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ABSTRACT

The stated purpose of this publication is to present a large amount of relevant data on energy use in an easily retrievable and usable format. The following topics are covered in eight chapters: (1) sector definitions; (2) buildings inventory; (3) appliance inventory; (4) heating and cooling units inventory; (5) appliance efficiencies; (6) structural characteristics; (7) climatological data and appliance fuel use; (8) national economic and demographic determinants; (9) fuel consumption and prices; and (10) a survey of selected energy studies. A list of data sources is provided at the end of each chapter, and a more general bibliography is included at the end of the book. This publication endeavors to fill a need for a definitive compilation of residential/commercial energy use data. The data presented are considered to be the most reliable data available and for the most part estimates are excluded. Tables compiled through diverse sources present the data and when necessary explanatory text or graphs accompany the tables. A user's guide and a glossary are included. (Author/MR)

ORNL-5363

BUILDINGS ENERGY USE DATA BOOK EDITION ONE

G. E. LIEPINS, ET AL

OAK RIDGE NATIONAL LABORATORY
OAK RIDGE, TENNESSEE

APRIL 1978

C.

ORNL-5363

Buildings Energy Use Data Book
Edition
1

G. E. Liepins
M. A. Smith
A. B. Rose
K. Haygood

OAK RIDGE NATIONAL LABORATORY
OPERATED BY UNION CARBIDE CORPORATION · FOR THE DEPARTMENT OF ENERGY

Volume Conversions

From \ To	in.^{3}	ft^3	U.S. gal	liter	bbl
in.^{3}	1	5.787×10^{-4}	4.329×10^{-3}	0.01639	1.031×10^{-4}
ft^3	1728	1	7.481	28.32	0.1781
U.S. gal	231	0.1337	1	3.785	2.381×10^{-2}
liter	61.02	3.531×10^{-2}	0.2642	1	6.29×10^{-3}
bbl	9702	5.615	42	158.97	1

Mass Conversions

From \ To	lb (avoirdupois)	kg	Short ton	Long ton	Metric ton
lb (avoirdupois)	1	0.4536	5.0×10^{-4}	4.4643×10^{-4}	4.5362×10^{-4}
kg	2.205	1	1.1023×10^{-3}	9.8425×10^{-4}	1.0×10^{-3}
Short ton	2000	907.2	1	0.8929	0.9072
Long ton	2240	1016	1.12	1	1.016
Metric ton	2205	1000	1.102	0.9842	1

Length Conversions

From \ To	cm	in.	ft	yd	m	mile	km
cm	1	0.3937	3.281×10^{-2}	1.0936×10^{-2}	1.0×10^{-2}	6.214×10^{-6}	1.0×10^{-5}
in.	2.54	1	8.333×10^{-2}	2.778×10^{-2}	2.54×10^{-2}	1.578×10^{-5}	2.54×10^{-5}
ft	30.48	12	1	0.333	0.3048	1.894×10^{-4}	3.048×10^{-4}
yd	91.44	36	3	1	0.9144	5.682×10^{-4}	9.144×10^{-4}
m	100	39.37	3.281	1.0936	1	$6.214 \times 10^{-}$[illegible]	1.0×10^{-3}
mile	160,934	63,630	5280	1760	1609	1	1.609
km	100,000	39,370	3281	1093.6	1000	0.6214	

Energy Conversions

From \ To	ft-lb	kg-m	hp-hr	Metric hp-hr	Btu	kWhr	Joule
Ft-lb	1	0.1383	5.0505×10^{-7}	5.12×10^{-7}	1.285×10^{-3}	3.766×10^{-7}	1.355
kg-m	7.233	1	3.653×10^{-6}	3.704×10^{-6}	9.295×10^{-3}	2.724×10^{-6}	9.808
hp-hr	1.98×10^{6}	2.7375×10^{5}	1	1.0139	2544	0.7457	2.683×10^{6}
Metric hp-hr	1.953×10^{6}	270,000	0.9863	1	2510	0.7355	2.646×10^{6}
Btu	778.2	107.6	3.93×10^{-4}	3.985×10^{-4}	1	2.931×10^{-4}	1055
kWhr	2.655×10^{6}	3.671×10^{5}	1.341	1.3596	3412	1	3.6×10^{6}
Joule	0.738	0.102	3.727×10^{-7}	3.779×10^{-7}	9.479×10^{-4}	2.778×10^{-7}	1

