecasting studies in an effort to reduce variations in assumptions on future fuel prices and economic activity.

Three studies were located for this comparison. The first is the long-term energy forecasts published by the Energy Information Administration in the 1979 Annual Report to Congress (Department of Energy (1980)). The modeling approach used in this portion of EIA's forecast is a general equilibrium model where sectors are represented by general processes which are calibrated on more detailed models of the sectors. The second commercial sector energy demand study was recently completed by Huntington and Soffer (1979) at Data Resources Incorporated (DRI). This study utilized an econometric model whose parameters were estimated with state level cross-section time series data. The third modeling activity is one by MITRE Corporation and documented in Rebibo (1979) and Taul and deJong (1980). The MITRE model is a building components simulation model which essentially represents a detailed accounting framework.

Table VIII-1 presents energy forecasts and assumptions on fuel prices and economic activity measure used in the different models. It is obvious from the table that even with studies published within the last year, assumptions on economic activity and fuel prices are extremely diverse. While variations in fuel price and economic activity make a detailed comparison difficult, it is possible to adjust, in a very rough way, the DRI and MITRE forecasts to reflect the same level of economic activity by multiplying energy use by a factor given by our floor space forecasts for 2000 divided by each study's floor space forecast by 2000. These studies also yield differ-

Table VIII-1
COMPARISON OF RECENT COMMERCIAL ENERGY USE FORECASTS

	EIA	DRI	MITRE	Conservation Scenario
Energy Use (10^{15}Btu)				
Electricity[a]	8.43	8.23	11.75[b]	10.53
Gas	2.80	1.59	2.69	2.31
Oil	1.00	3.10	.88	1.75
Solar	.10	-	.66	.47
Total	12.33	12.72	15.99	15.06
Year 2000 Prices (1975$/$10^6$ Btu)				
Electricty	3.81[c]	5.04	4.36	3.77
Gas	5.88	5.25	4.35	3.97
Oil	3.62	4.21	4.87	6.18
Floor space growth	-	2.5	2.2[d]	2.8

[a]All electricity is measured as primary energy, that is 11,500 Btu = 1 kwh

[b]DRI prices estimated from information provided in Huntington and Stoffer (1979)

[c]We assume that floor space grows at the same rate as number of establishments.

ent forecasts because of different assumptions on commercial sector historical fuel use. Again we roughly adjust year 2000 fuel use estimates by multiplying estimates from each study by a factor defined by our 1978 fuel use estimates.

The adjusted forecasts are given in Table VIII-2. Forecast electricity use is almost identical for the MITRE and Conservation Scenario (CS hereafter), DRI's electricity forecast is considerably greater than the MITRE or CS forecasts. If adjustments could be made for different price assumptions, MITRE's electricity use forecast would be increased to correspond to lower price increase assumptions in CS and DRI forecasts.

Forecasts of gas use are similar for MITRE and CS, although MITRE forecasts would increase if adjustments were made to reduce MITRE's price assumptions. DRI's gas use would increase if price adjustments could be made.

Table VIII-2
COMPARISONOF ADJUSTED COMMERCIAL
SECTOR FORECASTS

	DRI	MITRE	Conservation Scenario
Energy Use (10^{15} Btu)			
Electricity	11.89	10.58	10.53
Gas	2.05	2.42	2.31
Oil	6.21	.79	1.75
Solar	____	.60	.47
Total	20.15	14.39	15.06

Oil use varies most significantly accross studies. DRI's forecast is three times the CS forecast and almost eight times that of MITRE. Some of this discrepancy is due to price assumptions shown in Table VIII-1. Solar forecasts are surprisingly close for the MITRE and CS forecasts. Solar represents 4 percent and 3 percent of the MITRE and CS forecsts respectively.

In general, we should expect DRI's econometric forecast to be greater than the end use forecasts from MITRE and CS because of the inherent characteristics of these two modeling approaches. A closer examination of the DRI forecasts show that the gas and oil and the floor space projections are consistent only if the efficiency of space heating systems does not improve after 1978. Thus the DRI forecast is undoubedly upward biased. While more information is required for a detailed comparison of the MITRE and CS forecasts; their consistency probably should be interpreted as mutually supportive of both studies.

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Appendix A

Regional Historical Energy Use by Building Type, Fuel and End Use

TABLE A-1. REGION 1 HISTORICAL ENERGY USE

BY BUILDING TYPE AND FUEL

	1970	1971	1972	1973	1974	1975	1976	1977	1978
OFFICE									
ELEC	0.0343	0.0383	0.0414	0.0473	0.0466	0.0494	0.0520	0.0538	0.0554
GAS	0.0045	0.0049	0.0049	0.0050	0.0050	0.0050	0.0049	0.0053	0.0058
OIL	0.0557	0.0580	0.0609	0.0628	0.0513	0.0443	0.0504	0.0456	0.0451
OTHR	0.0005	0.0006	0.0006	0.0006	0.0007	0.0006	0.0006	0.0007	0.0008
TOTAL	0.0950	0.1018	0.1077	0.1157	0.1036	0.0993	0.1080	0.1053	0.1071
RETL-WHL									
ELEC	0.0426	0.0474	0.0510	0.0566	0.0552	0.0589	0.0620	0.0641	0.0661
GAS	0.0121	0.0126	0.0124	0.0128	0.0128	0.0123	0.0120	0.0123	0.0131
OIL	0.0529	0.0553	0.0584	0.0578	0.0472	0.0405	0.0472	0.0420	0.0416
OTHR	0.0005	0.0006	0.0006	0.0006	0.0006	0.0006	0.0006	0.0006	0.0008
TOTAL	0.1081	0.1159	0.1224	0.1278	0.1158	0.1122	0.1218	0.1190	0.1216
AUTO REP									
ELEC	0.0022	0.0025	0.0027	0.0028	0.0026	0.0030	0.0032	0.0032	0.0033
GAS	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0004
OIL	0.0034	0.0036	0.0038	0.0034	0.0028	0.0024	0.0030	0.0026	0.0026
OTHR	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001
TOTAL	0.0060	0.0064	0.0068	0.0065	0.0057	0.0057	0.0065	0.0061	0.0063
WAREHSE									
ELEC	0.0046	0.0051	0.0056	0.0063	0.0061	0.0066	0.0070	0.0072	0.0074
GAS	0.0006	0.0007	0.0007	0.0007	0.0007	0.0007	0.0007	0.0007	0.0008
OIL	0.0078	0.0082	0.0087	0.0085	0.0071	0.0059	0.0071	0.0062	0.0062
OTHR	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
TOTAL	0.0131	0.0140	0.0151	0.0156	0.0139	0.0133	0.0149	0.0143	0.0145
EDUC SER									
ELEC	0.0414	0.0452	0.0501	0.0534	0.0509	0.0563	0.0596	0.0611	0.0630
GAS	0.0063	0.0067	0.0069	0.0067	0.0065	0.0067	0.0067	0.0071	0.0078
OIL	0.0799	0.0815	0.0866	0.0851	0.0679	0.0599	0.0678	0.0613	0.0590
OTHR	0.0007	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0009	0.0010
TOTAL	0.1283	0.1341	0.1444	0.1460	0.1262	0.1238	0.1350	0.1303	0.1309
PUB BLDG									
ELEC	0.0025	0.0027	0.0031	0.0031	0.0029	0.0035	0.0038	0.0038	0.0039
GAS	0.0004	0.0005	0.0005	0.0004	0.0004	0.0005	0.0005	0.0005	0.0006
OIL	0.0054	0.0055	0.0059	0.0056	0.0044	0.0039	0.0047	0.0041	0.0041
OTHR	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
TOTAL	0.0084	0.0088	0.0096	0.0092	0.0078	0.0079	0.0090	0.0084	0.0087
FED BLDG									
ELEC	0.0011	0.0012	0.0014	0.0014	0.0013	0.0015	0.0017	0.0017	0.0017
GAS	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0003
OIL	0.0024	0.0025	0.0026	0.0025	0.0020	0.0017	0.0021	0.0018	0.0018
OTHR	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
TOTAL	0.0037	0.0039	0.0042	0.0041	0.0035	0.0035	0.0040	0.0037	0.0039
HEALTH									
ELEC	0.0258	0.0284	0.0308	0.0331	0.0318	0.0348	0.0368	0.0379	0.0394
GAS	0.0045	0.0048	0.0048	0.0048	0.0047	0.0047	0.0047	0.0049	0.0054
OIL	0.0591	0.0593	0.0617	0.0605	0.0492	0.0442	0.0487	0.0448	0.0437
OTHR	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.0005	0.0005
TOTAL	0.0899	0.0930	0.0978	0.0988	0.0862	0.0841	0.0905	0.0881	0.0891
REL SERV									
ELEC	0.0115	0.0124	0.0138	0.0147	0.0140	0.0154	0.0162	0.0166	0.0170
GAS	0.0015	0.0016	0.0016	0.0016	0.0015	0.0016	0.0016	0.0017	0.0018
OIL	0.0189	0.0192	0.0205	0.0204	0.0160	0.0142	0.0159	0.0144	0.0138
OTHR	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002
TOTAL	0.0322	0.0333	0.0362	0.0369	0.0317	0.0314	0.0338	0.0328	0.0328
HOTLBLDG									
ELEC	0.0086	0.0094	0.0107	0.0113	0.0107	0.0126	0.0137	0.0140	0.0144
GAS	0.0023	0.0024	0.0025	0.0024	0.0023	0.0024	0.0023	0.0025	0.0027
OIL	0.0292	0.0296	0.0315	0.0312	0.0249	0.0219	0.0245	0.0221	0.0211
OTHR	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0004
TOTAL	0.0404	0.0417	0.0449	0.0453	0.0382	0.0371	0.0408	0.0389	0.0386
MISC									
ELEC	0.0234	0.0253	0.0279	0.0308	0.0298	0.0318	0.0333	0.0343	0.0353
GAS	0.0028	0.0029	0.0030	0.0029	0.0029	0.0029	0.0029	0.0031	0.0036
OIL	0.0345	0.0349	0.0373	0.0369	0.0301	0.0260	0.0299	0.0267	0.0263
OTHR	0.0003	0.0003	0.0004	0.0004	0.0004	0.0003	0.0004	0.0004	0.0005
TOTAL	0.0609	0.0635	0.0686	0.0710	0.0632	0.0611	0.0665	0.0645	0.0657

TABLE A-2. REGION 2 HISTORICAL ENERGY USE

BY BUILDING TYPE AND FUEL

	1970	1971	1972	1973	1974	1975	1976	1977	1978
OFFICE									
ELEC	0.0933	0.0998	0.1044	0.1129	0.1313	0.1129	0.1152	0.1209	0.1289
GAS	0.0220	0.0236	0.0239	0.0234	0.0228	0.0206	0.0208	0.0217	0.0224
OIL	0.1152	0.1149	0.1156	0.1179	0.1055	0.0963	0.1122	0.1124	0.1099
OTHR	0.0012	0.0013	0.0013	0.0013	0.0014	0.0013	0.0014	0.0016	0.0019
TOTAL	0.2317	0.2396	0.2452	0.2555	0.2610	0.2311	0.2495	0.2566	0.2631
RETL-WHL									
ELEC	0.1142	0.1218	0.1273	0.1358	0.1521	0.1349	0.1380	0.1420	0.1498
GAS	0.0409	0.0430	0.0428	0.0420	0.0417	0.0386	0.0384	0.0392	0.0400
OIL	0.1106	0.1094	0.1115	0.1103	0.0977	0.0894	0.1056	0.1042	0.1011
OTHR	0.0012	0.0013	0.0013	0.0013	0.0013	0.0012	0.0013	0.0015	0.0018
TOTAL	0.2670	0.2755	0.2827	0.2895	0.2929	0.2642	0.2833	0.2869	0.2927
AUTO REP									
ELEC	0.0070	0.0074	0.0078	0.0081	0.0084	0.0077	0.0079	0.0076	0.0078
GAS	0.0017	0.0018	0.0019	0.0016	0.0015	0.0014	0.0015	0.0014	0.0015
OIL	0.0089	0.0086	0.0090	0.0082	0.0072	0.0066	0.0080	0.0077	0.0074
OTHR	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
TOTAL	0.0177	0.0179	0.0188	0.0180	0.0172	0.0158	0.0174	0.0168	0.0169
WAREHSE									
ELEC	0.0131	0.0139	0.0147	0.0157	0.0183	0.0157	0.0160	0.0166	0.0176
GAS	0.0036	0.0038	0.0040	0.0037	0.0036	0.0032	0.0033	0.0034	0.0035
OIL	0.0188	0.0185	0.0190	0.0186	0.0168	0.0152	0.0181	0.0180	0.0176
OTHR	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0003	0.0003
TOTAL	0.0358	0.0365	0.0379	0.0383	0.0389	0.0343	0.0376	0.0383	0.0391
EDUC SER									
ELEC	0.0974	0.1012	0.1088	0.1145	0.1258	0.1117	0.1141	0.1134	0.1180
GAS	0.0269	0.0283	0.0292	0.0281	0.0260	0.0245	0.0247	0.0246	0.0247
OIL	0.1417	0.1391	0.1419	0.1426	0.1217	0.1137	0.1321	0.1277	0.1193
OTHR	0.0015	0.0016	0.0017	0.0016	0.0016	0.0016	0.0017	0.0018	0.0021
TOTAL	0.2675	0.2701	0.2816	0.2868	0.2750	0.2515	0.2725	0.2675	0.2642
PUB BLDG									
ELEC	0.0147	0.0152	0.0162	0.0169	0.0176	0.0162	0.0165	0.0160	0.0164
GAS	0.0035	0.0036	0.0037	0.0036	0.0032	0.0031	0.0031	0.0030	0.0030
OIL	0.0183	0.0178	0.0181	0.0181	0.0150	0.0142	0.0164	0.0155	0.0145
OTHR	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0003
TOTAL	0.0367	0.0368	0.0382	0.0389	0.0360	0.0337	0.0363	0.0347	0.0341
FED BLDG									
ELEC	0.0068	0.0070	0.0075	0.0078	0.0081	0.0075	0.0076	0.0074	0.0075
GAS	0.0016	0.0016	0.0017	0.0016	0.0014	0.0014	0.0014	0.0013	0.0014
OIL	0.0082	0.0080	0.0081	0.0081	0.0067	0.0063	0.0074	0.0069	0.0065
OTHR	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
TOTAL	0.0166	0.0167	0.0174	0.0175	0.0163	0.0152	0.0164	0.0157	0.0155
HEALTH									
ELEC	0.0616	0.0647	0.0684	0.0721	0.0795	0.0711	0.0728	0.0731	0.0765
GAS	0.0181	0.0190	0.0194	0.0187	0.0175	0.0164	0.0165	0.0165	0.0168
OIL	0.0976	0.0962	0.0973	0.0967	0.0833	0.0782	0.0893	0.0869	0.0821
OTHR	0.0009	0.0009	0.0010	0.0009	0.0009	0.0009	0.0009	0.0010	0.0012
TOTAL	0.1782	0.1809	0.1860	0.1884	0.1813	0.1665	0.1795	0.1775	0.1765
REL SERV									
ELEC	0.0129	0.0131	0.0144	0.0151	0.0168	0.0147	0.0150	0.0147	0.0153
GAS	0.0043	0.0044	0.0046	0.0044	0.0040	0.0038	0.0039	0.0038	0.0039
OIL	0.0221	0.0215	0.0222	0.0224	0.0190	0.0177	0.0209	0.0200	0.0191
OTHR	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0004
TOTAL	0.0395	0.0393	0.0416	0.0422	0.0402	0.0365	0.0400	0.0389	0.0386
HOTLBLDG									
ELEC	0.0189	0.0192	0.0213	0.0223	0.0269	0.0222	0.0229	0.0225	0.0236
GAS	0.0107	0.0111	0.0114	0.0111	0.0102	0.0096	0.0096	0.0096	0.0096
OIL	0.0566	0.0551	0.0560	0.0569	0.0486	0.0454	0.0524	0.0504	0.0473
OTHR	0.0006	0.0006	0.0006	0.0006	0.0006	0.0006	0.0006	0.0007	0.0008
TOTAL	0.0868	0.0861	0.0894	0.0909	0.0864	0.0778	0.0855	0.0832	0.0813
MISC									
ELEC	0.0686	0.0710	0.0761	0.0814	0.0904	0.0800	0.0815	0.0831	0.0872
GAS	0.0147	0.0153	0.0160	0.0152	0.0145	0.0133	0.0135	0.0138	0.0144
OIL	0.0769	0.0746	0.0770	0.0762	0.0672	0.0618	0.0723	0.0711	0.0685
OTHR	0.0008	0.0008	0.0009	0.0009	0.0009	0.0009	0.0009	0.0010	0.0013
TOTAL	0.1610	0.1617	0.1701	0.1736	0.1731	0.1559	0.1683	0.1690	0.1713

TABLE A-3. REGION 3 HISTORICAL ENERGY USE
BY BUILDING TYPE AND FUEL

	1970	1971	1972	1973	1974	1975	1976	1977	1978
OFFICE									
ELEC	0.0645	0.0701	0.0755	0.0864	0.0885	0.0932	0.0968	0.1007	0.1172
GAS	0.0235	0.0266	0.0292	0.0296	0.0283	0.0258	0.0294	0.0276	0.0287
OIL	0.0423	0.0426	0.0427	0.0454	0.0388	0.0331	0.0355	0.0339	0.0315
OTHR	0.0033	0.0032	0.0033	0.0031	0.0029	0.0028	0.0027	0.0027	0.0025
TOTAL	0.1337	0.1426	0.1507	0.1645	0.1585	0.1549	0.1644	0.1649	0.1798
RETL-WHL									
ELEC	0.0980	0.1062	0.1131	0.1251	0.1246	0.1336	0.1399	0.1447	0.1669
GAS	0.0428	0.0469	0.0498	0.0497	0.0481	0.0443	0.0488	0.0459	0.0478
OIL	0.0514	0.0513	0.0514	0.0523	0.0436	0.0377	0.0409	0.0390	0.0361
OTHR	0.0042	0.0040	0.0041	0.0037	0.0035	0.0033	0.0033	0.0033	0.0029
TOTAL	0.1965	0.2083	0.2184	0.2307	0.2198	0.2189	0.2330	0.2330	0.2537
AUTO REP									
ELEC	0.0042	0.0045	0.0047	0.0048	0.0044	0.0051	0.0055	0.0055	0.0064
GAS	0.0016	0.0018	0.0019	0.0016	0.0014	0.0015	0.0017	0.0016	0.0018
OIL	0.0028	0.0028	0.0028	0.0026	0.0020	0.0019	0.0021	0.0020	0.0019
OTHR	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002
TOTAL	0.0088	0.0092	0.0096	0.0092	0.0080	0.0086	0.0094	0.0093	0.0102
WAREHSE									
ELEC	0.0130	0.0140	0.0151	0.0170	0.0170	0.0184	0.0192	0.0199	0.0233
GAS	0.0054	0.0060	0.0067	0.0064	0.0060	0.0055	0.0064	0.0061	0.0064
OIL	0.0097	0.0096	0.0097	0.0099	0.0083	0.0071	0.0078	0.0074	0.0069
OTHR	0.0008	0.0008	0.0008	0.0007	0.0007	0.0006	0.0006	0.0006	0.0006
TOTAL	0.0289	0.0304	0.0323	0.0339	0.0320	0.0317	0.0340	0.0340	0.0372
EDUC SER									
ELEC	0.0959	0.1014	0.1091	0.1158	0.1102	0.1238	0.1309	0.1337	0.1559
GAS	0.0397	0.0441	0.0483	0.0462	0.0413	0.0400	0.0464	0.0426	0.0438
OIL	0.0720	0.0712	0.0713	0.0718	0.0583	0.0514	0.0555	0.0524	0.0471
OTHR	0.0056	0.0053	0.0055	0.0049	0.0045	0.0043	0.0043	0.0043	0.0035
TOTAL	0.2133	0.2221	0.2342	0.2387	0.2143	0.2195	0.2371	0.2330	0.2503
PUB BLDG									
ELEC	0.0169	0.0178	0.0187	0.0192	0.0176	0.0206	0.0217	0.0219	0.0253
GAS	0.0061	0.0067	0.0072	0.0067	0.0057	0.0058	0.0068	0.0061	0.0063
OIL	0.0110	0.0108	0.0106	0.0104	0.0082	0.0074	0.0080	0.0074	0.0068
OTHR	0.0009	0.0008	0.0008	0.0007	0.0007	0.0006	0.0006	0.0006	0.0005
TOTAL	0.0348	0.0360	0.0374	0.0370	0.0321	0.0345	0.0371	0.0361	0.0390
FED BLDG									
ELEC	0.0062	0.0065	0.0068	0.0070	0.0064	0.0075	0.0079	0.0080	0.0092
GAS	0.0022	0.0025	0.0027	0.0025	0.0021	0.0021	0.0025	0.0023	0.0024
OIL	0.0040	0.0040	0.0039	0.0038	0.0030	0.0027	0.0029	0.0027	0.0025
OTHR	0.0003	0.0003	0.0003	0.0003	0.0002	0.0002	0.0002	0.0002	0.0002
TOTAL	0.0128	0.0132	0.0137	0.0135	0.0118	0.0126	0.0136	0.0133	0.0143
HEALTH									
ELEC	0.0528	0.0563	0.0597	0.0638	0.0614	0.0683	0.0725	0.0741	0.0861
GAS	0.0220	0.0244	0.0264	0.0253	0.0230	0.0219	0.0252	0.0233	0.0240
OIL	0.0405	0.0402	0.0400	0.0401	0.0331	0.0294	0.0316	0.0300	0.0273
OTHR	0.0029	0.0028	0.0028	0.0025	0.0024	0.0023	0.0023	0.0023	0.0019
TOTAL	0.1182	0.1237	0.1290	0.1317	0.1198	0.1219	0.1313	0.1296	0.1392
REL SERV									
ELEC	0.0128	0.0133	0.0146	0.0152	0.0142	0.0166	0.0176	0.0180	0.0214
GAS	0.0064	0.0071	0.0079	0.0074	0.0064	0.0064	0.0075	0.0069	0.0072
OIL	0.0116	0.0114	0.0115	0.0115	0.0093	0.0082	0.0089	0.0084	0.0077
OTHR	0.0010	0.0009	0.0009	0.0008	0.0008	0.0007	0.0007	0.0007	0.0006
TOTAL	0.0318	0.0327	0.0348	0.0350	0.0308	0.0319	0.0348	0.0340	0.0369
HOTLBLDG									
ELEC	0.0209	0.0218	0.0236	0.0249	0.0233	0.0277	0.0297	0.0304	0.0370
GAS	0.0144	0.0158	0.0173	0.0166	0.0149	0.0141	0.0163	0.0150	0.0154
OIL	0.0263	0.0258	0.0257	0.0261	0.0212	0.0186	0.0199	0.0187	0.0167
OTHR	0.0021	0.0019	0.0020	0.0018	0.0017	0.0016	0.0016	0.0015	0.0012
TOTAL	0.0636	0.0653	0.0686	0.0694	0.0611	0.0620	0.0675	0.0656	0.0703
MISC									
ELEC	0.0551	0.0580	0.0632	0.0696	0.0687	0.0735	0.0768	0.0790	0.0909
GAS	0.0183	0.0201	0.0224	0.0216	0.0199	0.0186	0.0216	0.0202	0.0214
OIL	0.0330	0.0322	0.0328	0.0332	0.0277	0.0240	0.0260	0.0247	0.0227
OTHR	0.0026	0.0025	0.0025	0.0023	0.0021	0.0020	0.0020	0.0020	0.0016
TOTAL	0.1091	0.1128	0.1209	0.1267	0.1185	0.1181	0.1264	0.1259	0.1366

TABLE A-4. REGION 4 HISTORICAL ENERGY USE
BY BUILDING TYPE AND FUEL

	1970	1971	1972	1973	1974	1975	1976	1977	1978
OFFICE									
ELEC	0.0878	0.0976	0.1148	0.1303	0.1412	0.1280	0.1359	0.1514	0.1565
GAS	0.0260	0.0278	0.0286	0.0295	0.0300	0.0285	0.0330	0.0334	0.0315
OIL	0.0162	0.0170	0.0208	0.0232	0.0249	0.0225	0.0330	0.0333	0.0313
OTHR	0.0042	0.0040	0.0043	0.0042	0.0039	0.0036	0.0039	0.0038	0.0034
TOTAL	0.1342	0.1464	0.1686	0.1873	0.2000	0.1827	0.2059	0.2219	0.2227
RETL-WHL									
ELEC	0.1360	0.1505	0.1694	0.1878	0.1961	0.1875	0.1986	0.2166	0.2224
GAS	0.0510	0.0531	0.0564	0.0568	0.0580	0.0562	0.0615	0.0610	0.0584
OIL	0.0205	0.0212	0.0246	0.0270	0.0276	0.0261	0.0393	0.0389	0.0361
OTHR	0.0055	0.0051	0.0054	0.0052	0.0047	0.0045	0.0049	0.0048	0.0040
TOTAL	0.2129	0.2299	0.2558	0.2767	0.2864	0.2743	0.3043	0.3212	0.3210
AUTO REP									
ELEC	0.0046	0.0051	0.0053	0.0056	0.0052	0.0062	0.0063	0.0065	0.0066
GAS	0.0014	0.0015	0.0013	0.0013	0.0011	0.0014	0.0017	0.0016	0.0015
OIL	0.0009	0.0009	0.0010	0.0010	0.0009	0.0011	0.0016	0.0016	0.0014
OTHR	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002
TOTAL	0.0072	0.0076	0.0078	0.0081	0.0074	0.0089	0.0098	0.0099	0.0096
WARENSE									
ELEC	0.0206	0.0227	0.0257	0.0289	0.0305	0.0281	0.0301	0.0333	0.0343
GAS	0.0071	0.0073	0.0072	0.0073	0.0071	0.0069	0.0084	0.0084	0.0079
OIL	0.0045	0.0046	0.0054	0.0060	0.0062	0.0057	0.0088	0.0088	0.0082
OTHR	0.0012	0.0011	0.0012	0.0012	0.0010	0.0010	0.0011	0.0011	0.0009
TOTAL	0.0334	0.0357	0.0394	0.0434	0.0448	0.0417	0.0484	0.0516	0.0512
EDUC SER									
ELEC	0.1205	0.1304	0.1406	0.1530	0.1509	0.1578	0.1643	0.1752	0.1776
GAS	0.0413	0.0432	0.0418	0.0413	0.0386	0.0423	0.0476	0.0460	0.0418
OIL	0.0270	0.0278	0.0320	0.0342	0.0341	0.0343	0.0489	0.0474	0.0427
OTHR	0.0068	0.0064	0.0068	0.0064	0.0057	0.0056	0.0058	0.0056	0.0045
TOTAL	0.1956	0.2077	0.2211	0.2349	0.2293	0.2400	0.2665	0.2742	0.2666
PUB BLDG									
ELEC	0.0185	0.0199	0.0207	0.0219	0.0207	0.0241	0.0243	0.0251	0.0252
GAS	0.0056	0.0058	0.0053	0.0052	0.0046	0.0056	0.0061	0.0057	0.0053
OIL	0.0036	0.0037	0.0041	0.0042	0.0041	0.0044	0.0061	0.0058	0.0053
OTHR	0.0009	0.0009	0.0009	0.0008	0.0007	0.0007	0.0007	0.0007	0.0006
TOTAL	0.0287	0.0303	0.0310	0.0321	0.0300	0.0348	0.0373	0.0373	0.0363
FED BLDG									
ELEC	0.0088	0.0094	0.0098	0.0104	0.0098	0.0114	0.0115	0.0119	0.0119
GAS	0.0027	0.0028	0.0025	0.0025	0.0022	0.0027	0.0029	0.0028	0.0025
OIL	0.0017	0.0017	0.0019	0.0020	0.0019	0.0020	0.0029	0.0027	0.0025
OTHR	0.0004	0.0004	0.0004	0.0004	0.0003	0.0004	0.0004	0.0003	0.0003
TOTAL	0.0136	0.0143	0.0147	0.0152	0.0142	0.0165	0.0177	0.0177	0.0172
HEALTH									
ELEC	0.0676	0.0737	0.0794	0.0864	0.0865	0.0895	0.0935	0.1001	0.1018
GAS	0.0232	0.0242	0.0236	0.0234	0.0222	0.0238	0.0267	0.0259	0.0238
OIL	0.0152	0.0157	0.0181	0.0192	0.0191	0.0190	0.0267	0.0260	0.0236
OTHR	0.0035	0.0033	0.0035	0.0033	0.0030	0.0029	0.0031	0.0030	0.0025
TOTAL	0.1096	0.1169	0.1246	0.1323	0.1308	0.1353	0.1499	0.1550	0.1517
REL SERV									
ELEC	0.0176	0.0188	0.0198	0.0216	0.0207	0.0223	0.0233	0.0249	0.0253
GAS	0.0072	0.0075	0.0072	0.0071	0.0065	0.0073	0.0083	0.0080	0.0074
OIL	0.0047	0.0048	0.0055	0.0059	0.0058	0.0060	0.0086	0.0083	0.0076
OTHR	0.0013	0.0012	0.0012	0.0012	0.0010	0.0010	0.0011	0.0010	0.0008
TOTAL	0.0308	0.0322	0.0337	0.0357	0.0341	0.0366	0.0413	0.0422	0.0411
HOTLBLDG									
ELEC	0.0381	0.0408	0.0411	0.0458	0.0440	0.0454	0.0486	0.0530	0.0535
GAS	0.0210	0.0219	0.0207	0.0206	0.0193	0.0204	0.0230	0.0222	0.0204
OIL	0.0133	0.0136	0.0152	0.0164	0.0164	0.0160	0.0227	0.0219	0.0198
OTHR	0.0035	0.0032	0.0034	0.0032	0.0028	0.0028	0.0028	0.0027	0.0022
TOTAL	0.0759	0.0795	0.0803	0.0859	0.0826	0.0846	0.0971	0.0998	0.0959
MISC									
ELEC	0.0784	0.0843	0.0961	0.1064	0.1098	0.1051	0.1108	0.1199	0.1226
GAS	0.0215	0.0221	0.0219	0.0221	0.0212	0.0214	0.0252	0.0249	0.0233
OIL	0.0137	0.0138	0.0163	0.0178	0.0181	0.0172	0.0256	0.0253	0.0235
OTHR	0.0035	0.0032	0.0035	0.0033	0.0030	0.0029	0.0031	0.0030	0.0024
TOTAL	0.1171	0.1235	0.1378	0.1496	0.1521	0.1466	0.1647	0.1731	0.1718

TABLE A-5. REGION 5 HISTORICAL ENERGY USE
BY BUILDING TYPE AND FUEL

	1970	1971	1972	1973	1974	1975	1976	1977	1978
OFFICE									
ELEC	0.1195	0.1292	0.1381	0.1542	0.1639	0.1605	0.1675	0.1810	0.1859
GAS	0.0927	0.0982	0.1050	0.1086	0.1183	0.1088	0.1100	0.1000	0.1128
OIL	0.0562	0.0542	0.0575	0.0572	0.0607	0.0617	0.0694	0.0697	0.0718
OTHR	0.0145	0.0139	0.0145	0.0127	0.0122	0.0115	0.0116	0.0116	0.0096
TOTAL	0.2829	0.2954	0.3152	0.3326	0.3550	0.3425	0.3586	0.3622	0.3801
RETL-WHL									
ELEC	0.1968	0.2123	0.2240	0.2449	0.2506	0.2523	0.2637	0.2786	0.2840
GAS	0.1564	0.1637	0.1732	0.1727	0.1836	0.1724	0.1745	0.1599	0.1751
OIL	0.0751	0.0716	0.0764	0.0725	0.0752	0.0778	0.0887	0.0876	0.0891
OTHR	0.0196	0.0187	0.0197	0.0167	0.0161	0.0153	0.0157	0.0156	0.0122
TOTAL	0.4478	0.4662	0.4933	0.5069	0.5256	0.5177	0.5426	0.5417	0.5605
AUTO REP									
ELEC	0.0070	0.0075	0.0077	0.0080	0.0072	0.0078	0.0082	0.0081	0.0080
GAS	0.0058	0.0060	0.0066	0.0058	0.0057	0.0057	0.0061	0.0053	0.0058
OIL	0.0035	0.0033	0.0036	0.0030	0.0030	0.0032	0.0038	0.0037	0.0037
OTHR	0.0009	0.0009	0.0010	0.0007	0.0007	0.0007	0.0007	0.0007	0.0005
TOTAL	0.0173	0.0177	0.0189	0.0176	0.0167	0.0175	0.0188	0.0178	0.0180
WAREHSE									
ELEC	0.0288	0.0309	0.0330	0.0363	0.0374	0.0374	0.0392	0.0419	0.0427
GAS	0.0258	0.0268	0.0295	0.0285	0.0310	0.0288	0.0298	0.0270	0.0303
OIL	0.0157	0.0148	0.0161	0.0150	0.0160	0.0164	0.0188	0.0188	0.0192
OTHR	0.0041	0.0039	0.0042	0.0035	0.0034	0.0032	0.0033	0.0033	0.0026
TOTAL	0.0745	0.0764	0.0828	0.0832	0.0878	0.0858	0.0912	0.0910	0.0947
EDUC SER									
ELEC	0.1680	0.1765	0.1877	0.1999	0.1904	0.1992	0.2086	0.2129	0.2129
GAS	0.1488	0.1548	0.1649	0.1652	0.1647	0.1604	0.1622	0.1407	0.1526
OIL	0.0907	0.0858	0.0907	0.0874	0.0856	0.0903	0.1014	0.0977	0.0964
OTHR	0.0232	0.0220	0.0227	0.0196	0.0182	0.0173	0.0173	0.0170	0.0127
TOTAL	0.4307	0.4391	0.4660	0.4722	0.4589	0.4672	0.4895	0.4683	0.4745
PUB BLDG									
ELEC	0.0252	0.0263	0.0275	0.0287	0.0260	0.0280	0.0292	0.0289	0.0285
GAS	0.0195	0.0202	0.0210	0.0209	0.0196	0.0197	0.0199	0.0167	0.0182
OIL	0.0118	0.0111	0.0115	0.0110	0.0102	0.0110	0.0123	0.0115	0.0113
OTHR	0.0030	0.0029	0.0029	0.0026	0.0023	0.0022	0.0022	0.0021	0.0016
TOTAL	0.0596	0.0604	0.0629	0.0631	0.0580	0.0609	0.0635	0.0592	0.0597
FED BLDG									
ELEC	0.0098	0.0102	0.0106	0.0111	0.0100	0.0108	0.0113	0.0112	0.0110
GAS	0.0076	0.0078	0.0082	0.0081	0.0076	0.0077	0.0077	0.0065	0.0071
OIL	0.0046	0.0043	0.0045	0.0042	0.0040	0.0043	0.0048	0.0045	0.0044
OTHR	0.0012	0.0011	0.0012	0.0010	0.0009	0.0009	0.0009	0.0008	0.0006
TOTAL	0.0232	0.0234	0.0245	0.0244	0.0225	0.0236	0.0247	0.0230	0.0232
HEALTH									
ELEC	0.0926	0.0982	0.1030	0.1102	0.1068	0.1112	0.1167	0.1202	0.1209
GAS	0.0801	0.0835	0.0883	0.0879	0.0885	0.0856	0.0867	0.0760	0.0823
OIL	0.0491	0.0468	0.0491	0.0470	0.0465	0.0487	0.0547	0.0529	0.0524
OTHR	0.0120	0.0114	0.0119	0.0103	0.0097	0.0093	0.0094	0.0093	0.0072
TOTAL	0.2337	0.2399	0.2523	0.2553	0.2514	0.2549	0.2675	0.2585	0.2628
REL SERV									
ELEC	0.0233	0.0239	0.0258	0.0272	0.0251	0.0268	0.0283	0.0286	0.0283
GAS	0.0256	0.0263	0.0284	0.0283	0.0279	0.0274	0.0278	0.0240	0.0265
OIL	0.0156	0.0146	0.0156	0.0149	0.0146	0.0155	0.0175	0.0167	0.0169
OTHR	0.0041	0.0039	0.0040	0.0035	0.0032	0.0030	0.0030	0.0029	0.0022
TOTAL	0.0685	0.0687	0.0738	0.0739	0.0708	0.0728	0.0766	0.0723	0.0740
HOTLBLDG									
ELEC	0.0356	0.0365	0.0391	0.0414	0.0378	0.0410	0.0439	0.0448	0.0444
GAS	0.0548	0.0566	0.0599	0.0608	0.0605	0.0584	0.0585	0.0504	0.0554
OIL	0.0337	0.0315	0.0331	0.0322	0.0314	0.0330	0.0366	0.0350	0.0345
OTHR	0.0086	0.0082	0.0084	0.0074	0.0068	0.0065	0.0064	0.0062	0.0046
TOTAL	0.1327	0.1328	0.1405	0.1418	0.1365	0.1389	0.1454	0.1366	0.1389
MISC									
ELEC	0.1008	0.1057	0.1140	0.1245	0.1256	0.1264	0.1315	0.1375	0.1391
GAS	0.0713	0.0732	0.0801	0.0790	0.0830	0.0786	0.0805	0.0717	0.0800
OIL	0.0432	0.0403	0.0437	0.0415	0.0428	0.0443	0.0504	0.0496	0.0503
OTHR	0.0111	0.0104	0.0110	0.0093	0.0089	0.0085	0.0085	0.0084	0.0062
TOTAL	0.2265	0.2296	0.2489	0.2543	0.2603	0.2577	0.2708	0.2671	0.2757

TABLE A-6. REGION 6 HISTORICAL ENERGY USE
BY BUILDING TYPE AND FUEL

	1970	1971	1972	1973	1974	1975	1976	1977	1978
OFFICE									
ELEC	0.0655	0.0731	0.0808	0.0923	0.0984	0.0993	0.1100	0.1166	0.1239
GAS	0.0338	0.0327	0.0321	0.0333	0.0319	0.0283	0.0325	0.0343	0.0377
OIL	0.0042	0.0044	0.0070	0.0089	0.0129	0.0140	0.0173	0.0218	0.0233
OTHR	0.0021	0.0020	0.0022	0.0022	0.0020	0.0019	0.0020	0.0019	0.0017
TOTAL	0.1056	0.1121	0.1221	0.1367	0.1452	0.1435	0.1619	0.1745	0.1866
RETL-WHL									
ELEC	0.1014	0.1126	0.1237	0.1351	0.1400	0.1445	0.1545	0.1660	0.1760
GAS	0.0553	0.0534	0.0536	0.0541	0.0517	0.0466	0.0513	0.0528	0.0568
OIL	0.0052	0.0053	0.0087	0.0105	0.0146	0.0163	0.0194	0.0249	0.0271
OTHR	0.0027	0.0025	0.0028	0.0027	0.0024	0.0023	0.0025	0.0023	0.0020
TOTAL	0.1647	0.1738	0.1889	0.2024	0.2086	0.2096	0.2277	0.2459	0.2619
AUTO REP									
ELEC	0.0043	0.0048	0.0052	0.0051	0.0049	0.0057	0.0054	0.0061	0.0064
GAS	0.0024	0.0021	0.0024	0.0020	0.0017	0.0017	0.0018	0.0020	0.0023
OIL	0.0003	0.0003	0.0005	0.0005	0.0007	0.0008	0.0009	0.0012	0.0014
OTHR	0.0002	0.0001	0.0002	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
TOTAL	0.0071	0.0073	0.0083	0.0079	0.0074	0.0084	0.0082	0.0094	0.0103
WAREHSE									
ELEC	0.0142	0.0157	0.0175	0.0194	0.0202	0.0208	0.0226	0.0243	0.0258
GAS	0.0083	0.0077	0.0080	0.0078	0.0072	0.0065	0.0074	0.0079	0.0088
OIL	0.0010	0.0010	0.0018	0.0021	0.0029	0.0033	0.0040	0.0050	0.0055
OTHR	0.0005	0.0005	0.0006	0.0005	0.0005	0.0005	0.0005	0.0005	0.0004
TOTAL	0.0241	0.0249	0.0278	0.0298	0.0308	0.0310	0.0344	0.0376	0.0405
EDUC SER									
ELEC	0.0857	0.0932	0.1044	0.1080	0.1072	0.1147	0.1165	0.1287	0.1369
GAS	0.0509	0.0484	0.0478	0.0462	0.0420	0.0388	0.0416	0.0452	0.0483
OIL	0.0064	0.0064	0.0104	0.0123	0.0168	0.0190	0.0217	0.0284	0.0301
OTHR	0.0032	0.0030	0.0033	0.0031	0.0027	0.0026	0.0027	0.0026	0.0022
TOTAL	0.1461	0.1510	0.1658	0.1696	0.1687	0.1751	0.1826	0.2049	0.2175
PUB BLDG									
ELEC	0.0127	0.0137	0.0152	0.0150	0.0144	0.0165	0.0156	0.0175	0.0185
GAS	0.0064	0.0061	0.0059	0.0055	0.0048	0.0048	0.0048	0.0053	0.0057
OIL	0.0008	0.0008	0.0013	0.0015	0.0019	0.0023	0.0025	0.0033	0.0035
OTHR	0.0004	0.0004	0.0004	0.0004	0.0003	0.0003	0.0003	0.0003	0.0003
TOTAL	0.0204	0.0210	0.0228	0.0223	0.0214	0.0239	0.0231	0.0263	0.0280
FED BLDG									
ELEC	0.0063	0.0068	0.0076	0.0075	0.0072	0.0082	0.0078	0.0087	0.0092
GAS	0.0035	0.0033	0.0033	0.0030	0.0026	0.0026	0.0026	0.0029	0.0031
OIL	0.0004	0.0004	0.0007	0.0008	0.0010	0.0012	0.0013	0.0017	0.0019
OTHR	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0001
TOTAL	0.0105	0.0108	0.0117	0.0115	0.0110	0.0122	0.0119	0.0135	0.0144
HEALTH									
ELEC	0.0466	0.0512	0.0565	0.0590	0.0592	0.0629	0.0647	0.0712	0.0757
GAS	0.0274	0.0262	0.0258	0.0250	0.0229	0.0211	0.0227	0.0244	0.0261
OIL	0.0035	0.0035	0.0055	0.0065	0.0088	0.0099	0.0114	0.0147	0.0156
OTHR	0.0016	0.0015	0.0017	0.0016	0.0014	0.0014	0.0015	0.0014	0.0012
TOTAL	0.0792	0.0823	0.0896	0.0921	0.0923	0.0953	0.1002	0.1116	0.1186
REL SERV									
ELEC	0.0122	0.0131	0.0149	0.0151	0.0147	0.0162	0.0161	0.0182	0.0195
GAS	0.0087	0.0082	0.0082	0.0078	0.0070	0.0065	0.0070	0.0077	0.0085
OIL	0.0011	0.0011	0.0018	0.0021	0.0029	0.0033	0.0037	0.0049	0.0054
OTHR	0.0006	0.0005	0.0006	0.0005	0.0005	0.0005	0.0005	0.0005	0.0004
TOTAL	0.0226	0.0228	0.0255	0.0256	0.0251	0.0265	0.0273	0.0312	0.0337
HOTLBLDG									
ELEC	0.0224	0.0240	0.0274	0.0278	0.0272	0.0301	0.0304	0.0347	0.0373
GAS	0.0216	0.0204	0.0198	0.0192	0.0174	0.0160	0.0171	0.0184	0.0197
OIL	0.0027	0.0027	0.0043	0.0051	0.0069	0.0078	0.0087	0.0114	0.0120
OTHR	0.0014	0.0013	0.0014	0.0013	0.0012	0.0011	0.0012	0.0011	0.0009
TOTAL	0.0481	0.0485	0.0529	0.0533	0.0527	0.0550	0.0574	0.0656	0.0700
MISC									
ELEC	0.0538	0.0580	0.0652	0.0710	0.0728	0.0750	0.0794	0.0852	0.0901
GAS	0.0256	0.0237	0.0243	0.0238	0.0219	0.0199	0.0222	0.0237	0.0261
OIL	0.0032	0.0031	0.0053	0.0063	0.0087	0.0098	0.0116	0.0149	0.0165
OTHR	0.0016	0.0014	0.0017	0.0016	0.0014	0.0013	0.0014	0.0013	0.0011
TOTAL	0.0841	0.0863	0.0965	0.1027	0.1048	0.1060	0.1146	0.1252	0.1338