Heat Content for Various Fuels

Fuel oils		
Crude	138,100	Btu/gal
Residual	149,700	Btu/gal
Distillate	138,700	Btu/gal
Automotive gasoline	125,000	Btu/gal
AVGAS	124,000	Btu/gal
Jet fuel (kerosine)	135,000	Btu/gal
Jet fuel (naphta)	127,500	Btu/gal
Diesel oil (#2)	138,700	Btu/gal
Coal products		
Crude light oil	130,000	Btu/gal
Crude coal tar	150,000	Btu/gal
Crude petroleum	138,100	Btu/gal
Ethane	73,390	Btu/gal
Still gas	142,286	Btu/gal

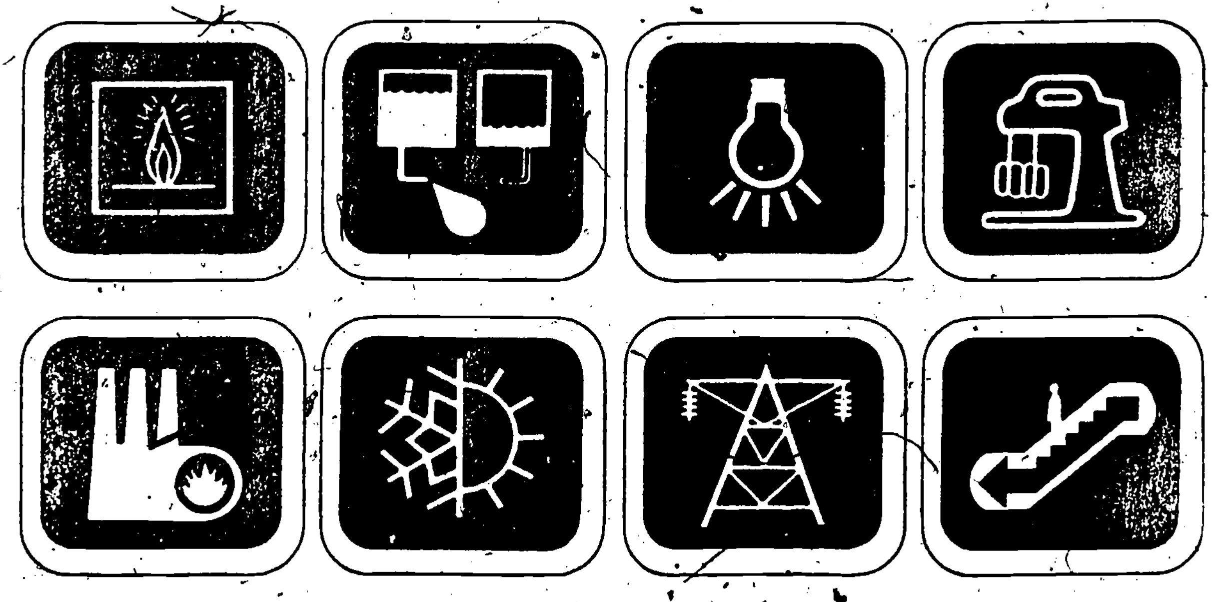
Natural gas		
Liquid	95,800	Btu/gal
Wet	1,095	Btu/ft^3
Dry	1,021	Btu/ft^3
Coal		
Anthracite	25.4×10^{6}	Btu/short ton
Bituminous	26.2×10^{6}	Btu/short ton
Lignite	13.4×10^{6}	Btu/short ton
(Electrical generation and distribution efficiency)		≈30%
Lubricants	144,405	Btu/gal
Waxes	155,643	Btu/gal
Petroleum coke	143,423	Btu/gal
Asphalt and road oil	158,000	Btu/gal
Natural gasoline and cycle products	110,000	Btu/gal