TABLE A-7. REGION 7 HISTORICAL ENERGY USE
BY BUILDING TYPE AND FUEL

	1970	1971	1972	1973	1974	1975	1976	1977	1978
OFFICE									
ELEC	0.0320	0.0347	0.0367	0.0414	0.0447	0.0458	0.0547	0.0567	0.0590
GAS	0.0252	0.0264	0.0277	0.0267	0.0295	0.0283	0.0307	0.0286	0.0284
OIL	0.0082	0.0075	0.0082	0.0086	0.0088	0.0087	0.0104	0.0103	0.0115
OTHR	0.0017	0.0017	0.0018	0.0017	0.0017	0.0016	0.0016	0.0015	0.0013
TOTAL	0.0671	0.0703	0.0743	0.0783	0.0847	0.0844	0.0974	0.0972	0.1002
RETL-WHL									
ELEC	0.0548	0.0593	0.0621	0.0674	0.0687	0.0726	0.0852	0.0890	0.0925
GAS	0.0425	0.0441	0.0460	0.0432	0.0460	0.0448	0.0477	0.0446	0.0449
OIL	0.0113	0.0103	0.0113	0.0113	0.0109	0.0111	0.0133	0.0132	0.0150
OTHR	0.0024	0.0023	0.0025	0.0022	0.0022	0.0021	0.0021	0.0020	0.0017
TOTAL	0.1111	0.1160	0.1219	0.1241	0.1279	0.1307	0.1484	0.1488	0.1541
AUTO REP									
ELEC	0.0015	0.0016	0.0016	0.0016	0.0013	0.0016	0.0018	0.0020	0.0020
GAS	0.0012	0.0012	0.0013	0.0011	0.0010	0.0011	0.0012	0.0011	0.0012
OIL	0.0004	0.0004	0.0004	0.0003	0.0003	0.0003	0.0004	0.0004	0.0005
OTHR	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
TOTAL	0.0032	0.0032	0.0034	0.0031	0.0027	0.0031	0.0035	0.0035	0.0037
WAREHSE									
ELEC	0.0076	0.0082	0.0087	0.0095	0.0098	0.0104	0.0125	0.0131	0.0136
GAS	0.0067	0.0069	0.0074	0.0067	0.0072	0.0071	0.0077	0.0072	0.0073
OIL	0.0022	0.0020	0.0022	0.0022	0.0022	0.0022	0.0027	0.0026	0.0030
OTHR	0.0005	0.0005	0.0005	0.0004	0.0004	0.0004	0.0004	0.0004	0.0003
TOTAL	0.0170	0.0175	0.0188	0.0188	0.0196	0.0202	0.0233	0.0233	0.0243
EDUC SER									
ELEC	0.0488	0.0515	0.0546	0.0560	0.0517	0.0585	0.0685	0.0723	0.0754
GAS	0.0428	0.0441	0.0463	0.0418	0.0408	0.0423	0.0449	0.0424	0.0413
OIL	0.0141	0.0127	0.0139	0.0137	0.0125	0.0130	0.0153	0.0153	0.0166
OTHR	0.0029	0.0028	0.0029	0.0027	0.0025	0.0024	0.0024	0.0023	0.0019
TOTAL	0.1086	0.1112	0.1177	0.1142	0.1076	0.1161	0.1311	0.1322	0.1352
PUB BLDG									
ELEC	0.0067	0.0070	0.0073	0.0072	0.0062	0.0074	0.0083	0.0088	0.0092
GAS	0.0052	0.0053	0.0055	0.0048	0.0043	0.0047	0.0049	0.0047	0.0046
OIL	0.0017	0.0015	0.0016	0.0016	0.0013	0.0014	0.0016	0.0016	0.0018
OTHR	0.0004	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0002
TOTAL	0.0139	0.0141	0.0147	0.0138	0.0121	0.0138	0.0151	0.0154	0.0158
FED BLDG									
ELEC	0.0038	0.0040	0.0042	0.0041	0.0035	0.0042	0.0048	0.0051	0.0053
GAS	0.0030	0.0030	0.0031	0.0027	0.0024	0.0027	0.0028	0.0027	0.0026
OIL	0.0010	0.0009	0.0009	0.0009	0.0008	0.0008	0.0010	0.0010	0.0011
OTHR	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0001	0.0001
TOTAL	0.0079	0.0081	0.0084	0.0079	0.0069	0.0079	0.0087	0.0088	0.0091
HEALTH									
ELEC	0.0276	0.0295	0.0308	0.0319	0.0301	0.0336	0.0395	0.0416	0.0435
GAS	0.0239	0.0247	0.0258	0.0233	0.0231	0.0236	0.0251	0.0236	0.0232
OIL	0.0079	0.0072	0.0078	0.0077	0.0071	0.0074	0.0087	0.0086	0.0094
OTHR	0.0016	0.0015	0.0016	0.0015	0.0014	0.0013	0.0014	0.0013	0.0011
TOTAL	0.0611	0.0630	0.0660	0.0645	0.0617	0.0660	0.0746	0.0752	0.0771
REL SERV									
ELEC	0.0070	0.0072	0.0078	0.0078	0.0068	0.0081	0.0096	0.0102	0.0107
GAS	0.0074	0.0076	0.0081	0.0072	0.0069	0.0073	0.0077	0.0073	0.0073
OIL	0.0024	0.0022	0.0024	0.0024	0.0021	0.0022	0.0026	0.0026	0.0029
OTHR	0.0005	0.0005	0.0005	0.0005	0.0004	0.0004	0.0004	0.0004	0.0003
TOTAL	0.0174	0.0175	0.0187	0.0178	0.0163	0.0180	0.0204	0.0206	0.0213
HOTL&LDG									
ELEC	0.0104	0.0108	0.0114	0.0115	0.0100	0.0122	0.0152	0.0163	0.0171
GAS	0.0148	0.0151	0.0157	0.0144	0.0141	0.0144	0.0152	0.0143	0.0137
OIL	0.0049	0.0044	0.0047	0.0047	0.0043	0.0045	0.0052	0.0052	0.0055
OTHR	0.0010	0.0010	0.0010	0.0009	0.0009	0.0009	0.0008	0.0008	0.0006
TOTAL	0.0311	0.0313	0.0329	0.0315	0.0293	0.0319	0.0366	0.0366	0.0369
MISC									
ELEC	0.0296	0.0311	0.0334	0.0360	0.0362	0.0382	0.0447	0.0466	0.0482
GAS	0.0212	0.0216	0.0231	0.0210	0.0218	0.0219	0.0235	0.0220	0.0222
OIL	0.0069	0.0061	0.0069	0.0068	0.0066	0.0067	0.0080	0.0079	0.0089
OTHR	0.0015	0.0014	0.0015	0.0013	0.0013	0.0012	0.0012	0.0012	0.0009
TOTAL	0.0592	0.0602	0.0648	0.0652	0.0659	0.0680	0.0775	0.0776	0.0802

TABLE A-8. REGION 8 HISTORICAL ENERGY USE
BY BUILDING TYPE AND FUEL

	1970	1971	1972	1973	1974	1975	1976	1977	1978
OFFICE									
ELEC	0.0166	0.0182	0.0205	0.0230	0.0265	0.0249	0.0262	0.0267	0.0282
GAS	0.0133	0.0136	0.0145	0.0151	0.0159	0.0161	0.0182	0.0163	0.0160
OIL	0.0054	0.0058	0.0064	0.0075	0.0100	0.0103	0.0118	0.0100	0.0119
OTHR	0.0015	0.0015	0.0015	0.0015	0.0014	0.0014	0.0013	0.0012	0.0011
TOTAL	0.0368	0.0391	0.0430	0.0471	0.0538	0.0527	0.0575	0.0543	0.0572
RETL-WHL									
ELEC	0.0248	0.0270	0.0295	0.0323	0.0350	0.0340	0.0349	0.0362	0.0383
GAS	0.0199	0.0205	0.0214	0.0219	0.0222	0.0227	0.0244	0.0223	0.0219
OIL	0.0068	0.0072	0.0078	0.0088	0.0111	0.0119	0.0129	0.0111	0.0134
OTHR	0.0019	0.0019	0.0019	0.0018	0.0017	0.0017	0.0016	0.0015	0.0013
TOTAL	0.0534	0.0565	0.0605	0.0649	0.0700	0.0703	0.0737	0.0710	0.0748
AUTO REP									
ELEC	0.0008	0.0009	0.0009	0.0009	0.0009	0.0010	0.0008	0.0009	0.0010
GAS	0.0007	0.0007	0.0007	0.0007	0.0006	0.0007	0.0007	0.0006	0.0006
OIL	0.0003	0.0003	0.0003	0.0003	0.0004	0.0005	0.0004	0.0004	0.0005
OTHR	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0000
TOTAL	0.0019	0.0020	0.0020	0.0021	0.0019	0.0022	0.0020	0.0020	0.0022
WAREHSE									
ELEC	0.0032	0.0035	0.0039	0.0043	0.0047	0.0046	0.0046	0.0048	0.0051
GAS	0.0030	0.0030	0.0032	0.0033	0.0033	0.0035	0.0037	0.0033	0.0033
OIL	0.0012	0.0013	0.0014	0.0016	0.0020	0.0022	0.0023	0.0020	0.0024
OTHR	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0002
TOTAL	0.0077	0.0081	0.0088	0.0095	0.0103	0.0105	0.0110	0.0104	0.0111
EDUC SER									
ELEC	0.0241	0.0255	0.0275	0.0290	0.0284	0.0292	0.0276	0.0298	0.0318
GAS	0.0220	0.0222	0.0230	0.0231	0.0215	0.0233	0.0243	0.0228	0.0218
OIL	0.0091	0.0095	0.0102	0.0115	0.0137	0.0148	0.0158	0.0141	0.0166
OTHR	0.0025	0.0025	0.0024	0.0023	0.0021	0.0021	0.0019	0.0018	0.0015
TOTAL	0.0578	0.0597	0.0632	0.0660	0.0657	0.0693	0.0697	0.0686	0.0717
PUB BLDG									
ELEC	0.0036	0.0038	0.0040	0.0041	0.0037	0.0042	0.0037	0.0041	0.0043
GAS	0.0029	0.0029	0.0030	0.0029	0.0025	0.0030	0.0029	0.0028	0.0027
OIL	0.0012	0.0012	0.0013	0.0014	0.0016	0.0018	0.0018	0.0017	0.0020
OTHR	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0002	0.0002	0.0002
TOTAL	0.0081	0.0084	0.0086	0.0088	0.0081	0.0092	0.0086	0.0088	0.0092
FED BLDG									
ELEC	0.0028	0.0029	0.0030	0.0031	0.0028	0.0032	0.0028	0.0031	0.0033
GAS	0.0023	0.0023	0.0023	0.0022	0.0019	0.0023	0.0022	0.0021	0.0021
OIL	0.0009	0.0010	0.0010	0.0011	0.0012	0.0014	0.0014	0.0013	0.0015
OTHR	0.0003	0.0003	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0001
TOTAL	0.0062	0.0064	0.0066	0.0067	0.0062	0.0071	0.0066	0.0067	0.0070
HEALTH									
ELEC	0.0124	0.0133	0.0142	0.0151	0.0151	0.0154	0.0149	0.0160	0.0170
GAS	0.0111	0.0112	0.0116	0.0116	0.0109	0.0118	0.0123	0.0115	0.0110
OIL	0.0046	0.0048	0.0051	0.0058	0.0069	0.0074	0.0079	0.0070	0.0083
OTHR	0.0012	0.0012	0.0012	0.0012	0.0011	0.0010	0.001C	0.0009	0.0008
TOTAL	0.0293	0.0306	0.0321	0.0337	0.0340	0.0356	0.0361	0.0354	0.0371
REL SERV									
ELEC	0.0035	0.0036	0.0039	0.0041	0.0038	0.0040	0.0036	0.0040	0.0043
GAS	0.0038	0.0038	0.0040	0.0040	0.0036	0.0040	0.0041	0.0039	0.0038
OIL	0.0016	0.0016	0.0017	0.0020	0.0023	0.0025	0.0027	0.0024	0.0029
OTHR	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.0003	0.0003	0.0003
TOTAL	0.0093	0.0094	0.0100	0.0104	0.0101	0.0109	0.0107	0.0106	0.0112
HOTLBLDG									
ELEC	0.0063	0.0066	0.0071	0.0074	0.0069	0.0074	0.0066	0.0074	0.0081
GAS	0.0091	0.0091	0.0095	0.0096	0.0091	0.0097	0.0103	0.0096	0.0092
OIL	0.0039	0.0040	0.0043	0.0048	0.0057	0.0062	0.0067	0.0059	0.0069
OTHR	0.0010	0.0010	0.0010	0.0010	0.0009	0.0009	0.0008	0.0008	0.0006
TOTAL	0.0204	0.0207	0.0219	0.0228	0.0226	0.0241	0.0244	0.0236	0.0248
MISC									
ELEC	0.0150	0.0158	0.0177	0.0193	0.0205	0.0199	0.0201	0.0209	0.0220
GAS	0.0113	0.0113	0.0120	0.0121	0.0118	0.0126	0.0133	0.0122	0.0119
OIL	0.0046	0.0048	0.0053	0.0060	0.0074	0.0080	0.0086	0.0075	0.0090
OTHR	0.0013	0.0013	0.0013	0.0012	0.0011	0.0011	0.0010	0.0009	0.0008
TOTAL	0.0322	0.0332	0.0361	0.0386	0.0408	0.0416	0.0430	0.0414	0.0437

TABLE A-9. REGION 9 HISTORICAL ENERGY USE

BY BUILDING TYPE AND FUEL

	1970	1971	1972	1973	1974	1975	1976	1977	1978
OFFICE									
ELEC	0.0982	0.1059	0.1168	0.1291	0.1251	0.1476	0.1559	0.1555	0.1565
GAS	0.0387	0.0375	0.0367	0.0388	0.0393	0.0402	0.0390	0.0392	0.0378
OIL	0.0060	0.0082	0.0116	0.0159	0.0130	0.0094	0.0111	0.0118	0.0137
OTHR	0.0010	0.0011	0.0010	0.0012	0.0012	0.0011	0.0010	0.0010	0.0011
TOTAL	0.1438	0.1527	0.1661	0.1850	0.1786	0.1984	0.2070	0.2076	0.2091
RETL-WHL									
ELEC	0.1388	0.1492	0.1641	0.1748	0.1678	0.2005	0.2109	0.2122	0.2140
GAS	0.0608	0.0611	0.0588	0.0615	0.0620	0.0625	0.0591	0.0592	0.0574
OIL	0.0067	0.0093	0.0130	0.0171	0.0138	0.0102	0.0115	0.0125	0.0146
OTHR	0.0011	0.0013	0.0012	0.0013	0.0012	0.0013	0.0010	0.0011	0.0011
TOTAL	0.2075	0.2210	0.2371	0.2548	0.2448	0.2744	0.2824	0.2850	0.2872
AUTO REP									
ELEC	0.0072	0.0077	0.0085	0.0083	0.0077	0.0101	0.0103	0.0106	0.0108
GAS	0.0030	0.0031	0.0028	0.0028	0.0027	0.0031	0.0025	0.0028	0.0027
OIL	0.0005	0.0007	0.0010	0.0012	0.0009	0.0008	0.0007	0.0009	0.0011
OTHR	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
TOTAL	0.0107	0.0116	0.0124	0.0124	0.0114	0.0141	0.0136	0.0143	0.0146
WAREHSE									
ELEC	0.0165	0.0176	0.0196	0.0211	0.0202	0.0244	0.0256	0.0257	0.0258
GAS	0.0074	0.0074	0.0070	0.0073	0.0072	0.0077	0.0068	0.0071	0.0068
OIL	0.0012	0.0016	0.0023	0.0031	0.0025	0.0018	0.0020	0.0022	0.0025
OTHR	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002
TOTAL	0.0253	0.0269	0.0291	0.0317	0.0300	0.0341	0.0345	0.0351	0.0354
EDUC SER									
ELEC	0.1061	0.1115	0.1255	0.1279	0.1202	0.1513	0.1567	0.1592	0.1608
GAS	0.0476	0.0453	0.0449	0.0445	0.0441	0.0471	0.0452	0.0460	0.0432
OIL	0.0075	0.0099	0.0143	0.0180	0.0145	0.0109	0.0127	0.0137	0.0157
OTHR	0.0012	0.0014	0.0013	0.0014	0.0013	0.0013	0.0011	0.0012	0.0012
TOTAL	0.1624	0.1679	0.1859	0.1918	0.1801	0.2106	0.2158	0.2202	0.2209
PUB BLDG									
ELEC	0.0192	0.0201	0.0225	0.0221	0.0206	0.0265	0.0271	0.0277	0.0281
GAS	0.0075	0.0070	0.0070	0.0067	0.0065	0.0072	0.0069	0.0070	0.0068
OIL	0.0012	0.0015	0.0022	0.0027	0.0021	0.0016	0.0019	0.0021	0.0024
OTHR	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002
TOTAL	0.0281	0.0289	0.0320	0.0317	0.0294	0.0356	0.0360	0.0369	0.0375
FED BLDG									
ELEC	0.0080	0.0083	0.0093	0.0091	0.0085	0.0110	0.0112	0.0114	0.0116
GAS	0.0032	0.0030	0.0030	0.0028	0.0028	0.0031	0.0029	0.0030	0.0029
OIL	0.0005	0.0007	0.0010	0.0012	0.0009	0.0007	0.0008	0.0009	0.0010
OTHR	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
TOTAL	0.0117	0.0121	0.0133	0.0132	0.0123	0.0148	0.0150	0.0154	0.0156
HEALTH									
ELEC	0.0613	0.0651	0.0722	0.0742	0.0702	0.0875	0.0910	0.0924	0.0934
GAS	0.0275	0.0267	0.0260	0.0261	0.0259	0.0274	0.0259	0.0264	0.0249
OIL	0.0043	0.0057	0.0080	0.0101	0.0082	0.0062	0.0071	0.0077	0.0087
OTHR	0.0006	0.0008	0.0007	0.0007	0.0007	0.0007	0.0006	0.0007	0.0006
TOTAL	0.0938	0.0982	0.1069	0.1111	0.1050	0.1218	0.1246	0.1271	0.1277
REL SERV									
ELEC	0.0149	0.0153	0.0176	0.0176	0.0163	0.0214	0.0221	0.0226	0.0230
GAS	0.0080	0.0075	0.0076	0.0074	0.0073	0.0080	0.0076	0.0078	0.0075
OIL	0.0013	0.0017	0.0025	0.0031	0.0025	0.0019	0.0022	0.0024	0.0028
OTHR	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002
TOTAL	0.0244	0.0248	0.0279	0.0284	0.0263	0.0314	0.0321	0.0330	0.0335
HOTLBLDG									
ELEC	0.0349	0.0359	0.0414	0.0413	0.0377	0.0508	0.0529	0.0540	0.0548
GAS	0.0280	0.0257	0.0259	0.0253	0.0250	0.0262	0.0259	0.0258	0.0247
OIL	0.0051	0.0064	0.0095	0.0119	0.0095	0.0069	0.0084	0.0088	0.0102
OTHR	0.0007	0.0008	0.0008	0.0008	0.0008	0.0008	0.0007	0.0007	0.0007
TOTAL	0.0687	0.0689	0.0776	0.0793	0.0730	0.0847	0.0878	0.0893	0.0905
MISC									
ELEC	0.0937	0.0984	0.1103	0.1172	0.1118	0.1334	0.1394	0.1400	0.1408
GAS	0.0345	0.0333	0.0325	0.0333	0.0331	0.0349	0.0323	0.0332	0.0319
OIL	0.0060	0.0080	0.0115	0.0151	0.0122	0.0090	0.0104	0.0112	0.0132
OTHR	0.0009	0.0010	0.0009	0.0011	0.0010	0.0010	0.0008	0.0009	0.0009
TOTAL	0.1350	0.1407	0.1553	0.1667	0.1581	0.1783	0.1829	0.1853	0.1868