1 Btu/gal = 278.7 joule/liter = 2.787×10^{5} joule/m^3

1 Btu/short ton = 942.0 joule/metric ton

DATA MANAGEMENT
AND ANALYSIS

Buildings Energy Use Data Book



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BUILDINGS ENERGY USE DATA BOOK
EDITION 1

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Energy Division

Prepared for the Office of the Assistant Secretary for
Conservation and Solar Applications
Conservation Planning and Policy
Department of Energy

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BUILDINGS ENERGY USE DATA BOOK

Contents

Abstract

This document represents the initial effort of Oak Ridge National Laboratory to develop the document Buildings Energy Use Data Book for use as a desk-top reference by the Office of the Assistant Secretary for Conservation and Solar Applications, Conservation Planning and Policy. It represents an assembly and display of statistics which characterize current and past energy end use activities in the residential/commercial sector and presents data on other factors which influence the residential/commercial sector in the nation.

Statistical data on energy use in the residential/commercial sector in the form of tables, graphs, and charts are presented. The purpose of this publication is to present a large amount of relevant data in an easily retrievable and usable format. The following topics are covered in eight chapters: sector definitions, buildings inventory, appliance inventory, heating and cooling units inventory, appliance efficiencies, structural characteristics, climatological data and appliance fuel use, national economic and demographic determinants, fuel consumption and prices, and a survey of selected energy studies. A list of data sources is provided at the end of each chapter, and a more general Bibliography is included at the end of the book.

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Acknowledgments

The authors of the Buildings Energy Use Data Book have benefited from the expertise of many individuals who contributed significantly to the publication of this document. We would like to express our appreciation to the following Oak Ridge National Laboratory staff members: Judith Arehart for her fine editorial assistance; Mary Ogle for technical support; Stephanie Davison and Pat Boggess who rapidly and efficiently transformed our rough drafts into final form; Mary Johnson and David Needham for their programming assistance which provided us with the indexes as well as the graphics; the staff of the Energy Information Center, Beverly Barber, Ann Ehrenshaft, Elizabeth Howard, Ann Jordan, and Carolyn Seaborn for their thorough bibliographic preparation; Dr. Eric Hirst, Dr. Jerry Jackson, Dr. William Fulkerson, and Dr. Richard Davis for their thoughtful review and suggestions. Special thanks goes to James Eberhart of the Office of Conservation Planning and Policy for his continuous support and guiding influence in the preparation of the Buildings Energy Use Data Book.

Support for this project was provided by the Office of Conservation Planning and Policy for the Office of the Assistant Secretary for Conservation and Solar Applications, the Department of Energy.