TABLE A-10. REGION 10 HISTORICAL ENERGY USE

BY BUILDING TYPE AND FUEL

	1970	1971	1972	1973	1974	1975	1976	1977	1978
OFFICE									
ELEC	0.0259	0.0285	0.0337	0.0379	0.0424	0.0403	0.0445	0.0446	0.0465
GAS	0.0115	0.0138	0.0156	0.0174	0.0200	0.0187	0.0184	0.0165	0.0147
OIL	0.0095	0.0104	0.0112	0.0101	0.0098	0.0071	0.0055	0.0059	0.0064
OTHR	0.0006	0.0006	0.0006	0.0006	0.0007	0.0006	0.0006	0.0006	0.0006
TOTAL	0.0474	0.0534	0.0611	0.0660	0.0729	0.0667	0.0691	0.0677	0.0681
RETL-WHL									
ELEC	0.0380	0.0418	0.0490	0.0533	0.0555	0.0575	0.0609	0.0623	0.0652
GAS	0.0184	0.0216	0.0236	0.0249	0.0262	0.0272	0.0254	0.0235	0.0217
OIL	0.0117	0.0129	0.0139	0.0119	0.0110	0.0084	0.0062	0.0068	0.0073
OTHR	0.0007	0.0008	0.0008	0.0008	0.0008	0.0008	0.0007	0.0007	0.0007
TOTAL	0.0688	0.0771	0.0873	0.0910	0.0935	0.0937	0.0932	0.0934	0.0949
AUTO REP									
ELEC	0.0015	0.0017	0.0020	0.0019	0.0017	0.0022	0.0021	0.0023	0.0024
GAS	0.0007	0.0009	0.0010	0.0009	0.0008	0.0011	0.0009	0.0009	0.0008
OIL	0.0006	0.0007	0.0007	0.0005	0.0005	0.0004	0.0003	0.0003	0.0003
OTHR	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
TOTAL	0.0028	0.0032	0.0037	0.0034	0.0030	0.0038	0.0032	0.0035	0.0036
WAREHSE									
ELEC	0.0051	0.0056	0.0067	0.0073	0.0078	0.0077	0.0083	0.0084	0.0088
GAS	0.0026	0.0031	0.0035	0.0037	0.0041	0.0041	0.0038	0.0035	0.0031
OIL	0.0021	0.0023	0.0025	0.0021	0.0020	0.0015	0.0011	0.0012	0.0013
OTHR	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
TOTAL	0.0099	0.0112	0.0128	0.0133	0.0140	0.0134	0.0133	0.0133	0.0133
EDUC SER									
ELEC	0.0369	0.0396	0.0477	0.0495	0.0465	0.0531	0.0535	0.0562	0.0592
GAS	0.0177	0.0208	0.0241	0.0243	0.0227	0.0271	0.0240	0.0225	0.0202
OIL	0.0148	0.0160	0.0174	0.0147	0.0129	0.0102	0.0076	0.0083	0.0086
OTHR	0.0009	0.0010	0.0009	0.0009	0.0008	0.0009	0.0009	0.0009	0.0008
TOTAL	0.0704	0.0774	0.0901	0.0895	0.0829	0.0913	0.0860	0.0880	0.0887
PUB BLDG									
ELEC	0.0059	0.0062	0.0074	0.0074	0.0066	0.0083	0.0079	0.0085	0.0090
GAS	0.0026	0.0030	0.0034	0.0033	0.0028	0.0038	0.0032	0.0031	0.0028
OIL	0.0021	0.0023	0.0025	0.0020	0.0017	0.0014	0.0010	0.0011	0.0012
OTHR	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
TOTAL	0.0107	0.0116	0.0135	0.0128	0.0113	0.0136	0.0122	0.0128	0.0132
FED BLDG									
ELEC	0.0037	0.0039	0.0047	0.0047	0.0042	0.0052	0.0050	0.0053	0.0057
GAS	0.0017	0.0020	0.0023	0.0022	0.0019	0.0026	0.0022	0.0021	0.0019
OIL	0.0014	0.0015	0.0016	0.0013	0.0011	0.0009	0.0007	0.0007	0.0008
OTHR	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
TOTAL	0.0069	0.0076	0.0088	0.0083	0.0073	0.0088	0.0079	0.0083	0.0085
HEALTH									
ELEC	0.0202	0.0218	0.0257	0.0269	0.0258	0.0290	0.0295	0.0308	0.0324
GAS	0.0093	0.0110	0.0124	0.0126	0.0119	0.0139	0.0124	0.0116	0.0104
OIL	0.0083	0.0090	0.0096	0.0083	0.0073	0.0059	0.0046	0.0050	0.0051
OTHR	0.0005	0.0005	0.0005	0.0005	0.0004	0.0005	0.0004	0.0004	0.0004
TOTAL	0.0383	0.0423	0.0482	0.0482	0.0454	0.0493	0.0469	0.0478	0.0483
REL SERV									
ELEC	0.0053	0.0057	0.0070	0.0072	0.0065	0.0077	0.0076	0.0082	0.0087
GAS	0.0030	0.0034	0.0041	0.0040	0.0037	0.0045	0.0040	0.0038	0.0034
OIL	0.0024	0.0026	0.0029	0.0024	0.0021	0.0016	0.0012	0.0013	0.0014
OTHR	0.0002	0.0002	0.0002	0.0002	0.0001	0.0002	0.0001	0.0001	0.0001
TOTAL	0.0109	0.0119	0.0141	0.0138	0.0124	0.0140	0.0129	0.0134	0.0136
HOTLBLDG									
ELEC	0.0103	0.0109	0.0136	0.0139	0.0130	0.0145	0.0147	0.0155	0.0163
GAS	0.0070	0.0080	0.0093	0.0094	0.0091	0.0102	0.0093	0.0086	0.0078
OIL	0.0058	0.0062	0.0067	0.0057	0.0051	0.0039	0.0029	0.0032	0.0033
OTHR	0.0004	0.0004	0.0004	0.0004	0.0003	0.0003	0.0003	0.0003	0.0003
TOTAL	0.0235	0.0255	0.0299	0.0294	0.0274	0.0290	0.0272	0.0277	0.0278
MISC									
ELEC	0.0213	0.0228	0.0273	0.0295	0.0303	0.0315	0.0330	0.0338	0.0353
GAS	0.0089	0.0105	0.0121	0.0126	0.0130	0.0139	0.0127	0.0118	0.0108
OIL	0.0073	0.0079	0.0086	0.0074	0.0068	0.0052	0.0039	0.0042	0.0044
OTHR	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0004	0.0004	0.0004
TOTAL	0.0380	0.0417	0.0485	0.0500	0.0506	0.0510	0.0500	0.0503	0.0510

TABLE A-11. REGION 1 HISTORICAL ENERGY USE BY BUILDING TYPE AND END USE

	1970	1971	1972	1973	1974	1975	1976	1977	1978
OFFICE									
HEAT	0.0521	0.0554	0.0589	0.0606	0.0504	0.0445	0.0513	0.0469	0.0475
COOL	0.0094	0.0109	0.0127	0.0142	0.0135	0.0171	0.0191	0.0195	0.0196
WATR	0.0112	0.0108	0.0106	0.0111	0.0099	0.0093	0.0092	0.0093	0.0096
LGHT	0.0188	0.0208	0.0214	0.0251	0.0249	0.0235	0.0234	0.0242	0.0248
OTHR	0.0036	0.0040	0.0041	0.0047	0.0049	0.0048	0.0050	0.0054	0.0057
TOTAL	0.0950	0.1018	0.1077	0.1157	0.1036	0.0993	0.1080	0.1053	0.1071
RETL-WHL									
HEAT	0.0543	0.0574	0.0612	0.0604	0.0502	0.0445	0.0520	0.0470	0.0480
COOL	0.0107	0.0123	0.0145	0.0155	0.0145	0.0187	0.0208	0.0212	0.0212
WATR	0.0056	0.0054	0.0053	0.0054	0.0048	0.0045	0.0045	0.0045	0.0046
LGHT	0.0207	0.0227	0.0235	0.0267	0.0261	0.0249	0.0248	0.0256	0.0262
OTHR	0.0168	0.0180	0.0180	0.0198	0.0202	0.0196	0.0197	0.0207	0.0216
TOTAL	0.1081	0.1159	0.1224	0.1278	0.1158	0.1122	0.1218	0.1190	0.1216
AUTO REP									
HEAT	0.0037	0.0039	0.0042	0.0037	0.0031	0.0028	0.0035	0.0031	0.0032
COOL	0.0007	0.0008	0.0009	0.0009	0.0008	0.0011	0.0012	0.0012	0.0012
WATR	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
LGHT	0.0012	0.0013	0.0014	0.0015	0.0014	0.0014	0.0014	0.0014	0.0015
OTHR	0.0002	0.0002	0.0002	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
TOTAL	0.0060	0.0064	0.0068	0.0065	0.0057	0.0057	0.0065	0.0061	0.0063
WAREHSE									
HEAT	0.0085	0.0089	0.0096	0.0094	0.0079	0.0069	0.0082	0.0074	0.0075
COOL	0.0015	0.0017	0.0020	0.0022	0.0021	0.0026	0.0029	0.0030	0.0030
WATR	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
LGHT	0.0023	0.0026	0.0027	0.0031	0.0030	0.0029	0.0029	0.0030	0.0030
OTHR	0.0005	0.0005	0.0006	0.0006	0.0007	0.0006	0.0007	0.0007	0.0008
TOTAL	0.0131	0.0140	0.0151	0.0156	0.0139	0.0133	0.0149	0.0143	0.0145
EDUC SER									
HEAT	0.0723	0.0756	0.0816	0.0801	0.0647	0.0586	0.0675	0.0614	0.0607
COOL	0.0126	0.0140	0.0169	0.0173	0.0159	0.0209	0.0233	0.0236	0.0236
WATR	0.0183	0.0173	0.0173	0.0170	0.0148	0.0143	0.0142	0.0142	0.0146
LGHT	0.0208	0.0225	0.0236	0.0261	0.0252	0.0244	0.0243	0.0250	0.0254
OTHR	0.0044	0.0047	0.0049	0.0054	0.0055	0.0055	0.0058	0.0062	0.0065
TOTAL	0.1283	0.1341	0.1444	0.1460	0.1262	0.1238	0.1350	0.1303	0.1309
PUB BLDG									
HEAT	0.0058	0.0060	0.0065	0.0061	0.0049	0.0045	0.0054	0.0048	0.0050
COOL	0.0010	0.0011	0.0013	0.0013	0.0011	0.0016	0.0018	0.0018	0.0018
WATR	0.0003	0.0003	0.0003	0.0003	0.0002	0.0002	0.0002	0.0002	0.0002
LGHT	0.0012	0.0013	0.0013	0.0014	0.0014	0.0014	0.0014	0.0014	0.0014
OTHR	0.0001	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002
TOTAL	0.0084	0.0088	0.0096	0.0092	0.0078	0.0079	0.0090	0.0084	0.0087
FED BLDG									
HEAT	0.0026	0.0027	0.0029	0.0027	0.0022	0.0020	0.0024	0.0021	0.0022
COOL	0.0004	0.0005	0.0006	0.0006	0.0005	0.0007	0.0008	0.0008	0.0008
WATR	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
LGHT	0.0005	0.0006	0.0006	0.0006	0.0006	0.0006	0.0006	0.0006	0.0006
OTHR	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
TOTAL	0.0037	0.0039	0.0042	0.0041	0.0035	0.0035	0.0040	0.0037	0.0039
HEALTH									
HEAT	0.0408	0.0429	0.0458	0.0448	0.0365	0.0328	0.0379	0.0344	0.0341
COOL	0.0072	0.0081	0.0096	0.0099	0.0091	0.0120	0.0133	0.0135	0.0135
WATR	0.0264	0.0252	0.0249	0.0247	0.0216	0.0208	0.0205	0.0205	0.0211
LGHT	0.0101	0.0110	0.0114	0.0127	0.0123	0.0118	0.0118	0.0121	0.0124
OTHR	0.0053	0.0058	0.0060	0.0066	0.0067	0.0067	0.0070	0.0075	0.0079
TOTAL	0.0899	0.0930	0.0978	0.0988	0.0862	0.0841	0.0905	0.0881	0.0891
REL SERV									
HEAT	0.0177	0.0183	0.0199	0.0198	0.0156	0.0143	0.0162	0.0148	0.0146
COOL	0.0032	0.0035	0.0042	0.0043	0.0039	0.0052	0.0058	0.0058	0.0058
WATR	0.0038	0.0035	0.0036	0.0035	0.0030	0.0029	0.0029	0.0029	0.0030
LGHT	0.0063	0.0068	0.0072	0.0079	0.0076	0.0074	0.0074	0.0076	0.0077
OTHR	0.0012	0.0013	0.0014	0.0015	0.0015	0.0015	0.0016	0.0017	0.0018
TOTAL	0.0322	0.0333	0.0362	0.0369	0.0317	0.0314	0.0338	0.0328	0.0328
HOTLBLDG									
HEAT	0.0270	0.0280	0.0301	0.0298	0.0240	0.0216	0.0246	0.0223	0.0219
COOL	0.0042	0.0047	0.0057	0.0059	0.0054	0.0071	0.0078	0.0080	0.0079
WATR	0.0061	0.0058	0.0058	0.0058	0.0050	0.0048	0.0048	0.0048	0.0049
LGHT	0.0024	0.0026	0.0028	0.0031	0.0030	0.0029	0.0029	0.0029	0.0030
OTHR	0.0006	0.0006	0.0007	0.0007	0.0007	0.0007	0.0008	0.0008	0.0009
TOTAL	0.0404	0.0417	0.0449	0.0453	0.0382	0.0371	0.0408	0.0389	0.0386
MISC									
HEAT	0.0326	0.0337	0.0365	0.0359	0.0298	0.0264	0.0308	0.0279	0.0284
COOL	0.0060	0.0066	0.0080	0.0085	0.0080	0.0103	0.0114	0.0117	0.0117
WATR	0.0065	0.0061	0.0061	0.0062	0.0054	0.0052	0.0051	0.0051	0.0053
LGHT	0.0140	0.0151	0.0158	0.0180	0.0176	0.0167	0.0166	0.0172	0.0175
OTHR	0.0019	0.0020	0.0021	0.0024	0.0024	0.0024	0.0025	0.0027	0.0029
TOTAL	0.0609	0.0635	0.0686	0.0710	0.0632	0.0611	0.0665	0.0645	0.0657

TABLE A-12. REGION 2 HISTORICAL ENERGY USE BY BUILDING TYPE AND END USE

	1970	1971	1972	1973	1974	1975	1976	1977	1978
OFFICE									
HEAT	0.1269	0.1282	0.1297	0.1315	0.1199	0.1085	0.1248	0.1256	0.1241
COOL	0.0345	0.0361	0.0397	0.0424	0.0592	0.0441	0.0456	0.0465	0.0499
WATR	0.0119	0.0120	0.0118	0.0116	0.0108	0.0103	0.0102	0.0107	0.0109
LGHT	0.0490	0.0531	0.0538	0.0589	0.0594	0.0566	0.0568	0.0606	0.0636
OTHR	0.0094	0.0102	0.0103	0.0111	0.0117	0.0116	0.0121	0.0134	0.0146
TOTAL	0.2317	0.2396	0.2452	0.2555	0.2610	0.2311	0.2495	0.2566	0.2631
RETL-WHL									
HEAT	0.1276	0.1278	0.1307	0.1283	0.1157	0.1053	0.1220	0.1210	0.1191
COOL	0.0394	0.0411	0.0452	0.0475	0.0635	0.0485	0.0502	0.0494	0.0521
WATR	0.0057	0.0057	0.0057	0.0055	0.0050	0.0048	0.0048	0.0049	0.0050
LGHT	0.0517	0.0559	0.0567	0.0614	0.0604	0.0584	0.0586	0.0612	0.0636
OTHR	0.0425	0.0450	0.0445	0.0468	0.0482	0.0471	0.0477	0.0505	0.0530
TOTAL	0.2670	0.2755	0.2827	0.2895	0.2929	0.2642	0.2833	0.2869	0.2927
AUTO REP									
HEAT	0.0105	0.0103	0.0109	0.0098	0.0087	0.0080	0.0094	0.0091	0.0090
COOL	0.0027	0.0028	0.0031	0.0032	0.0038	0.0031	0.0032	0.0029	0.0030
WATR	0.0002	0.0002	0.0002	0.0002	0.0001	0.0001	0.0001	0.0001	0.0001
LGHT	0.0036	0.0039	0.0039	0.0042	0.0039	0.0039	0.0039	0.0039	0.0039
OTHR	0.0006	0.0007	0.0007	0.0007	0.0007	0.0007	0.0008	0.0008	0.0008
TOTAL	0.0177	0.0179	0.0188	0.0180	0.0172	0.0158	0.0174	0.0168	0.0169
WAREHSE									
HEAT	0.0224	0.0222	0.0229	0.0222	0.0204	0.0183	0.0213	0.0214	0.0212
COOL	0.0055	0.0057	0.0063	0.0066	0.0091	0.0069	0.0071	0.0071	0.0076
WATR	0.0004	0.0004	0.0004	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
LGHT	0.0063	0.0068	0.0069	0.0075	0.0075	0.0072	0.0072	0.0076	0.0080
OTHR	0.0013	0.0014	0.0014	0.0015	0.0016	0.0016	0.0017	0.0018	0.0020
TOTAL	0.0358	0.0365	0.0379	0.0383	0.0389	0.0343	0.0376	0.0383	0.0391
EDUC SER									
HEAT	0.1539	0.1528	0.1569	0.1570	0.1363	0.1267	0.1455	0.1410	0.1334
COOL	0.0396	0.0399	0.0453	0.0467	0.0596	0.0468	0.0484	0.0459	0.0478
WATR	0.0169	0.0167	0.0167	0.0161	0.0143	0.0140	0.0139	0.0139	0.0139
LGHT	0.0471	0.0499	0.0516	0.0553	0.0531	0.0521	0.0522	0.0534	0.0549
OTHR	0.0101	0.0107	0.0110	0.0117	0.0117	0.0119	0.0124	0.0132	0.0141
TOTAL	0.2675	0.2701	0.2816	0.2868	0.2750	0.2515	0.2725	0.2675	0.2642
PUB BLDG									
HEAT	0.0201	0.0198	0.0203	0.0203	0.0170	0.0161	0.0184	0.0173	0.0164
COOL	0.0058	0.0058	0.0061	0.0062	0.0075	0.0061	0.0064	0.0058	0.0059
WATR	0.0019	0.0018	0.0018	0.0018	0.0015	0.0015	0.0015	0.0015	0.0014
LGHT	0.0077	0.0081	0.0084	0.0089	0.0083	0.0083	0.0083	0.0083	0.0084
OTHR	0.0015	0.0016	0.0016	0.0017	0.0016	0.0017	0.0018	0.0018	0.0019
TOTAL	0.0367	0.0368	0.0382	0.0389	0.0360	0.0337	0.0363	0.0347	0.0341
FED BLDG									
HEAT	0.0090	0.0089	0.0091	0.0090	0.0076	0.0071	0.0082	0.0077	0.0074
COOL	0.0025	0.0025	0.0028	0.0029	0.0035	0.0028	0.0029	0.0027	0.0027
WATR	0.0009	0.0008	0.0008	0.0008	0.0007	0.0007	0.0007	0.0007	0.0007
LGHT	0.0036	0.0037	0.0039	0.0041	0.0038	0.0038	0.0038	0.0038	0.0039
OTHR	0.0007	0.0007	0.0007	0.0008	0.0008	0.0008	0.0008	0.0008	0.0009
TOTAL	0.0166	0.0167	0.0174	0.0175	0.0163	0.0152	0.0164	0.0157	0.0155
HEALTH									
HEAT	0.0918	0.0915	0.0934	0.0928	0.0812	0.0752	0.0866	0.0843	0.0802
COOL	0.0239	0.0245	0.0272	0.0282	0.0362	0.0284	0.0293	0.0280	0.0292
WATR	0.0257	0.0255	0.0253	0.0245	0.0218	0.0213	0.0212	0.0212	0.0211
LGHT	0.0240	0.0257	0.0262	0.0282	0.0272	0.0266	0.0266	0.0273	0.0282
OTHR	0.0128	0.0137	0.0139	0.0148	0.0149	0.0151	0.0157	0.0167	0.0178
TOTAL	0.1782	0.1809	0.1860	0.1884	0.1813	0.1665	0.1795	0.1775	0.1765
REL SERV									
HEAT	0.0261	0.0257	0.0267	0.0266	0.0230	0.0214	0.0247	0.0238	0.0230
COOL	0.0063	0.0062	0.0072	0.0074	0.0093	0.0074	0.0076	0.0072	0.0075
WATR	0.0006	0.0006	0.0006	0.0006	0.0005	0.0005	0.0005	0.0005	0.0005
LGHT	0.0058	0.0061	0.0063	0.0068	0.0065	0.0064	0.0064	0.0065	0.0067
OTHR	0.0007	0.0008	0.0008	0.0008	0.0008	0.0009	0.0009	0.0009	0.0010
TOTAL	0.0395	0.0393	0.0416	0.0422	0.0402	0.0365	0.0400	0.0389	0.0386
HOTLBLDG									
HEAT	0.0620	0.0611	0.0624	0.0631	0.0547	0.0508	0.0579	0.0559	0.0530
COOL	0.0130	0.0129	0.0147	0.0153	0.0198	0.0154	0.0160	0.0154	0.0160
WATR	0.0062	0.0061	0.0061	0.0059	0.0053	0.0052	0.0051	0.0051	0.0052
LGHT	0.0042	0.0044	0.0046	0.0049	0.0048	0.0046	0.0047	0.0048	0.0050
OTHR	0.0015	0.0016	0.0016	0.0017	0.0017	0.0017	0.0018	0.0019	0.0021
TOTAL	0.0868	0.0861	0.0894	0.0909	0.0864	0.0778	0.0855	0.0832	0.0813
MISC									
HEAT	0.0853	0.0837	0.0870	0.0854	0.0768	0.0700	0.0810	0.0800	0.0784
COOL	0.0238	0.0238	0.0271	0.0285	0.0380	0.0292	0.0302	0.0296	0.0312
WATR	0.0073	0.0072	0.0072	0.0071	0.0064	0.0062	0.0062	0.0063	0.0063
LGHT	0.0392	0.0414	0.0428	0.0463	0.0455	0.0440	0.0441	0.0460	0.0476
OTHR	0.0054	0.0057	0.0058	0.0062	0.0064	0.0065	0.0067	0.0072	0.0078
TOTAL	0.1610	0.1617	0.1701	0.1736	0.1731	0.1559	0.1683	0.1690	0.1713

TABLE A-13. REGION 3 HISTORICAL ENERGY USE BY BUILDING TYPE AND END USE

	1970	1971	1972	1973	1974	1975	1976	1977	1978
OFFICE									
HEAT	0.0675	0.0707	0.0739	0.0762	0.0677	0.0607	0.0671	0.0639	0.0636
COOL	0.0286	0.0310	0.0337	0.0375	0.0364	0.0448	0.0480	0.0500	0.0640
WATR	0.0036	0.0037	0.0037	0.0039	0.0040	0.0036	0.0036	0.0035	0.0036
LGHT	0.0285	0.0312	0.0332	0.0394	0.0420	0.0379	0.0377	0.0388	0.0395
OTHR	0.0055	0.0060	0.0063	0.0075	0.0084	0.0079	0.0081	0.0087	0.0092
TOTAL	0.1337	0.1426	0.1507	0.1645	0.1585	0.1549	0.1644	0.1649	0.1798
RETL-WHL									
HEAT	0.0842	0.0873	0.0909	0.0897	0.0778	0.0711	0.0795	0.0756	0.0755
COOL	0.0420	0.0452	0.0486	0.0518	0.0483	0.0611	0.0660	0.0681	0.0866
WATR	0.0022	0.0022	0.0022	0.0023	0.0022	0.0021	0.0020	0.0020	0.0020
LGHT	0.0376	0.0410	0.0432	0.0496	0.0514	0.0473	0.0473	0.0483	0.0490
OTHR	0.0306	0.0326	0.0334	0.0372	0.0401	0.0374	0.0382	0.0390	0.0406
TOTAL	0.1965	0.2083	0.2184	0.2307	0.2198	0.2189	0.2330	0.2330	0.2537
AUTO REP									
HEAT	0.0047	0.0048	0.0050	0.0044	0.0037	0.0036	0.0041	0.0039	0.0040
COOL	0.0019	0.0021	0.0022	0.0021	0.0018	0.0025	0.0028	0.0028	0.0035
WATR	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
LGHT	0.0018	0.0019	0.0020	0.0022	0.0021	0.0021	0.0021	0.0021	0.0021
OTHR	0.0003	0.0003	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.0005
TOTAL	0.0088	0.0092	0.0096	0.0092	0.0080	0.0086	0.0094	0.0093	0.0102
WAREHSE									
HEAT	0.0162	0.0166	0.0175	0.0172	0.0151	0.0137	0.0153	0.0147	0.0147
COOL	0.0064	0.0068	0.0074	0.0081	0.0077	0.0096	0.0103	0.0107	0.0136
WATR	0.0001	0.0001	0.0001	0.0002	0.0002	0.0001	0.0001	0.0001	0.0001
LGHT	0.0052	0.0056	0.0060	0.0070	0.0074	0.0067	0.0067	0.0069	0.0070
OTHR	0.0011	0.0012	0.0013	0.0015	0.0016	0.0015	0.0016	0.0017	0.0018
TOTAL	0.0289	0.0304	0.0323	0.0339	0.0320	0.0317	0.0340	0.0340	0.0372
EDUC SER									
HEAT	0.1137	0.1170	0.1218	0.1193	0.1001	0.0937	0.1048	0.0983	0.0955
COOL	0.0456	0.0479	0.0521	0.0532	0.0477	0.0624	0.0681	0.0696	0.0885
WATR	0.0073	0.0072	0.0073	0.0072	0.0069	0.0065	0.0065	0.0064	0.0064
LGHT	0.0385	0.0412	0.0438	0.0487	0.0488	0.0462	0.0465	0.0470	0.0476
OTHR	0.0082	0.0088	0.0093	0.0103	0.0108	0.0107	0.0112	0.0118	0.0124
TOTAL	0.2133	0.2221	0.2342	0.2387	0.2143	0.2195	0.2371	0.2330	0.2503
PUB BLDG									
HEAT	0.0174	0.0178	0.0182	0.0174	0.0140	0.0137	0.0153	0.0141	0.0139
COOL	0.0075	0.0078	0.0083	0.0081	0.0069	0.0096	0.0106	0.0106	0.0135
WATR	0.0010	0.0009	0.0009	0.0009	0.0008	0.0008	0.0008	0.0008	0.0008
LGHT	0.0075	0.0079	0.0083	0.0089	0.0086	0.0085	0.0086	0.0086	0.0087
OTHR	0.0014	0.0015	0.0016	0.0017	0.0017	0.0018	0.0019	0.0019	0.0020
TOTAL	0.0348	0.0360	0.0374	0.0370	0.0321	0.0345	0.0371	0.0361	0.0390
FED BLDG									
HEAT	0.0064	0.0066	0.0067	0.0064	0.0052	0.0050	0.0056	0.0052	0.0052
COOL	0.0027	0.0028	0.0030	0.0030	0.0025	0.0035	0.0039	0.0039	0.0049
WATR	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
LGHT	0.0027	0.0029	0.0030	0.0033	0.0032	0.0031	0.0031	0.0031	0.0032
OTHR	0.0005	0.0006	0.0006	0.0006	0.0006	0.0006	0.0007	0.0007	0.0007
TOTAL	0.0128	0.0132	0.0137	0.0135	0.0118	0.0126	0.0136	0.0133	0.0143
HEALTH									
HEAT	0.0586	0.0605	0.0625	0.0611	0.0516	0.0480	0.0538	0.0506	0.0492
COOL	0.0240	0.0255	0.0273	0.0281	0.0253	0.0329	0.0359	0.0368	0.0468
WATR	0.0096	0.0096	0.0096	0.0096	0.0092	0.0086	0.0086	0.0084	0.0084
LGHT	0.0170	0.0184	0.0193	0.0216	0.0218	0.0205	0.0206	0.0209	0.0212
OTHR	0.0090	0.0097	0.0102	0.0113	0.0120	0.0118	0.0123	0.0129	0.0136
TOTAL	0.1182	0.1237	0.1290	0.1317	0.1198	0.1219	0.1313	0.1296	0.1392
REL SERV									
HEAT	0.0192	0.0196	0.0206	0.0200	0.0167	0.0158	0.0177	0.0166	0.0165
COOL	0.0071	0.0073	0.0080	0.0082	0.0072	0.0096	0.0105	0.0107	0.0136
WATR	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002
LGHT	0.0047	0.0050	0.0053	0.0059	0.0058	0.0056	0.0056	0.0057	0.0057
OTHR	0.0006	0.0006	0.0007	0.0007	0.0007	0.0007	0.0008	0.0008	0.0009
TOTAL	0.0318	0.0327	0.0348	0.0350	0.0308	0.0319	0.0348	0.0340	0.0369
HOTLBLDG									
HEAT	0.0417	0.0426	0.0440	0.0435	0.0364	0.0339	0.0376	0.0350	0.0339
COOL	0.0139	0.0145	0.0158	0.0164	0.0149	0.0192	0.0209	0.0214	0.0271
WATR	0.0024	0.0024	0.0024	0.0024	0.0023	0.0022	0.0022	0.0021	0.0021
LGHT	0.0045	0.0048	0.0051	0.0057	0.0058	0.0054	0.0055	0.0055	0.0056
OTHR	0.0011	0.0011	0.0012	0.0014	0.0014	0.0014	0.0015	0.0015	0.0016
TOTAL	0.0636	0.0653	0.0686	0.0694	0.0611	0.0620	0.0675	0.0656	0.0703
MISC									
HEAT	0.0527	0.0536	0.0567	0.0558	0.0482	0.0441	0.0493	0.0468	0.0466
COOL	0.0233	0.0243	0.0268	0.0285	0.0264	0.0335	0.0363	0.0374	0.0475
WATR	0.0026	0.0026	0.0027	0.0027	0.0027	0.0025	0.0024	0.0024	0.0024
LGHT	0.0267	0.0284	0.0306	0.0350	0.0360	0.0332	0.0333	0.0339	0.0344
OTHR	0.0036	0.0039	0.0041	0.0047	0.0051	0.0049	0.0051	0.0054	0.0057
TOTAL	0.1091	0.1128	0.1209	0.1267	0.1185	0.1181	0.1264	0.1259	0.1366

TABLE A-14. REGION 4 HISTORICAL ENERGY USE BY BUILDING TYPE AND END USE

	1970	1971	1972	1973	1974	1975	1976	1977	1978
OFFICE									
HEAT	0.0498	0.0523	0.0554	0.0597	0.0602	0.0568	0.0735	0.0754	0.0715
COOL	0.0379	0.0424	0.0429	0.0510	0.0510	0.0479	0.0534	0.0620	0.0631
WATR	0.0031	0.0032	0.0041	0.0042	0.0046	0.0041	0.0040	0.0041	0.0042
LGHT	0.0365	0.0406	0.0555	0.0608	0.0701	0.0611	0.0614	0.0655	0.0679
OTHR	0.0070	0.0078	0.0106	0.0116	0.0140	0.0128	0.0134	0.0149	0.0160
TOTAL	0.1342	0.1464	0.1686	0.1873	0.2000	0.1827	0.2059	0.2219	0.2227
RETL-WHL									
HEAT	0.0645	0.0666	0.0672	0.0710	0.0680	0.0674	0.0889	0.0893	0.0839
COOL	0.0583	0.0649	0.0621	0.0719	0.0686	0.0681	0.0756	0.0854	0.0859
WATR	0.0019	0.0020	0.0024	0.0024	0.0025	0.0023	0.0023	0.0023	0.0023
LGHT	0.0487	0.0540	0.0705	0.0756	0.0835	0.0764	0.0765	0.0799	0.0820
OTHR	0.0395	0.0424	0.0536	0.0558	0.0637	0.0599	0.0610	0.0642	0.0669
TOTAL	0.2129	0.2299	0.2558	0.2767	0.2864	0.2743	0.3043	0.3212	0.3210
AUTO REP									
HEAT	0.0029	0.0029	0.0027	0.0027	0.0024	0.0029	0.0039	0.0037	0.0035
COOL	0.0021	0.0023	0.0021	0.0022	0.0019	0.0025	0.0026	0.0027	0.0027
WATR	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
LGHT	0.0019	0.0021	0.0025	0.0026	0.0026	0.0029	0.0028	0.0028	0.0028
OTHR	0.0003	0.0004	0.0004	0.0005	0.0005	0.0006	0.0006	0.0006	0.0006
TOTAL	0.0072	0.0076	0.0078	0.0081	0.0074	0.0089	0.0098	0.0099	0.0096
WAREHSE									
HEAT	0.0144	0.0147	0.0149	0.0159	0.0153	0.0148	0.0199	0.0202	0.0190
COOL	0.0096	0.0106	0.0105	0.0123	0.0121	0.0115	0.0128	0.0147	0.0148
WATR	0.0001	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002
LGHT	0.0077	0.0085	0.0115	0.0124	0.0141	0.0124	0.0125	0.0132	0.0137
OTHR	0.0016	0.0018	0.0024	0.0026	0.0030	0.0028	0.0030	0.0033	0.0035
TOTAL	0.0334	0.0357	0.0394	0.0434	0.0448	0.0417	0.0484	0.0516	0.0512
EDUC SER									
HEAT	0.0808	0.0834	0.0835	0.0866	0.0811	0.0861	0.1085	0.1070	0.0976
COOL	0.0545	0.0592	0.0553	0.0624	0.0568	0.0624	0.0676	0.0745	0.0741
WATR	0.0057	0.0058	0.0069	0.0067	0.0069	0.0068	0.0066	0.0065	0.0065
LGHT	0.0450	0.0489	0.0622	0.0654	0.0692	0.0687	0.0675	0.0689	0.0700
OTHR	0.0096	0.0104	0.0132	0.0138	0.0154	0.0160	0.0164	0.0174	0.0184
TOTAL	0.1956	0.2077	0.2211	0.2349	0.2293	0.2400	0.2665	0.2742	0.2666
PUB BLDG									
HEAT	0.0109	0.0112	0.0107	0.0108	0.0097	0.0112	0.0137	0.0132	0.0121
COOL	0.0080	0.0086	0.0076	0.0083	0.0071	0.0089	0.0094	0.0100	0.0099
WATR	0.0007	0.0007	0.0008	0.0007	0.0007	0.0008	0.0007	0.0007	0.0007
LGHT	0.0077	0.0083	0.0101	0.0104	0.0105	0.0115	0.0110	0.0110	0.0110
OTHR	0.0015	0.0016	0.0019	0.0020	0.0021	0.0024	0.0024	0.0025	0.0026
TOTAL	0.0287	0.0303	0.0310	0.0321	0.0300	0.0348	0.0373	0.0373	0.0363
FED BLDG									
HEAT	0.0052	0.0053	0.0051	0.0051	0.0046	0.0053	0.0066	0.0063	0.0058
COOL	0.0037	0.0040	0.0036	0.0039	0.0034	0.0042	0.0044	0.0047	0.0046
WATR	0.0003	0.0003	0.0004	0.0003	0.0003	0.0004	0.0003	0.0003	0.0003
LGHT	0.0036	0.0039	0.0048	0.0049	0.0049	0.0054	0.0052	0.0052	0.0052
OTHR	0.0007	0.0007	0.0009	0.0009	0.0010	0.0011	0.0011	0.0012	0.0012
TOTAL	0.0136	0.0143	0.0147	0.0152	0.0142	0.0165	0.0177	0.0177	0.0172
HEALTH									
HEAT	0.0416	0.0430	0.0426	0.0443	0.0415	0.0437	0.0557	0.0550	0.0502
COOL	0.0293	0.0321	0.0298	0.0338	0.0309	0.0335	0.0364	0.0403	0.0401
WATR	0.0076	0.0078	0.0092	0.0090	0.0093	0.0091	0.0089	0.0088	0.0088
LGHT	0.0203	0.0222	0.0282	0.0297	0.0316	0.0310	0.0306	0.0313	0.0319
OTHR	0.0107	0.0118	0.0149	0.0156	0.0174	0.0179	0.0184	0.0196	0.0207
TOTAL	0.1096	0.1169	0.1246	0.1323	0.1308	0.1353	0.1499	0.1550	0.1517
REL SERV									
HEAT	0.0148	0.0151	0.0152	0.0157	0.0146	0.0158	0.0199	0.0195	0.0182
COOL	0.0090	0.0096	0.0090	0.0101	0.0091	0.0103	0.0111	0.0121	0.0121
WATR	0.0002	0.0002	0.0003	0.0002	0.0002	0.0003	0.0002	0.0002	0.0002
LGHT	0.0060	0.0064	0.0082	0.0085	0.0090	0.0091	0.0089	0.0090	0.0091
OTHR	0.0008	0.0008	0.0010	0.0011	0.0012	0.0012	0.0013	0.0013	0.0014
TOTAL	0.0308	0.0322	0.0337	0.0357	0.0341	0.0366	0.0413	0.0422	0.0411
HOTLBLDG									
HEAT	0.0408	0.0418	0.0405	0.0421	0.0395	0.0406	0.0509	0.0500	0.0457
COOL	0.0229	0.0248	0.0233	0.0265	0.0245	0.0259	0.0282	0.0313	0.0312
WATR	0.0027	0.0028	0.0033	0.0033	0.0034	0.0033	0.0032	0.0032	0.0032
LGHT	0.0076	0.0082	0.0107	0.0113	0.0122	0.0117	0.0116	0.0120	0.0122
OTHR	0.0018	0.0020	0.0026	0.0027	0.0030	0.0031	0.0032	0.0034	0.0036
TOTAL	0.0759	0.0795	0.0803	0.0859	0.0826	0.0846	0.0971	0.0998	0.0959
MISC									
HEAT	0.0417	0.0422	0.0432	0.0456	0.0436	0.0434	0.0571	0.0572	0.0537
COOL	0.0325	0.0351	0.0340	0.0394	0.0373	0.0374	0.0414	0.0467	0.0469
WATR	0.0024	0.0024	0.0029	0.0029	0.0031	0.0028	0.0028	0.0028	0.0028
LGHT	0.0357	0.0386	0.0507	0.0544	0.0596	0.0549	0.0549	0.0571	0.0586
OTHR	0.0049	0.0052	0.0069	0.0073	0.0084	0.0081	0.0085	0.0092	0.0098
TOTAL	0.1171	0.1235	0.1378	0.1496	0.1521	0.1466	0.1647	0.1731	0.1718

TABLE A-15. REGION 5 HISTORICAL ENERGY USE BY BUILDING TYPE AND END USE

	1970	1971	1972	1973	1974	1975	1976	1977	1978
OFFICE									
HEAT	0.1569	0.1593	0.1705	0.1711	0.1820	0.1745	0.1842	0.1740	0.1866
COOL	0.0518	0.0543	0.0582	0.0634	0.0599	0.0646	0.0704	0.0750	0.0751
WATR	0.0043	0.0044	0.0044	0.0046	0.0050	0.0045	0.0044	0.0046	0.0047
LGHT	0.0588	0.0651	0.0691	0.0788	0.0903	0.0820	0.0820	0.0888	0.0923
OTHR	0.0111	0.0123	0.0130	0.0147	0.0178	0.0169	0.0176	0.0199	0.0215
TOTAL	0.2829	0.2954	0.3152	0.3326	0.3550	0.3425	0.3586	0.3622	0.3801
RETL-WHL									
HEAT	0.2125	0.2137	0.2302	0.2205	0.2286	0.2238	0.2391	0.2225	0.2354
COOL	0.0806	0.0842	0.0887	0.0941	0.0839	0.0935	0.1019	0.1052	0.1035
WATR	0.0028	0.0029	0.0028	0.0029	0.0030	0.0028	0.0028	0.0028	0.0028
LGHT	0.0841	0.0928	0.0976	0.1091	0.1194	0.1113	0.1113	0.1175	0.1206
OTHR	0.0678	0.0727	0.0741	0.0803	0.0906	0.0863	0.0875	0.0937	0.0981
TOTAL	0.4478	0.4662	0.4933	0.5069	0.5256	0.5177	0.5426	0.5417	0.5605
AUTO REP									
HEAT	0.0101	0.0099	0.0109	0.0093	0.0092	0.0094	0.0105	0.0095	0.0098
COOL	0.0032	0.0034	0.0034	0.0034	0.0027	0.0032	0.0035	0.0034	0.0032
WATR	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
LGHT	0.0034	0.0037	0.0038	0.0041	0.0041	0.0040	0.0040	0.0040	0.0040
OTHR	0.0006	0.0007	0.0007	0.0007	0.0007	0.0008	0.0008	0.0008	0.0009
TOTAL	0.0173	0.0177	0.0189	0.0176	0.0167	0.0175	0.0188	0.0178	0.0180
WAREHSE									
HEAT	0.0447	0.0445	0.0489	0.0458	0.0489	0.0472	0.0509	0.0481	0.0510
COOL	0.0140	0.0146	0.0156	0.0167	0.0154	0.0168	0.0183	0.0192	0.0191
WATR	0.0002	0.0002	0.0002	0.0002	0.0003	0.0002	0.0002	0.0002	0.0002
LGHT	0.0129	0.0142	0.0151	0.0171	0.0192	0.0176	0.0176	0.0189	0.0195
OTHR	0.0026	0.0029	0.0031	0.0035	0.0041	0.0039	0.0041	0.0046	0.0049
TOTAL	0.0745	0.0764	0.0828	0.0832	0.0878	0.0858	0.0912	0.0910	0.0947
EDUC SER									
HEAT	0.2516	0.2512	0.2674	0.2606	0.2555	0.2567	0.2706	0.2449	0.2511
COOL	0.0794	0.0806	0.0857	0.0885	0.0741	0.0857	0.0934	0.0934	0.0907
WATR	0.0081	0.0082	0.0082	0.0083	0.0082	0.0078	0.0076	0.0076	0.0075
LGHT	0.0757	0.0819	0.0866	0.0951	0.0994	0.0952	0.0952	0.0980	0.0995
OTHR	0.0159	0.0172	0.0181	0.0197	0.0217	0.0217	0.0227	0.0244	0.0257
TOTAL	0.4307	0.4391	0.4660	0.4722	0.4589	0.4672	0.4895	0.4683	0.4745
PUB BLDG									
HEAT	0.0330	0.0327	0.0342	0.0330	0.0306	0.0316	0.0331	0.0291	0.0300
COOL	0.0109	0.0110	0.0114	0.0115	0.0089	0.0108	0.0118	0.0113	0.0109
WATR	0.0009	0.0009	0.0009	0.0009	0.0008	0.0008	0.0008	0.0008	0.0007
LGHT	0.0124	0.0133	0.0139	0.0150	0.0148	0.0147	0.0147	0.0147	0.0147
OTHR	0.0023	0.0025	0.0026	0.0028	0.0029	0.0030	0.0032	0.0033	0.0034
TOTAL	0.0596	0.0604	0.0629	0.0631	0.0580	0.0609	0.0635	0.0592	0.0597
FED BLDG									
HEAT	0.0129	0.0127	0.0133	0.0127	0.0119	0.0123	0.0129	0.0114	0.0117
COOL	0.0042	0.0042	0.0044	0.0044	0.0034	0.0042	0.0046	0.0044	0.0042
WATR	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
LGHT	0.0048	0.0052	0.0054	0.0058	0.0057	0.0057	0.0057	0.0057	0.0057
OTHR	0.0009	0.0010	0.0010	0.0011	0.0011	0.0012	0.0012	0.0013	0.0013
TOTAL	0.0232	0.0234	0.0245	0.0244	0.0225	0.0236	0.0247	0.0230	0.0232
HEALTH									
HEAT	0.1301	0.1303	0.1383	0.1336	0.1324	0.1325	0.1403	0.1276	0.1312
COOL	0.0417	0.0429	0.0449	0.0466	0.0398	0.0453	0.0494	0.0496	0.0483
WATR	0.0107	0.0109	0.0108	0.0109	0.0109	0.0104	0.0102	0.0102	0.0100
LGHT	0.0336	0.0367	0.0384	0.0423	0.0445	0.0425	0.0424	0.0439	0.0446
OTHR	0.0176	0.0192	0.0200	0.0219	0.0242	0.0242	0.0253	0.0272	0.0287
TOTAL	0.2337	0.2399	0.2523	0.2553	0.2514	0.2549	0.2675	0.2585	0.2628
REL SERV									
HEAT	0.0444	0.0438	0.0471	0.0457	0.0446	0.0450	0.0475	0.0428	0.0449
COOL	0.0130	0.0130	0.0140	0.0144	0.0119	0.0139	0.0152	0.0150	0.0146
WATR	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
LGHT	0.0097	0.0103	0.0110	0.0120	0.0124	0.0120	0.0120	0.0123	0.0124
OTHR	0.0012	0.0013	0.0014	0.0015	0.0016	0.0016	0.0017	0.0018	0.0019
TOTAL	0.0685	0.0687	0.0738	0.0739	0.0708	0.0728	0.0766	0.0723	0.0740
HOTLBLDG									
HEAT	0.0938	0.0929	0.0980	0.0968	0.0945	0.0943	0.0983	0.0884	0.0911
COOL	0.0252	0.0254	0.0272	0.0283	0.0242	0.0276	0.0301	0.0304	0.0296
WATR	0.0027	0.0027	0.0027	0.0028	0.0028	0.0026	0.0026	0.0026	0.0025
LGHT	0.0089	0.0096	0.0102	0.0113	0.0120	0.0114	0.0113	0.0118	0.0120
OTHR	0.0021	0.0023	0.0024	0.0027	0.0030	0.0030	0.0031	0.0033	0.0035
TOTAL	0.1327	0.1328	0.1405	0.1418	0.1365	0.1389	0.1454	0.1366	0.1389
MISC									
HEAT	0.1207	0.1188	0.1300	0.1244	0.1283	0.1260	0.1345	0.1246	0.1314
COOL	0.0413	0.0416	0.0451	0.0477	0.0422	0.0474	0.0516	0.0531	0.0522
WATR	0.0030	0.0030	0.0031	0.0032	0.0033	0.0030	0.0030	0.0030	0.0030
LGHT	0.0543	0.0584	0.0625	0.0698	0.0759	0.0710	0.0710	0.0747	0.0768
OTHR	0.0072	0.0078	0.0083	0.0092	0.0106	0.0103	0.0108	0.0118	0.0126
TOTAL	0.2265	0.2296	0.2489	0.2543	0.2603	0.2577	0.2708	0.2671	0.2757

TABLE A-16. REGION 6 HISTORICAL ENERGY USE BY BUILDING TYPE AND END USE

	1970	1971	1972	1973	1974	1975	1976	1977	1978
OFFICE									
HEAT	0.0372	0.0359	0.0384	0.0409	0.0429	0.0410	0.0482	0.0549	0.0599
COOL	0.0370	0.0412	0.0467	0.0501	0.0512	0.0565	0.0600	0.0690	0.0753
WATR	0.0011	0.0012	0.0012	0.0013	0.0014	0.0013	0.0014	0.0013	0.0013
LGHT	0.0254	0.0284	0.0300	0.0373	0.0415	0.0370	0.0430	0.0403	0.0406
OTHR	0.0048	0.0054	0.0057	0.0070	0.0082	0.0077	0.0093	0.0091	0.0095
TOTAL	0.1056	0.1121	0.1221	0.1367	0.1452	0.1435	0.1619	0.1745	0.1866
RETL-WHL									
HEAT	0.0471	0.0445	0.0490	0.0491	0.0493	0.0484	0.0552	0.0636	0.0702
COOL	0.0557	0.0616	0.0696	0.0708	0.0696	0.0789	0.0800	0.0938	0.1018
WATR	0.0007	0.0007	0.0007	0.0008	0.0008	0.0007	0.0008	0.0007	0.0007
LGHT	0.0338	0.0375	0.0396	0.0471	0.0508	0.0463	0.0518	0.0493	0.0497
OTHR	0.0274	0.0295	0.0301	0.0346	0.0381	0.0354	0.0398	0.0386	0.0395
TOTAL	0.1647	0.1738	0.1889	0.2024	0.2086	0.2096	0.2277	0.2459	0.2619
AUTO REP									
HEAT	0.0027	0.0024	0.0029	0.0026	0.0024	0.0026	0.0027	0.0032	0.0037
COOL	0.0025	0.0028	0.0031	0.0029	0.0026	0.0033	0.0030	0.0037	0.0040
WATR	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
LGHT	0.0016	0.0018	0.0019	0.0021	0.0021	0.0021	0.0021	0.0021	0.0021
OTHR	0.0003	0.0003	0.0003	0.0004	0.0004	0.0004	0.0004	0.0004	0.0005
TOTAL	0.0071	0.0073	0.0083	0.0079	0.0074	0.0084	0.0082	0.0094	0.0103
WAREHSE									
HEAT	0.0094	0.0087	0.0099	0.0099	0.0099	0.0097	0.0113	0.0129	0.0143
COOL	0.0087	0.0096	0.0109	0.0114	0.0114	0.0127	0.0132	0.0153	0.0166
WATR	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
LGHT	0.0049	0.0055	0.0058	0.0071	0.0078	0.0070	0.0080	0.0075	0.0076
OTHR	0.0010	0.0011	0.0012	0.0015	0.0017	0.0016	0.0019	0.0019	0.0020
TOTAL	0.0241	0.0249	0.0278	0.0298	0.0308	0.0310	0.0344	0.0376	0.0405
EDUC SER									
HEAT	0.0560	0.0534	0.0573	0.0569	0.0566	0.0563	0.0617	0.0724	0.0773
COOL	0.0515	0.0557	0.0640	0.0620	0.0588	0.0686	0.0666	0.0796	0.0866
WATR	0.0020	0.0020	0.0020	0.0022	0.0022	0.0020	0.0021	0.0020	0.0019
LGHT	0.0302	0.0329	0.0351	0.0401	0.0419	0.0392	0.0421	0.0407	0.0410
OTHR	0.0064	0.0070	0.0074	0.0084	0.0092	0.0090	0.0102	0.0102	0.0107
TOTAL	0.1461	0.1510	0.1658	0.1696	0.1687	0.1751	0.1826	0.2049	0.2175
PUB BLDG									
HEAT	0.0071	0.0067	0.0071	0.0068	0.0065	0.0069	0.0070	0.0084	0.0091
COOL	0.0072	0.0077	0.0087	0.0080	0.0072	0.0092	0.0082	0.0101	0.0110
WATR	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002
LGHT	0.0049	0.0053	0.0057	0.0062	0.0062	0.0063	0.0063	0.0062	0.0063
OTHR	0.0009	0.0010	0.0011	0.0012	0.0012	0.0013	0.0014	0.0014	0.0015
TOTAL	0.0204	0.0210	0.0228	0.0223	0.0214	0.0239	0.0231	0.0263	0.0280
FED BLDG									
HEAT	0.0039	0.0037	0.0039	0.0037	0.0035	0.0037	0.0038	0.0046	0.0050
COOL	0.0036	0.0038	0.0044	0.0040	0.0036	0.0046	0.0041	0.0050	0.0055
WATR	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
LGHT	0.0025	0.0027	0.0028	0.0031	0.0031	0.0031	0.0031	0.0031	0.0031
OTHR	0.0005	0.0005	0.0005	0.0006	0.0006	0.0006	0.0007	0.0007	0.0007
TOTAL	0.0105	0.0108	0.0117	0.0115	0.0110	0.0122	0.0119	0.0135	0.0144
HEALTH									
HEAT	0.0288	0.0274	0.0294	0.0291	0.0289	0.0287	0.0317	0.0370	0.0397
COOL	0.0272	0.0297	0.0337	0.0329	0.0313	0.0364	0.0355	0.0424	0.0461
WATR	0.0027	0.0027	0.0027	0.0029	0.0029	0.0027	0.0028	0.0026	0.0025
LGHT	0.0134	0.0147	0.0156	0.0179	0.0188	0.0175	0.0189	0.0182	0.0184
OTHR	0.0071	0.0078	0.0082	0.0093	0.0103	0.0101	0.0114	0.0114	0.0119
TOTAL	0.0792	0.0823	0.0896	0.0921	0.0923	0.0953	0.1002	0.1116	0.1186
REL SERV									
HEAT	0.0099	0.0093	0.0101	0.0100	0.0098	0.0099	0.0108	0.0127	0.0140
COOL	0.0083	0.0088	0.0102	0.0098	0.0092	0.0109	0.0105	0.0126	0.0137
WATR	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
LGHT	0.0039	0.0042	0.0045	0.0051	0.0053	0.0050	0.0053	0.0051	0.0052
OTHR	0.0005	0.0005	0.0006	0.0006	0.0007	0.0007	0.0007	0.0008	0.0008
TOTAL	0.0226	0.0228	0.0255	0.0256	0.0251	0.0265	0.0273	0.0312	0.0337
HOTLBLDG									
HEAT	0.0242	0.0229	0.0240	0.0239	0.0236	0.0234	0.0253	0.0294	0.0314
COOL	0.0180	0.0193	0.0221	0.0217	0.0208	0.0240	0.0236	0.0280	0.0303
WATR	0.0008	0.0008	0.0008	0.0009	0.0009	0.0008	0.0008	0.0008	0.0008
LGHT	0.0041	0.0045	0.0048	0.0056	0.0059	0.0054	0.0060	0.0057	0.0058
OTHR	0.0010	0.0011	0.0011	0.0013	0.0015	0.0014	0.0016	0.0016	0.0017
TOTAL	0.0481	0.0485	0.0529	0.0533	0.0527	0.0550	0.0574	0.0656	0.0700
MISC									
HEAT	0.0281	0.0260	0.0292	0.0292	0.0293	0.0288	0.0328	0.0378	0.0418
COOL	0.0291	0.0312	0.0362	0.0367	0.0359	0.0408	0.0412	0.0484	0.0525
WATR	0.0008	0.0008	0.0008	0.0009	0.0009	0.0008	0.0009	0.0008	0.0008
LGHT	0.0230	0.0249	0.0267	0.0317	0.0339	0.0310	0.0345	0.0329	0.0331
OTHR	0.0031	0.0034	0.0036	0.0042	0.0048	0.0046	0.0053	0.0053	0.0055
TOTAL	0.0841	0.0863	0.0965	0.1027	0.1048	0.1060	0.1146	0.1252	0.1338

TABLE A-17. REGION 7 HISTORICAL ENERGY USE BY BUILDING TYPE AND END USE

	1970	1971	1972	1973	1974	1975	1976	1977	1978
OFFICE									
HEAT	0.0331	0.0335	0.0356	0.0346	0.0371	0.0362	0.0404	0.0383	0.0392
COOL	0.0173	0.0185	0.0193	0.0203	0.0184	0.0231	0.0308	0.0329	0.0349
WATR	0.0007	0.0008	0.0008	0.0008	0.0010	0.0008	0.0009	0.0008	0.0008
LGHT	0.0134	0.0147	0.0157	0.0190	0.0236	0.0201	0.0209	0.0206	0.0206
OTHR	0.0025	0.0028	0.0030	0.0036	0.0046	0.0041	0.0045	0.0046	0.0048
TOTAL	0.0671	0.0703	0.0743	0.0783	0.0847	0.0844	0.0974	0.0972	0.1002
RETL-WHL									
HEAT	0.0462	0.0464	0.0495	0.0456	0.0462	0.0469	0.0521	0.0494	0.0514
COOL	0.0283	0.0301	0.0311	0.0311	0.0262	0.0342	0.0449	0.0484	0.0511
WATR	0.0005	0.0005	0.0005	0.0005	0.0006	0.0005	0.0005	0.0005	0.0005
LGHT	0.0199	0.0219	0.0231	0.0270	0.0313	0.0277	0.0284	0.0282	0.0282
OTHR	0.0161	0.0172	0.0176	0.0198	0.0236	0.0214	0.0224	0.0223	0.0229
TOTAL	0.1111	0.1160	0.1219	0.1241	0.1279	0.1307	0.1484	0.1488	0.1541
AUTO REP									
HEAT	0.0016	0.0016	0.0017	0.0014	0.0013	0.0014	0.0016	0.0015	0.0016
COOL	0.0008	0.0009	0.0009	0.0008	0.0006	0.0008	0.0011	0.0012	0.0012
WATR	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
LGHT	0.0006	0.0006	0.0007	0.0007	0.0007	0.0007	0.0007	0.0007	0.0007
OTHR	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0002
TOTAL	0.0032	0.0032	0.0034	0.0031	0.0027	0.0031	0.0035	0.0035	0.0037
WAREHSE									
HEAT	0.0090	0.0089	0.0097	0.0089	0.0092	0.0093	0.0104	0.0098	0.0103
COOL	0.0045	0.0048	0.0050	0.0051	0.0045	0.0058	0.0076	0.0082	0.0086
WATR	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
LGHT	0.0028	0.0031	0.0033	0.0040	0.0048	0.0041	0.0043	0.0042	0.0042
OTHR	0.0006	0.0006	0.0007	0.0008	0.0010	0.0009	0.0010	0.0010	0.0011
TOTAL	0.0170	0.0175	0.0188	0.0188	0.0196	0.0202	0.0233	0.0233	0.0243
EDUC SER									
HEAT	0.0563	0.0561	0.0597	0.0545	0.0518	0.0541	0.0592	0.0568	0.0568
COOL	0.0285	0.0295	0.0309	0.0294	0.0229	0.0314	0.0406	0.0440	0.0468
WATR	0.0015	0.0015	0.0015	0.0016	0.0016	0.0015	0.0015	0.0014	0.0014
LGHT	0.0184	0.0199	0.0212	0.0238	0.0257	0.0238	0.0241	0.0240	0.0240
OTHR	0.0039	0.0042	0.0044	0.0049	0.0056	0.0054	0.0057	0.0060	0.0062
TOTAL	0.1086	0.1112	0.1177	0.1142	0.1076	0.1161	0.1311	0.1322	0.1352
PUB BLDG									
HEAT	0.0068	0.0067	0.0070	0.0062	0.0055	0.0061	0.0065	0.0062	0.0063
COOL	0.0036	0.0037	0.0038	0.0035	0.0024	0.0036	0.0046	0.0050	0.0053
WATR	0.0002	0.0002	0.0002	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
LGHT	0.0028	0.0030	0.0031	0.0034	0.0034	0.0033	0.0033	0.0033	0.0033
OTHR	0.0005	0.0006	0.0006	0.0006	0.0007	0.0007	0.0007	0.0007	0.0008
TOTAL	0.0139	0.0141	0.0147	0.0138	0.0121	0.0138	0.0151	0.0154	0.0158
FED BLDG									
HEAT	0.0039	0.0038	0.0040	0.0035	0.0031	0.0035	0.0037	0.0036	0.0036
COOL	0.0021	0.0021	0.0022	0.0020	0.0014	0.0021	0.0026	0.0029	0.0030
WATR	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
LGHT	0.0016	0.0017	0.0018	0.0019	0.0019	0.0019	0.0019	0.0019	0.0019
OTHR	0.0003	0.0003	0.0003	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004
TOTAL	0.0079	0.0081	0.0084	0.0079	0.0069	0.0079	0.0087	0.0088	0.0091
HEALTH									
HEAT	0.0305	0.0304	0.0322	0.0293	0.0281	0.0293	0.0321	0.0307	0.0309
COOL	0.0156	0.0163	0.0169	0.0162	0.0127	0.0173	0.0225	0.0244	0.0259
WATR	0.0021	0.0021	0.0021	0.0021	0.0023	0.0021	0.0021	0.0020	0.0019
LGHT	0.0085	0.0093	0.0098	0.0111	0.0121	0.0111	0.0112	0.0112	0.0112
OTHR	0.0044	0.0048	0.0051	0.0057	0.0066	0.0063	0.0067	0.0069	0.0072
TOTAL	0.0611	0.0630	0.0660	0.0645	0.0617	0.0660	0.0746	0.0752	0.0771
REL SERV									
HEAT	0.0100	0.0099	0.0106	0.0096	0.0090	0.0095	0.0104	0.0100	0.0102
COOL	0.0047	0.0048	0.0051	0.0048	0.0036	0.0051	0.0065	0.0071	0.0075
WATR	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0000	0.0000
LGHT	0.0024	0.0025	0.0027	0.0030	0.0032	0.0030	0.0030	0.0030	0.0030
OTHR	0.0003	0.0003	0.0003	0.0004	0.0004	0.0004	0.0004	0.0004	0.0005
TOTAL	0.0174	0.0175	0.0187	0.0178	0.0163	0.0180	0.0204	0.0206	0.0213
HOTLBLDG									
HEAT	0.0197	0.0194	0.0205	0.0189	0.0180	0.0186	0.0203	0.0193	0.0189
COOL	0.0084	0.0087	0.0091	0.0088	0.0071	0.0095	0.0123	0.0133	0.0140
WATR	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0004	0.0004
LGHT	0.0020	0.0022	0.0023	0.0027	0.0030	0.0027	0.0027	0.0027	0.0027
OTHR	0.0005	0.0005	0.0006	0.0006	0.0007	0.0007	0.0007	0.0008	0.0008
TOTAL	0.0311	0.0313	0.0329	0.0315	0.0293	0.0319	0.0366	0.0366	0.0369
MISC									
HEAT	0.0279	0.0274	0.0298	0.0273	0.0275	0.0280	0.0310	0.0294	0.0304
COOL	0.0153	0.0157	0.0167	0.0166	0.0139	0.0162	0.0239	0.0257	0.0272
WATR	0.0006	0.0006	0.0006	0.0006	0.0007	0.0006	0.0006	0.0006	0.0006
LGHT	0.0136	0.0146	0.0157	0.0183	0.0210	0.0186	0.0191	0.0189	0.0189
OTHR	0.0018	0.0019	0.0021	0.0024	0.0029	0.0027	0.0029	0.0030	0.0031
TOTAL	0.0592	0.0602	0.0648	0.0652	0.0659	0.0680	0.0775	0.0776	0.0802

TABLE A-18. REGION 8 HISTORICAL ENERGY USE BY BUILDING TYPE AND END USE

	1970	1971	1972	1973	1974	1975	1976	1977	1978
OFFICE									
HEAT	0.0191	0.0198	0.0212	0.0227	0.0255	0.0263	0.0294	0.0260	0.0274
COOL	0.0094	0.0101	0.0111	0.0119	0.0120	0.0125	0.0113	0.0126	0.0140
WATR	0.0004	0.0004	0.0004	0.0004	0.0005	0.0005	0.0005	0.0005	0.0005
LGHT	0.0067	0.0074	0.0086	0.0102	0.0131	0.0111	0.0133	0.0124	0.0123
OTHR	0.0013	0.0014	0.0017	0.0020	0.0026	0.0023	0.0029	0.0029	0.0030
TOTAL	0.0368	0.0391	0.0430	0.0471	0.0538	0.0527	0.0575	0.0543	0.0572
RETL-WHL									
HEAT	0.0241	0.0248	0.0260	0.0272	0.0286	0.0308	0.0325	0.0291	0.0310
COOL	0.0132	0.0141	0.0150	0.0154	0.0144	0.0156	0.0134	0.0154	0.0171
WATR	0.0002	0.0002	0.0002	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
LGHT	0.0088	0.0097	0.0109	0.0126	0.0152	0.0133	0.0153	0.0145	0.0145
OTHR	0.0072	0.0077	0.0084	0.0094	0.0115	0.0104	0.0121	0.0117	0.0120
TOTAL	0.0534	0.0565	0.0605	0.0649	0.0700	0.0703	0.0737	0.0710	0.0748
AUTO REP									
HEAT	0.0010	0.0011	0.0011	0.0011	0.0010	0.0012	0.0011	0.0010	0.0011
COOL	0.0005	0.0005	0.0005	0.0005	0.0004	0.0005	0.0004	0.0004	0.0005
WATR	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
LGHT	0.0003	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004
OTHR	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
TOTAL	0.0019	0.0020	0.0020	0.0021	0.0019	0.0022	0.0020	0.0020	0.0022
WAREHSE									
HEAT	0.0042	0.0045	0.0047	0.0050	0.0053	0.0057	0.0060	0.0053	0.0057
COOL	0.0020	0.0021	0.0023	0.0024	0.0024	0.0025	0.0022	0.0025	0.0028
WATR	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
LGHT	0.0011	0.0013	0.0014	0.0017	0.0021	0.0018	0.0022	0.0020	0.0020
OTHR	0.0002	0.0003	0.0003	0.0004	0.0005	0.0004	0.0005	0.0005	0.0005
TOTAL	0.0077	0.0081	0.0088	0.0095	0.0103	0.0105	0.0110	0.0104	0.0111
EDUC SER									
HEAT	0.0319	0.0324	0.0338	0.0349	0.0350	0.0382	0.0398	0.0366	0.0378
COOL	0.0146	0.0151	0.0159	0.0159	0.0135	0.0154	0.0125	0.0148	0.0166
WATR	0.0007	0.0007	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008
LGHT	0.0087	0.0095	0.0105	0.0119	0.0134	0.0122	0.0133	0.0130	0.0131
OTHR	0.0019	0.0020	0.0022	0.0025	0.0030	0.0029	0.0033	0.0033	0.0035
TOTAL	0.0578	0.0597	0.0632	0.0660	0.0657	0.0693	0.0697	0.0686	0.0717
PUB BLDG									
HEAT	0.0043	0.0043	0.0044	0.0044	0.0041	0.0048	0.0047	0.0044	0.0046
COOL	0.0021	0.0021	0.0021	0.0020	0.0016	0.0020	0.0015	0.0018	0.0020
WATR	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
LGHT	0.0015	0.0016	0.0017	0.0019	0.0020	0.0019	0.0020	0.0020	0.0020
OTHR	0.0003	0.0003	0.0003	0.0004	0.0004	0.0004	0.0004	0.0005	0.0005
TOTAL	0.0081	0.0084	0.0086	0.0088	0.0081	0.0092	0.0086	0.0088	0.0092
FED BLDG									
HEAT	0.0033	0.0033	0.0034	0.0034	0.0032	0.0037	0.0036	0.0034	0.0036
COOL	0.0016	0.0016	0.0016	0.0015	0.0012	0.0015	0.0011	0.0014	0.0015
WATR	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
LGHT	0.0011	0.0012	0.0013	0.0014	0.0015	0.0015	0.0015	0.0015	0.0015
OTHR	0.0002	0.0002	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0004
TOTAL	0.0062	0.0064	0.0066	0.0067	0.0062	0.0071	0.0066	0.0067	0.0070
HEALTH									
HEAT	0.0156	0.0159	0.0165	0.0170	0.0172	0.0187	0.0195	0.0179	0.0185
COOL	0.0073	0.0076	0.0079	0.0079	0.0069	0.0077	0.0064	0.0075	0.0084
WATR	0.0009	0.0009	0.0009	0.0010	0.0011	0.0010	0.0010	0.0010	0.0010
LGHT	0.0037	0.0040	0.0044	0.0050	0.0057	0.0052	0.0057	0.0055	0.0056
OTHR	0.0020	0.0021	0.0024	0.0027	0.0032	0.0030	0.0035	0.0035	0.0037
TOTAL	0.0293	0.0306	0.0321	0.0337	0.0340	0.0356	0.0361	0.0354	0.0371
REL SERV									
HEAT	0.0056	0.0056	0.0059	0.0061	0.0060	0.0066	0.0068	0.0063	0.0067
COOL	0.0024	0.0024	0.0026	0.0026	0.0022	0.0025	0.0020	0.0024	0.0027
WATR	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
LGHT	0.0011	0.0012	0.0013	0.0015	0.0017	0.0015	0.0016	0.0016	0.0016
OTHR	0.0001	0.0001	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0003
TOTAL	0.0093	0.0094	0.0100	0.0104	0.0101	0.0109	0.0107	0.0106	0.0112
HOTLBLDG									
HEAT	0.0134	0.0135	0.0141	0.0146	0.0148	0.0160	0.0169	0.0155	0.0159
COOL	0.0053	0.0054	0.0058	0.0059	0.0052	0.0058	0.0048	0.0056	0.0063
WATR	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
LGHT	0.0011	0.0012	0.0014	0.0016	0.0018	0.0016	0.0018	0.0018	0.0018
OTHR	0.0003	0.0003	0.0003	0.0004	0.0005	0.0004	0.0005	0.0005	0.0005
TOTAL	0.0204	0.0207	0.0219	0.0228	0.0226	0.0241	0.0244	0.0236	0.0248
MISC									
HEAT	0.0163	0.0165	0.0175	0.0182	0.0191	0.0205	0.0216	0.0194	0.0205
COOL	0.0080	0.0082	0.0090	0.0093	0.0085	0.0093	0.0080	0.0091	0.0102
WATR	0.0003	0.0003	0.0003	0.0003	0.0004	0.0003	0.0004	0.0003	0.0003
LGHT	0.0067	0.0072	0.0082	0.0095	0.0113	0.0099	0.0113	0.0108	0.0108
OTHR	0.0009	0.0010	0.0011	0.0013	0.0016	0.0015	0.0018	0.0018	0.0018
TOTAL	0.0322	0.0332	0.0361	0.0386	0.0408	0.0416	0.0430	0.0414	0.0437

TABLE A-19. REGION 9 HISTORICAL ENERGY USE BY BUILDING TYPE AND END USE

	1970	1971	1972	1973	1974	1975	1976	1977	1978
OFFICE									
HEAT	0.0445	0.0458	0.0488	0.0547	0.0515	0.0512	0.0510	0.0525	0.0531
COOL	0.0524	0.0546	0.0638	0.0661	0.0603	0.0849	0.0908	0.0923	0.0940
WATR	0.0018	0.0019	0.0019	0.0021	0.0022	0.0020	0.0020	0.0019	0.0019
LGHT	0.0377	0.0421	0.0432	0.0520	0.0537	0.0498	0.0517	0.0496	0.0486
OTHR	0.0074	0.0083	0.0084	0.0101	0.0109	0.0106	0.0114	0.0113	0.0115
TOTAL	0.1438	0.1527	0.1661	0.1850	0.1786	0.1984	0.2070	0.2076	0.2091
RETL-WHL									
HEAT	0.0507	0.0530	0.0553	0.0601	0.0555	0.0569	0.0537	0.0566	0.0572
COOL	0.0735	0.0762	0.0888	0.0882	0.0792	0.1134	0.1206	0.1235	0.1257
WATR	0.0010	0.0010	0.0010	0.0011	0.0011	0.0010	0.0010	0.0010	0.0010
LGHT	0.0450	0.0502	0.0515	0.0597	0.0608	0.0572	0.0591	0.0570	0.0561
OTHR	0.0373	0.0406	0.0404	0.0456	0.0482	0.0458	0.0480	0.0469	0.0472
TOTAL	0.2075	0.2210	0.2371	0.2548	0.2448	0.2744	0.2824	0.2850	0.2872
AUTO REP									
HEAT	0.0036	0.0040	0.0040	0.0041	0.0037	0.0042	0.0034	0.0038	0.0040
COOL	0.0040	0.0041	0.0048	0.0044	0.0038	0.0060	0.0062	0.0065	0.0067
WATR	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
LGHT	0.0027	0.0030	0.0030	0.0033	0.0033	0.0033	0.0033	0.0033	0.0032
OTHR	0.0005	0.0005	0.0006	0.0006	0.0006	0.0006	0.0007	0.0007	0.0007
TOTAL	0.0107	0.0116	0.0124	0.0124	0.0114	0.0141	0.0136	0.0143	0.0146
WAREHSE									
HEAT	0.0088	0.0094	0.0097	0.0107	0.0098	0.0101	0.0091	0.0098	0.0099
COOL	0.0095	0.0098	0.0114	0.0116	0.0105	0.0148	0.0158	0.0161	0.0164
WATR	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
LGHT	0.0057	0.0063	0.0065	0.0077	0.0079	0.0074	0.0077	0.0074	0.0072
OTHR	0.0012	0.0013	0.0014	0.0016	0.0017	0.0017	0.0018	0.0018	0.0019
TOTAL	0.0253	0.0269	0.0291	0.0317	0.0300	0.0341	0.0345	0.0351	0.0354
EDUC SER									
HEAT	0.0548	0.0551	0.0597	0.0626	0.0578	0.0599	0.0591	0.0616	0.0608
COOL	0.0598	0.0607	0.0721	0.0689	0.0612	0.0909	0.0954	0.0986	0.1007
WATR	0.0027	0.0028	0.0027	0.0029	0.0029	0.0027	0.0027	0.0026	0.0026
LGHT	0.0370	0.0405	0.0422	0.0472	0.0475	0.0461	0.0470	0.0457	0.0450
OTHR	0.0081	0.0089	0.0092	0.0102	0.0107	0.0109	0.0116	0.0116	0.0118
TOTAL	0.1624	0.1679	0.1859	0.1918	0.1801	0.2106	0.2158	0.2202	0.2209
PUB BLDG									
HEAT	0.0087	0.0086	0.0093	0.0094	0.0085	0.0091	0.0090	0.0093	0.0095
COOL	0.0103	0.0103	0.0123	0.0112	0.0098	0.0152	0.0157	0.0164	0.0168
WATR	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.0003	0.0003
LGHT	0.0074	0.0080	0.0083	0.0090	0.0089	0.0090	0.0090	0.0089	0.0088
OTHR	0.0014	0.0016	0.0016	0.0017	0.0018	0.0019	0.0020	0.0020	0.0021
TOTAL	0.0281	0.0289	0.0320	0.0317	0.0294	0.0356	0.0360	0.0369	0.0375
FED BLDG									
HEAT	0.0037	0.0037	0.0040	0.0040	0.0036	0.0039	0.0038	0.0040	0.0040
COOL	0.0042	0.0043	0.0051	0.0046	0.0040	0.0063	0.0065	0.0068	0.0070
WATR	0.0001	0.0002	0.0001	0.0002	0.0002	0.0001	0.0001	0.0001	0.0001
LGHT	0.0031	0.0033	0.0035	0.0037	0.0037	0.0037	0.0037	0.0037	0.0036
OTHR	0.0006	0.0006	0.0007	0.0007	0.0007	0.0008	0.0008	0.0008	0.0009
TOTAL	0.0117	0.0121	0.0133	0.0132	0.0123	0.0148	0.0150	0.0154	0.0156
HEALTH									
HEAT	0.0297	0.0304	0.0323	0.0341	0.0314	0.0326	0.0316	0.0331	0.0327
COOL	0.0336	0.0345	0.0404	0.0389	0.0346	0.0511	0.0536	0.0554	0.0565
WATR	0.0037	0.0039	0.0038	0.0040	0.0040	0.0038	0.0038	0.0036	0.0036
LGHT	0.0174	0.0192	0.0197	0.0222	0.0224	0.0217	0.0221	0.0215	0.0211
OTHR	0.0094	0.0104	0.0107	0.0119	0.0126	0.0127	0.0135	0.0135	0.0137
TOTAL	0.0938	0.0982	0.1069	0.1111	0.1050	0.1218	0.1246	0.1271	0.1277
PEL SERV									
HEAT	0.0097	0.0096	0.0105	0.0109	0.0101	0.0106	0.0104	0.0109	0.0111
COOL	0.0093	0.0094	0.0113	0.0107	0.0094	0.0142	0.0148	0.0154	0.0158
WATR	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
LGHT	0.0047	0.0051	0.0054	0.0059	0.0060	0.0058	0.0059	0.0058	0.0057
OTHR	0.0006	0.0006	0.0007	0.0007	0.0008	0.0008	0.0008	0.0008	0.0009
TOTAL	0.0244	0.0248	0.0279	0.0284	0.0263	0.0314	0.0321	0.0330	0.0335
MOTLBLDG									
HEAT	0.0335	0.0327	0.0362	0.0377	0.0345	0.0345	0.0355	0.0360	0.0364
COOL	0.0257	0.0259	0.0307	0.0296	0.0263	0.0385	0.0404	0.0416	0.0429
WATR	0.0013	0.0014	0.0013	0.0014	0.0015	0.0014	0.0014	0.0013	0.0013
LGHT	0.0065	0.0071	0.0074	0.0085	0.0085	0.0082	0.0084	0.0081	0.0080
OTHR	0.0016	0.0018	0.0018	0.0021	0.0022	0.0022	0.0023	0.0023	0.0024
TOTAL	0.0687	0.0689	0.0776	0.0793	0.0730	0.0847	0.0878	0.0893	0.0905
MISC									
HEAT	0.0403	0.0414	0.0445	0.0486	0.0447	0.0454	0.0434	0.0456	0.0464
COOL	0.0483	0.0488	0.0582	0.0576	0.0516	0.0742	0.0788	0.0808	0.0823
WATR	0.0015	0.0015	0.0015	0.0016	0.0016	0.0015	0.0015	0.0014	0.0014
LGHT	0.0394	0.0430	0.0449	0.0518	0.0526	0.0497	0.0512	0.0494	0.0485
OTHR	0.0055	0.0060	0.0062	0.0071	0.0076	0.0075	0.0080	0.0080	0.0081
TOTAL	0.1350	0.1407	0.1553	0.1667	0.1581	0.1783	0.1829	0.1853	0.1868

TABLE A-20. REGION 10 HISTORICAL ENERGY USE BY BUILDING TYPE AND END USE

	1970	1971	1972	1973	1974	1975	1976	1977	1978
OFFICE									
HEAT	0.0267	0.0304	0.0348	0.0353	0.0373	0.0338	0.0321	0.0313	0.0304
COOL	0.0096	0.0107	0.0135	0.0154	0.0170	0.0163	0.0184	0.0188	0.0200
WATR	0.0014	0.0015	0.0015	0.0016	0.0018	0.0016	0.0018	0.0016	0.0016
LGHT	0.0082	0.0091	0.0095	0.0115	0.0140	0.0124	0.0139	0.0130	0.0130
OTHR	0.0016	0.0017	0.0018	0.0022	0.0028	0.0026	0.0030	0.0030	0.0031
TOTAL	0.0474	0.0534	0.0611	0.0660	0.0729	0.0667	0.0691	0.0677	0.0681
RETL-WHL									
HEAT	0.0337	0.0386	0.0440	0.0425	0.0414	0.0414	0.0369	0.0371	0.0364
COOL	0.0142	0.0157	0.0198	0.0215	0.0215	0.0228	0.0244	0.0256	0.0274
WATR	0.0009	0.0009	0.0009	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010
LGHT	0.0110	0.0122	0.0127	0.0149	0.0167	0.0161	0.0172	0.0164	0.0165
OTHR	0.0090	0.0097	0.0098	0.0111	0.0128	0.0126	0.0137	0.0133	0.0137
TOTAL	0.0688	0.0771	0.0873	0.0910	0.0935	0.0937	0.0932	0.0934	0.0949
AUTO REP									
HEAT	0.0017	0.0020	0.0022	0.0019	0.0016	0.0021	0.0016	0.0017	0.0017
COOL	0.0006	0.0006	0.0008	0.0008	0.0007	0.0009	0.0009	0.0010	0.0010
WATR	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
LGHT	0.0005	0.0005	0.0005	0.0006	0.0006	0.0007	0.0006	0.0006	0.0006
OTHR	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
TOTAL	0.0028	0.0032	0.0037	0.0034	0.0030	0.0038	0.0032	0.0035	0.0036
WAREHSE									
HEAT	0.0061	0.0070	0.0080	0.0077	0.0078	0.0075	0.0067	0.0067	0.0065
COOL	0.0020	0.0022	0.0028	0.0032	0.0033	0.0033	0.0037	0.0038	0.0040
WATR	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
LGHT	0.0014	0.0015	0.0016	0.0019	0.0023	0.0021	0.0023	0.0022	0.0022
OTHR	0.0003	0.0003	0.0003	0.0004	0.0005	0.0005	0.0005	0.0005	0.0006
TOTAL	0.0099	0.0112	0.0128	0.0133	0.0140	0.0134	0.0133	0.0133	0.0133
EDUC SER									
HEAT	0.0412	0.0459	0.0535	0.0503	0.0452	0.0491	0.0428	0.0435	0.0421
COOL	0.0143	0.0153	0.0198	0.0204	0.0184	0.0219	0.0222	0.0239	0.0257
WATR	0.0026	0.0027	0.0027	0.0027	0.0027	0.0028	0.0028	0.0027	0.0027
LGHT	0.0101	0.0110	0.0117	0.0132	0.0136	0.0143	0.0147	0.0142	0.0144
OTHR	0.0022	0.0024	0.0025	0.0028	0.0030	0.0033	0.0036	0.0036	0.0038
TOTAL	0.0704	0.0774	0.0901	0.0895	0.0829	0.0913	0.0860	0.0880	0.0887
PUB BLDG									
HEAT	0.0060	0.0066	0.0077	0.0069	0.0058	0.0069	0.0058	0.0060	0.0059
COOL	0.0022	0.0023	0.0030	0.0029	0.0024	0.0033	0.0031	0.0035	0.0038
WATR	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
LGHT	0.0018	0.0020	0.0021	0.0023	0.0022	0.0026	0.0025	0.0025	0.0025
OTHR	0.0004	0.0004	0.0004	0.0004	0.0004	0.0005	0.0005	0.0006	0.0006
TOTAL	0.0107	0.0116	0.0135	0.0128	0.0113	0.0136	0.0122	0.0128	0.0132
FED BLDG									
HEAT	0.0040	0.0044	0.0051	0.0046	0.0039	0.0046	0.0038	0.0040	0.0039
COOL	0.0014	0.0015	0.0019	0.0018	0.0015	0.0021	0.0020	0.0022	0.0024
WATR	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002
LGHT	0.0012	0.0013	0.0013	0.0014	0.0014	0.0016	0.0016	0.0016	0.0016
OTHR	0.0002	0.0002	0.0003	0.0003	0.0003	0.0003	0.0003	0.0004	0.0004
TOTAL	0.0069	0.0076	0.0088	0.0083	0.0073	0.0088	0.0079	0.0083	0.0085
HEALTH									
HEAT	0.0208	0.0235	0.0269	0.0253	0.0229	0.0246	0.0214	0.0218	0.0211
COOL	0.0073	0.0080	0.0101	0.0105	0.0096	0.0113	0.0115	0.0124	0.0133
WATR	0.0034	0.0035	0.0034	0.0036	0.0035	0.0036	0.0036	0.0035	0.0035
LGHT	0.0044	0.0048	0.0051	0.0057	0.0060	0.0062	0.0064	0.0062	0.0063
OTHR	0.0023	0.0026	0.0027	0.0030	0.0033	0.0036	0.0039	0.0039	0.0042
TOTAL	0.0383	0.0423	0.0482	0.0482	0.0454	0.0493	0.0469	0.0478	0.0483
REL SERV									
HEAT	0.0071	0.0078	0.0092	0.0086	0.0076	0.0085	0.0073	0.0075	0.0074
COOL	0.0023	0.0024	0.0032	0.0032	0.0028	0.0035	0.0035	0.0038	0.0041
WATR	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
LGHT	0.0013	0.0014	0.0015	0.0016	0.0017	0.0018	0.0018	0.0018	0.0018
OTHR	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0003	0.0003	0.0003
TOTAL	0.0109	0.0119	0.0141	0.0138	0.0124	0.0140	0.0129	0.0134	0.0136
HOTLBLDG									
HEAT	0.0163	0.0178	0.0207	0.0195	0.0179	0.0185	0.0164	0.0164	0.0159
COOL	0.0047	0.0050	0.0065	0.0068	0.0064	0.0073	0.0075	0.0080	0.0085
WATR	0.0009	0.0009	0.0009	0.0010	0.0010	0.0010	0.0010	0.0009	0.0009
LGHT	0.0012	0.0014	0.0014	0.0016	0.0018	0.0018	0.0019	0.0018	0.0018
OTHR	0.0003	0.0003	0.0003	0.0004	0.0004	0.0005	0.0005	0.0005	0.0005
TOTAL	0.0235	0.0255	0.0299	0.0294	0.0274	0.0290	0.0272	0.0277	0.0278
MISC									
HEAT	0.0206	0.0231	0.0269	0.0259	0.0250	0.0251	0.0224	0.0225	0.0221
COOL	0.0077	0.0083	0.0107	0.0116	0.0115	0.0122	0.0130	0.0137	0.0147
WATR	0.0010	0.0010	0.0010	0.0011	0.0012	0.0011	0.0012	0.0011	0.0011
LGHT	0.0076	0.0082	0.0087	0.0102	0.0113	0.0109	0.0116	0.0111	0.0112
OTHR	0.0010	0.0011	0.0012	0.0014	0.0016	0.0016	0.0018	0.0018	0.0019
TOTAL	0.0380	0.0417	0.0485	0.0500	0.0506	0.0510	0.0500	0.0503	0.0510

Appendix B

Technical Description of the Commercial End Use Model

COMMERCIAL END USE MODEL STRUCTURE

The approach used to develop the commercial model is similar in its emphasis to the capital-stock energy demand models introduced by Fisher and Kaysen. The model developed here differs from previous models in that prior information (in the form of detailed engineering estimates of energy use by equipment, structure type, fuel type, and age of capital stock) is used to develop a highly disaggregated model of the commercial demand for energy. The capital-stock modeling approach explicitly recognizes the fact that energy is consumed by capital goods to provide desired services. For instance, electricity is combined with an electric heat pump to produce heating services. Since energy is consumed only in combination with such capital goods, the problem of estimating energy use in the short run (period of time where the stock of capital goods is fixed) requires only estimation of the equipment stock and of the utilization rate (intensity with which the stock is used). Over a longer period of time, changes in the stock of captial goods and changes in the energy-using characteristics of capital goods are also considered.

Energy demand is determined within the model with the basic energy demand equation

$$Q^T_{i,k,l} = \sum_{t=t_o}^{T} U^t_{i,k,l} \cdot e^t_{i,k,l} \cdot a^t_{i,k,l} \cdot A^t_l \cdot d_l\,(T-t) \quad (B1)$$

where:

T =simulation or forecast year

$Q_{i,k,l}$ = energy demand for fuel i, end use k, and building type l

t_o = age of oldest building stock additions

U = utilization, relative to some base year

e = energy use requirement (by fuel, end use, building type), Btu/ft^2/year

$a^t_{i,k,l}$ = fraction of floor space served by fuel (i), end use (k) and building type (l) for floor space additions of vintage t.

A^t_l = floor space additions by vintage (t) and building type (l)

d(T-t) = fraction of floor space of vintage t still standing in forecast year T.

A detailed discussion of the development of this demand equation is provided in Jackson (1979).

To forecast energy demand by fuel (i), end use (k), building type (l) and year (T) requires forecasting changes in the values of the right-hand variables of equation (B1). Since energy use is actually forecast by building vintage (and then summed over vintages), it is useful to describe changes in the right-hand variables of (B1) under two circumstances: the first circumstance occurs for existing buildings which undertake no change in captial equipment over the previous year; the second situation arises in new buildings and in existing buildings when equipment is replaced. We discuss changes in the right-hand variables of (B1) including utilization (U), energy use requirements (e), and floor space fractions (a) in both situations below.

EXISTING BUILDINGS - NO CHANGE IN EQUIPMENT

This situation represents the short-run component of the model; i.e., the capital stock is fixed. Thus, the energy use characteristics of the equipment (e) and the fraction of floor space served by fuel/end use combinations (a) do not change from one year to the next year. Utilization of equipment may change, however, in response to increasing fuel prices. We do not model a change in utilization resulting from a change in activity since this linkage is insignificant in the commercial sector. Conventional short-run own price elasticities cannot be used directly to capture this change in utilization since econometric short-run elasticities are actually one-year elasticities and as such include a one year efficiency increase and a one year fuel switching impact. We assume that the one year efficiency increase is negligible and approximate our "usage elasticity" by summing own and cross price elasticities. Utilization is then forecast in the model as

$$U^{t}_{i,k,l} = U^{t-1}_{i,k,l}\left[1 + \left(\frac{P^{t}_{i} - P^{t-1}_{i}}{P^{t-1}_{i}}\right) V_{i}\right] \qquad \text{(B2)}$$

where: U = utilization

P_i^t = price of fuel i in year t

V_i = utilization elasticity

U = 1 in the base year

NEW AND EXISTING BUILDINGS - CHANGE IN EQUIPMENT

New buildings obviously require the choice and installation of new equipment. For end use system in existing buildings, we presently assume that equipment wears out and is replaced at constant time intervals. Thus in 1990 space heating systems which were originally installed in 1972 are replaced and systems installed in 1954 are replaced for the second time since the building was constructed.

For lighting, water heating and "other" end uses we estimate efficiency increases using an "efficiency elasticity". The efficiency elasticity is related to econometrically estimated elasticities as follows:

efficiency elasticity = long run price effect - short run utilization effect - fuel switching effect

The short run and fuel switching effects must be netted out since they are captured elsewhere in the model.

The efficiency elasticity (w) can be calculated by using the sum of short run own and cross price elasticities (v) and the sum of long run own and cross price elasticities (r) (to remove the fuel switching effect) to solve for (w) in the following equation.

$$1 + \left(\frac{p^t - p^{t-1}}{p^{t-1}}\right) r = \left[1 + \left(\frac{p^t - p^{t-1}}{p^t}\right) v\right]\left[1 + \left(\frac{p^t - p^{t-1}}{p^{t-1}}\right) w\right] \qquad \text{(B3)}$$

where: P = fuel price

If we approximate the general solution by selecting a 10 percent price increase and solve (B3), we get

$$w = \frac{\frac{1 + 0.1r}{1 + 0.1v} - 1}{0.1}$$

A discussion of engineering efficiency determination for heating and cooling systems is deferred for the following subsection.

Fuel choice for space heating and water heating is presently forecast using the results of a national fuel choice study (Cohn, 1978). The application of this model is described in Jackson et.al. (1978). The prices of fuels are weighted by the efficiency of the new systems to relate fuel choice to the price of the end use service which is the correct price variable.

The fuel choice estimate is applied to space heating equipment in new buildings and in buildings where existing equipment is being replaced. We assume that water heating fuel choice is identical to that of space heating.

Utilization of equipment changes in this long run situation not only in response to fuel prices but also in response to changes in efficiency. The impacts of increased fuel prices will be offset to some extent by increased efficiency of equipment. That is, these two effects work in opposite directions in terms of their influence on the price of the end use service. This utilization relationship is represented as

$$U^{t}_{i,k,l} = U^{t-1}_{i,k,l} \left[1 + \left(\frac{P^{t}_{i} \cdot e^{t}_{i,k,l} - P^{t-1}_{i} \cdot e^{t-1}_{i,k,l}}{P^{t-1}_{i} \cdot e^{t-1}_{i,k,l}} \right) v_{i} \right] \qquad \text{(B4)}$$

EFFICIENCY CHANGES IN SPACE HEATING AND COOLING SYSTEM

Relationships between equipment cost and efficiency developed from engineering analysis are used to estimate space heating and cooling efficiency increases. The relationship between equipment energy use requirements (E) and capital cost (C) can be represented as

$$C = \frac{b - \ln (E-a)}{d} + 1 \qquad \text{(B5)}$$

where a, b, and d are parameters of the function and E and c are measured relative to a base year value. One of the engineering-based curves used in the model is shown in Figure IV-9.

The life cycle cost of an HVAC system can be represented as

$$\sum_{t=0}^{n-1} \frac{E \cdot EUI \cdot P_E \cdot (1+\alpha)^t}{(1+r)^t} + P_c \cdot C \qquad \text{(B6)}$$

where EUI = energy use per square foot in base year

P_c = cost of capital inputs

n = equipment lifetime

α = expected rate of fuel price increase

r = discount rate

P_E = price of energy

Minimizing life cycle cost with respect to the production constraint (B5) allows us to solve for energy use requirements as a function of capital cost, fuel prices and expected price increases, discount rate, and the production technology:

$$E = \frac{P_c}{P_E \cdot EUI \cdot D} + a \qquad \text{(B7)}$$

Appendix C

Regional Energy Use by Fuel and End Use

Table C - 1
Electrical Energy Use for the Baseline Case

	Annual energy use (Quads)					
Region	1978	1980	1985	1990	1995	2000
1	.307	.317	.352	.401	.462	.543
2	.659	.676	.780	.880	.968	1.064
3	.740	.763	.887	1.016	1.147	1.301
4	.938	.973	1.199	1.416	1.659	1.958
5	1.106	1.184	1.364	1.522	1.684	1.868
6	.719	.726	.844	.987	1.161	1.369
7	.377	.381	.418	.470	.515	.565
8	.164	.171	.185	.223	.265	.315
9	.920	.956	1.032	1.186	1.352	1.548
10	.289	.286	.340	.380	.438	.510
TOTAL	6.207	6.437	7.402	8.48	9.65	11.042

Source: Commercial energy use model

Table C - 2
Gas Energy Use for the Baseline Case

	Annual energy use (Quads)					
Region	1978	1980	1985	1990	1995	2000
1	.042	.040	.049	.058	.063	.071
2	.141	.140	.158	.172	.180	.193
3	.205	.192	.215	.238	.254	.278
4	.224	.213	.236	.264	.292	.327
5	.746	.709	.740	.778	.804	.846
6	.243	.222	.231	.244	.265	.294
7	.197	.169	.176	.179	.182	.187
8	.104	.101	.101	.105	.110	.119
9	.247	.249	.246	.260	.278	.306
10	.098	.099	.107	.120	.124	.130
TOTAL	2.247	2.133	2.259	2.417	2.552	2.750

Source: Commercial energy use model

Table C - 3
Oil Energy Use for the Baseline Case

	Annual energy use (Quads)					
Region	1978	1980	1985	1990	1995	2000
1	.265	.254	.229	.233	.243	.249
2	.593	.561	.504	.498	.503	.506
3	.207	.189	.171	.169	.171	.178
4	.202	.187	.182	.188	.204	.223
5	.450	.427	.400	.403	.412	.418
6	.142	.133	.135	.152	.172	.193
7	.076	.068	.064	.064	.066	.068
8	.075	.073	.074	.082	.092	.101
9	.086	.092	.093	.100	.106	.105
10	.040	.034	.031	.030	.031	.033
TOTAL	2.138	2.016	1.883	1.919	2.003	2.075

Source: Commercial energy use model

Table C - 4
Other Energy Use for the Baseline Case

Region	Annual energy use (Quads)					
	1978	1980	1985	1990	1995	2000
1	.005	.005	.005	.004	.004	.003
2	.010	.010	.010	.010	.008	.006
3	.016	.013	.010	.007	.006	.005
4	.022	.018	.013	.009	.008	.007
5	.060	.050	.031	.019	.016	.012
6	.011	.009	.007	.005	.004	.004
7	.009	.007	.005	.004	.003	.002
8	.007	.006	.004	.003	.002	.002
9	.006	.007	.006	.005	.004	.004
10	.004	.003	.003	.003	.002	.002
TOTAL	.148	.127	.093	.069	.059	.045

Source: Commercial energy use model

Table C - 5
Space Heating Energy Use

Region	Annual energy use (Quads)					
	1978	1980	1985	1990	1995	2000
1	.273	.260	.248	.261	.276	.298
2	.665	.631	.593	.600	.609	.620
3	.419	.385	.386	.407	.429	.460
4	.461	.427	.443	.479	.524	.588
5	1.174	1.100	1.081	1.104	1.131	1.171
6	.366	.334	.389	.364	.399	.443
7	.260	.224	.222	.224	.227	.232
8	.173	.167	.164	1.74	.188	.204
9	.325	.335	.330	.346	.366	.390
10	.194	.187	.198	.214	.227	.248
TOTAL	4.310	4.048	4.003	4.173	4.377	4.653

Source: Commercial energy use model

Table C - 6
Cooling Energy Use for the Baseline Case

Region	Annual energy use (Quads)					
	1978	1980	1985	1990	1995	2000
1	.110	.115	.132	.156	.185	.218
2	.253	.270	.325	.381	.433	.488
3	.410	.428	.503	.586	.675	.773
4	.385	.402	.499	.597	.713	.851
5	.451	.488	.574	.657	.747	.844
6	.443	.449	.528	.630	.754	.898
7	.226	.228	.252	.287	.320	.354
8	.082	.085	.096	.119	.143	.172
9	.564	.585	.637	.743	.856	.983
10	.125	.124	.151	.174	.205	.242
TOTAL	3.050	3.172	3.697	4.329	5.029	5.823

Source: Commercial energy use model

Table C - 7
Water Heating Energy Use for the Baseline Case

	Annual energy use (Quads)					
Region	1978	1980	1985	1990	1995	2000
1	.064	.064	.063	.068	.073	.081
2	.065	.065	.064	.067	.069	.073
3	.026	.026	.026	.028	.030	.033
4	.029	.029	.032	.035	.040	.047
5	.032	.032	.032	.033	.035	.037
6	.008	.008	.009	.009	.011	.012
7	.006	.006	.006	.006	.006	.006
8	.003	.003	.003	.003	.004	.004
9	.012	.012	.012	.013	.015	.017
10	.012	.011	.012	.012	.014	.016
TOTAL	.258	.256	.258	.275	.296	.324

Source: Commercial energy use model

Table C - 8
Lighting Energy Use for the Baseline Case

	Annual energy use (Quads)					
Region	1978	1980	1985	1990	1995	2000
1	.124	.125	.133	.148	.166	.188
2	.294	.298	.328	.359	.384	.410
3	.224	.229	.256	.285	.313	.344
4	.364	.375	.453	.528	.611	.709
5	.502	.526	.584	.638	.690	.748
6	.213	.212	.238	.272	.312	.359
7	.119	.119	.126	.139	.149	.159
8	.066	.067	.070	.082	.094	.109
9	.256	.264	.280	.318	.357	.403
10	.072	.070	.082	.090	.101	.115
TOTAL	2.233	2.287	2.548	2.857	3.170	3.544

Source: Commercial energy use model

Table C - 9
Other Energy Use for the Baseline Case

	Annual energy use (Quads)					
Region	1978	1980	1985	1990	1995	2000
1	.049	.051	.059	.063	.071	.082
2	.116	.123	.143	.155	.165	.178
3	.089	.095	.113	.124	.136	.152
4	.145	.156	.203	.238	.275	.321
5	.203	.223	.266	.290	.314	.344
6	.084	.088	.103	.113	.128	.148
7	.048	.050	.057	.061	.066	.071
8	.026	.028	.031	.035	.040	.048
9	.101	.107	.118	.131	.147	.169
10	.029	.030	.038	.042	.048	.055
TOTAL	.890	.951	1.131	1.251	1.389	1.568

Source: Commercial energy use model

Table C-10
ELECTRICITY ENERGY USE FOR THE CONSERVATION SCENARIO

Region	Annual Energy Use (Quads) 1985	1990	1995	2000
1	.345	.387	.441	.508
2	.767	.850	.921	.992
3	.870	.982	1.095	1.256
4	1.171	1.352	1.579	1.854
5	1.339	1.480	1.633	1.817
6	.826	.956	1.121	1.315
7	.411	.456	.497	.543
8	.181	.217	.256	.305
9	1.016	1.151	1.300	1.473
10	.332	.365	.419	.486
TOTAL	7.256	8.200	9.276	10.531

Source: Commercial energy use model

Table C-11
GAS ENERGY USE FOR THE CONSERVATION SCENARIO

Region	Annual Energy Use (Quads) 1985	1990	1995	2000
1	.048	.055	.059	.064
2	.155	.165	.168	.173
3	.209	.224	.229	.236
4	.228	.238	.244	.252
5	.725	.742	.743	.747
6	.222	.217	.215	.215
7	.172	.171	.170	.170
8	.098	.099	.101	.105
9	.239	.234	.232	.235
10	.104	.112	.111	.111
TOTAL	2.202	2.257	2.273	2.308

Source: Commercial energy use model

Table C-12
OIL ENERGY USE FOR THE CONSERVATION SCENARIO

Region	Annual Energy Use (Quads) 1985	1990	1995	2000
1	.229	.227	.228	.223
2	.504	.484	.470	.444
3	.172	.163	.160	.150
4	.186	.174	.169	.160
5	.410	.400	.391	.370
6	.147	.148	.145	.138
7	.067	.065	.065	.063
8	.076	.081	.086	.090
9	.100	.098	.093	.082
10	.032	.029	.029	.029
TOTAL	1.922	1.871	1.836	1.749

Source: Commercial energy use model

Table C-13
SOLAR ENERGY USE FOR THE CONSERVATION SCENARIO

Region	Annual Energy Use (Quads) 1985	1990	1995	2000
1	.0	.004	.011	.029
2	.002	.013	.032	.077
3	.0	.009	.005	.035
4	.002	.033	.069	.127
5	.001	.007	.018	.048
6	.002	.018	.040	.075
7	.0	.001	.002	.005
8	.0	.001	.002	.006
9	.003	.021	.041	.071
10	.0	.00	.001	.001
TOTAL	.010	.107	.221	.474

Source: Commercial energy use model

Table C-14
SPACE HEATING ENERGY USE FOR THE CONSERVATION SCENARIO

Region	Annual Energy Use (Quads) 1985	1990	1995	2000
1	.241	.248	.256	.273
2	.579	.568	.558	.548
3	.372	.385	.395	.419
4	.426	.460	.499	.566
5	1.044	1.051	1.049	1.063
6	.337	.349	.363	.386
7	.216	.213	.211	.211
8	.160	.165	.172	.182
9	.326	.331	.337	.349
10	.192	.202	.209	.224
TOTAL	3.893	3.972	4.050	4.220

Source: Commercial energy use model

Table C-15
COOLING ENERGY USE FOR THE CONSERVATION SCENARIO

Region	Annual Energy Use (Quads) 1985	1990	1995	2000
1	.129	.151	.181	.216
2	.318	.374	.431	.503
3	.491	.564	.647	.741
4	.485	.570	.678	.806
5	.561	.638	.729	.835
6	.545	.605	.721	.857
7	.247	.278	.308	.342
8	.094	.115	.140	.171
9	.625	.717	.821	.939
10	.147	.165	.195	.228
TOTAL	3.611	4.176	4.850	5.639

Source: Commercial energy use model

Table C-16
WATER HEATING ENERGY USE FOR THE CONSERVATION SCENARIO

Region	Annual Energy Use (Quads) 1985	1990	1995	2000
1	.063	.067	.071	.075
2	.064	.065	.067	.067
3	.026	.027	.028	.029
4	.031	.032	.033	.035
5	.032	.032	.033	.034
6	.009	.009	.009	.009
7	.006	.006	.006	.006
8	.003	.003	.004	.004
9	.012	.012	.012	.012
10	.011	.012	.013	.014
TOTAL	.256	.265	.275	.285

Source: Commercial energy use model

Table C-17
LIGHTING ENERGY USE FOR THE CONSERVATION SCENARIO

Region	Annual Energy Use (Quads) 1985	1990	1995	2000
1	.131	.144	.160	.177
2	.323	.350	.370	.389
3	.250	.276	.300	.327
4	.440	.504	.575	.660
5	.572	.617	.660	.706
6	.234	.265	.301	.343
7	.124	.135	.143	.151
8	.069	.079	.089	.101
9	.118	.131	.147	.169
10	.080	.086	.095	.106
TOTAL	2.499	2.769	3.043	3.349

Source: Commercial energy use model

Table C-18
OTHER ENERGY USE FOR THE CONSERVATION SCENARIO

Region	Annual Energy Use (Quads) 1985	1990	1995	2000
1	.059	.063	.071	.082
2	.143	.155	.165	.178
3	.113	.124	.136	.151
4	.203	.238	.275	.321
5	.266	.290	.314	.344
6	.103	.113	.128	.148
7	.057	.061	.066	.071
8	.031	.035	.040	.048
9	.118	.131	.147	.169
10	.038	.042	.048	.055
TOTAL	1.131	1.252	1.388	1.568

Source: Commercial energy use model

Table C-19
ELECTRICITY ENERGY USE FOR THE HIGH PRICE SCENARIO

Region	Annual Energy Use (Quads) 1985	1990	1995	2000
1	.334	.366	.398	.440
2	.743	.799	.833	.860
3	.844	.927	.999	1.087
4	1.133	1.281	1.434	1.632
5	1.298	1.392	1.463	1.538
6	.801	.900	1.013	1.151
7	.397	.430	.450	.474
8	.175	.202	.227	.255
9	.985	1.089	1.188	1.302
10	.323	.348	.385	.434
TOTAL	7.033	7.733	8.392	9.181

Source: Commercial energy use model

Table C-20
GAS ENERGY USE FOR THE HIGH PRICE SCENARIO

Region	Annual Energy Use (Quads) 1985	1990	1995	2000
1	.043	.451	.047	.046
2	.145	.146	.135	.125
3	.196	.197	.187	.175
4	.214	.209	.200	.189
5	.681	.659	.614	.570
6	.209	.194	.181	.170
7	.162	.153	.142	.131
8	.092	.088	.083	.080
9	.225	.208	.194	.185
10	.097	.098	.088	.079
TOTAL	2.067	1.998	1.869	1.749

Source: Commercial energy use model

Table C-21
OIL ENERGY USE FOR THE HIGH PRICE SCENARIO

Region	Annual Energy Use (Quads) 1985	1990	1995	2000
1	.219	.211	.203	.193
2	.482	.452	.425	.398
3	.165	.154	.187	.139
4	.179	.164	.154	.146
5	.395	.379	.364	.355
6	.142	.143	.141	.140
7	.064	.062	.061	.063
8	.073	.078	.083	.088
9	.097	.095	.089	.080
10	.030	.027	.026	.026
TOTAL	1.847	1.765	1.694	1.627

Source: Commercial energy use model

Table C-22
SOLAR ENERGY USE FOR THE HIGH PRICE SCENARIO

Region	Annual Energy Use (Quads) 1985	1990	1995	2000
1	.001	.008	.021	.054
2	.003	.020	.045	.107
3	.001	.014	.035	.083
4	.004	.048	.096	.177
5	.002	.022	.061	.154
6	.002	.027	.058	.108
7	.001	.004	.010	.021
8	.001	.005	.012	.026
9	.004	.028	.053	.090
10	.0	.003	.010	.022
TOTAL	.017	.181	.401	.842

Source: Commercial energy use model

Table C-23
SPACE HEATING ENERGY USE FOR THE HIGH PRICE SCENARIO

Region	Annual Energy Use (Quads) 1985	1990	1995	2000
1	.230	.230	.229	.241
2	.553	.524	.493	.472
3	.476	.534	.350	.365
4	.408	.430	.454	.513
5	.992	.961	.915	.902
6	.322	.325	.331	.353
7	.205	.195	.184	.179
8	.152	.153	.154	.160
9	.311	.308	.305	.314
10	.183	.187	.187	.198
TOTAL	3.710	3.666	3.601	3.697

Source: Commercial energy use model

Table C-24
COOLING ENERGY USE FOR THE HIGH PRICE SCENARIO

Region	Annual Energy Use (Quads) 1985	1990	1995	2000
1	.125	.143	.166	.194
2	.308	.354	.396	.452
3	.476	.534	.593	.665
4	.470	.539	.620	.721
5	.542	.602	.664	.744
6	.499	.573	.661	.769
7	.239	.263	.282	.306
8	.090	.109	.128	.153
9	.605	.680	.753	.843
10	.142	.157	.179	.205
TOTAL	3.500	3.955	4.443	5.051

Source: Commercial energy use model

Table C-25
WATER HEATING ENERGY USE FOR THE HIGH PRICE SCENARIO

Region	Annual Energy Use (Quads) 1985	1990	1995	2000
1	.060	.062	.063	.065
2	.061	.060	.059	.057
3	.025	.025	.025	.025
4	.030	.028	.030	.032
5	.030	.030	.029	.029
6	.008	.008	.008	.008
7	.005	.005	.005	.005
8	.003	.003	.003	.003
9	.011	.011	.011	.011
10	.011	.011	.012	.013
TOTAL	.245	.2455	.245	.247

Source: Commercial energy use model

Table C-26
LIGHTING ENERGY USE FOR THE HIGH PRICE SCENARIO

Region	Annual Energy Use (Quads) 1985	1990	1995	2000
1	.127	.137	.147	.160
2	.313	.333	.340	.350
3	.243	.262	.276	.294
4	.426	.478	.529	.593
5	.555	.586	.608	.636
6	.227	.251	.277	.309
7	.120	.128	.131	.136
8	.066	.075	.082	.091
9	.269	.298	.321	.350
10	.077	.081	.087	.095
TOTAL	2.424	2.630	2.799	3.014

Source: Commercial energy use model

Table C-27
OTHER ENERGY USE FOR THE HIGH PRICE SCENARIO

Region	Annual Energy Use (Quads) 1985	1990	1995	2000
1	.567	.596	.065	.732
2	.138	.146	.150	.158
3	.109	.117	.124	.135
4	.196	.225	.250	.285
5	.257	.273	.286	.305
6	.099	.107	.116	.131
7	.055	.058	.060	.063
8	.030	.033	.037	.433
9	.172	.123	.134	.150
10	.037	.040	.043	.049
TOTAL	1.092	1.181	1.264	1.393

Source: Commercial energy use model

Table C-28
ELECTRICITY ENERGY USE FOR THE LOW CONSUMPTION SCENARIO

Region	Annual Energy Use (Quads) 1985	1990	1995	2000
1	.323	.346	.374	.417
2	.717	.757	.780	.806
3	.810	.863	.918	.988
4	1.087	1.192	1.308	1.465
5	1.255	1.316	1.373	1.446
6	.763	.827	.914	1.021
7	.385	.405	.420	.438
8	.169	.189	.211	.237
9	.950	1.014	1.086	1.178
10	.311	.326	.355	.396
TOTAL	6.771	7.235	7.739	8.392

Source: Commercial energy use model

Table C-29
GAS ENERGY USE FOR THE LOW CONSUMPTION SCENARIO

Region	Annual Energy Use (Quads) 1985	1990	1995	2000
1	.044	.045	.043	.040
2	.142	.138	.126	.113
3	.191	.187	.172	.154
4	.208	.197	.182	.168
5	.666	.629	.568	.505
6	.203	.182	.164	.149
7	.159	.146	.132	.118
8	.090	.083	.075	.070
9	.220	.197	.177	.163
10	.095	.089	.079	.067
TOTAL	2.021	1.896	1.718	1.548

Source: Commercial energy use model

Table C-30
OIL ENERGY USE FOR THE LOW CONSUMPTION SCENARIO

Region	Annual Energy Use (Quads) 1985	1990	1995	2000
1	.212	.197	.183	.163
2	.472	.429	.389	.346
3	.147	.144	.132	.118
4	.173	.151	.135	.121
5	.385	.358	.331	.305
6	.137	.133	.124	.118
7	.063	.059	.056	.055
8	.071	.073	.074	.075
9	.099	.088	.079	.068
10	.030	.025	.023	.021
TOTAL	1.797	1.658	1.527	1.389

Source: Commercial energy use model

Table C-31
SOLAR USE FOR THE LOW CONSUMPTION SCENARIO

Region	Annual Energy Use (Quads) 1985	1990	1995	2000
1	.001	.006	.017	.048
2	.002	.014	.037	.097
3	.001	.012	.030	.075
4	.003	.042	.085	.159
5	.002	.018	.052	.138
6	.002	.024	.051	.098
7	.0	.003	.007	.019
8	.0	.003	.010	.023
9	.003	.024	.047	.081
10	.0	.003	.009	.020
TOTAL	.014	.150	.343	.758

Source: Commercial energy use model

Table C-32
SPACE HEATING USE FOR THE LOW CONSUMPTION SCENARIO

Region	Annual Energy Use (Quads) 1985	1990	1995	2000
1	.225	.218	.212	.222
2	.540	.498	.456	.424
3	.344	.334	.320	.327
4	.395	.403	.412	.455
5	.932	.913	.846	.816
6	.312	.303	.296	.305
7	.200	.185	.170	.162
8	.148	.144	.140	.141
9	.303	.290	.277	.277
10	.179	.177	.172	.179
TOTAL	3.613	3.465	3.299	3.308

Source: Commercial energy use model

Table C-33
COOLING USE FOR THE LOW CONSUMPTION SCENARIO

Region	Annual Energy Use (Quads) 1985	1990	1995	2000
1	.119	.132	.152	.179
2	.294	.327	.365	.421
3	.453	.490	.539	.599
4	.446	.492	.560	.648
5	.520	.560	.615	.692
6	.472	.520	.592	.682
7	.230	.245	.261	.281
8	.086	.100	.117	.140
9	.580	.627	.685	.757
10	.135	.144	.162	.184
TOTAL	3.335	3.638	4.047	4.584

Source: Commercial energy use model

Table C-34
WATER HEATING ENERGY USE FOR THE LOW CONSUMPTION SCENARIO

Region	Annual Energy Use (Quads) 1985	1990	1995	2000
1	.058	.058	.057	.056
2	.059	.057	.054	.051
3	.024	.023	.022	.022
4	.028	.027	.027	.027
5	.029	.028	.027	.025
6	.008	.007	.007	.006
7	.005	.005	.005	.005
8	.003	.003	.003	.003
9	.011	.010	.010	.009
10	.011	.010	.011	.011
TOTAL	.235	.228	.222	.216

Source: Commercial energy use model

Table C-35
LIGHTING USE FOR THE LOW CONSUMPTION SCENARIO

Region	Annual Energy Use (Quads) 1985	1990	1995	2000
1	.122	.127	.132	.138
2	.302	.310	.308	.307
3	.233	.242	.246	.253
4	.405	.435	.462	.498
5	.534	.547	.549	.556
6	.216	.229	.243	.260
7	.116	.120	.119	.120
8	.064	.069	.073	.078
9	.258	.273	.284	.297
10				
TOTAL	2.479	2.428	2.495	2.588

Source: Commercial energy use model

Table C-36
OTHER ENERGY USE FOR THE LOW CONSUMPTION SCENARIO

Region	Annual Energy Use (Quads) 1985	1990	1995	2000
1	.057	.060	.065	.073
2	.138	.146	.150	.158
3	.109	.117	.124	.135
4	.196	.225	.250	.285
5	.257	.273	.286	.305
6	.099	.107	.116	.131
7	.055	.058	.060	.063
8	.030	.033	.037	.043
9	.114	.123	.134	.150
10	.037	.040	.043	.049
TOTAL	1.092	1.181	1.264	1.393

Source: Commercial energy use model