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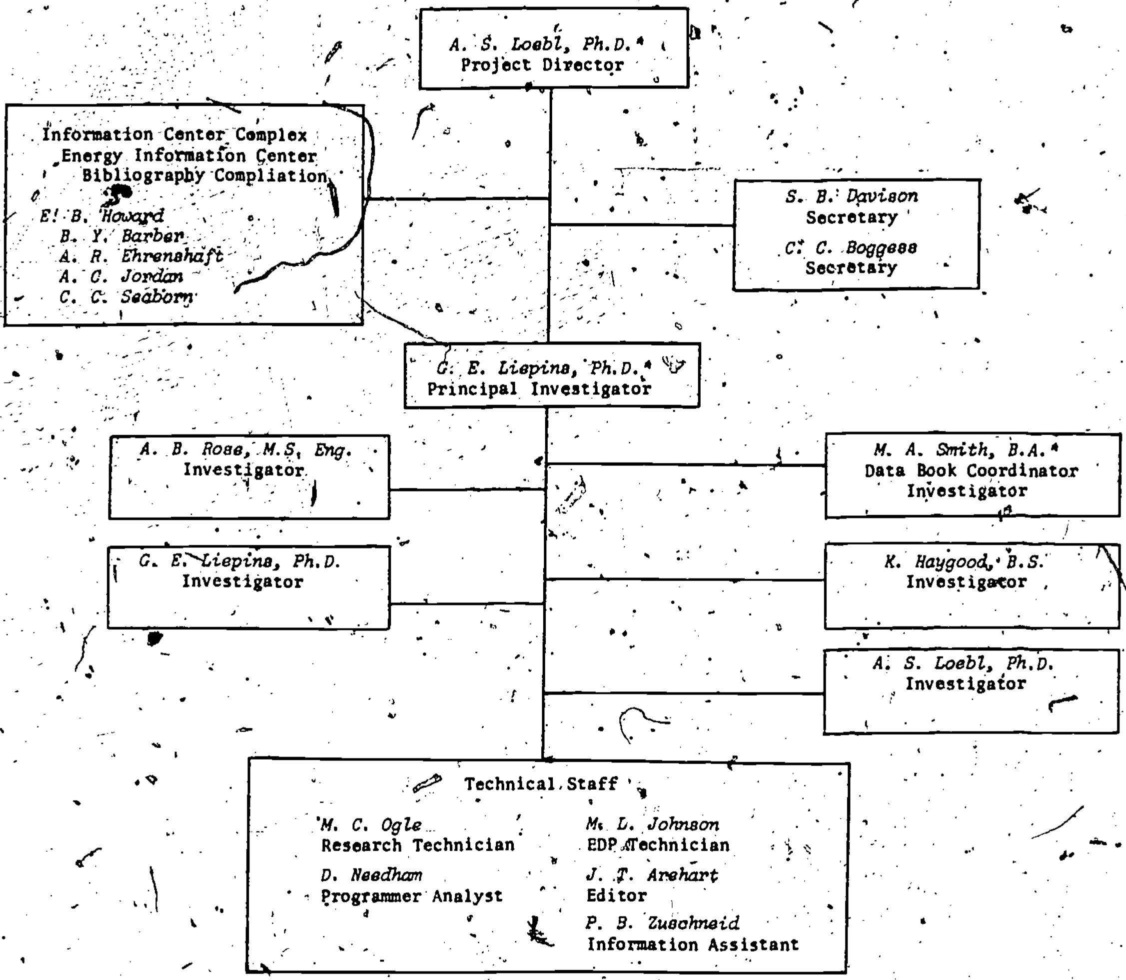
BUILDINGS ENERGY END USE DATA ANALYSIS PROGRAM FY 78[a]

OAK RIDGE NATIONAL LABORATORY



*Dual Capacity

[a] This organizational chart reflects recent staff additions and is applicable to the fiscal year program beginning October 1, 1977.

Introduction

The Buildings Energy Use Data Book endeavors to fill a long-felt need for a definitive compilation of residential/commercial energy use data. The book has four purposes: (1) to make available selected existing data, (2) to identify those areas where data are lacking, (3) to identify data inconsistencies, and (4) whenever possible, to resolve data inconsistencies. The data presented are considered to be the most reliable available data. With the exception of Chapter 8, which contains a survey of some of the existing energy studies, outright estimates have been excluded.

The means to achieve the Data Book objectives are numerous. Tables compiled through diverse sources present the data. Whenever it is necessary, explanatory text or graphs accompany the tables. These explanatory remarks serve to explain established relationships or to suggest possible dependencies.

Explanatory remarks of a more technical nature appear in the User's Guide. Also included in the User's Guide are remarks and supportive data that help reconcile discrepancies between various data sources.

To adequately understand any material, it is imperative that definitions be clear and precise. Unfortunately, energy studies have not yet developed to the point where this is always the case. As a result, one finds that different reporting organizations often use definitions not totally compatible with one another. In some cases the Glossary addresses these definitional discrepancies by indicating reporting organizations. Standard Industrial Classification (SIC) definitions are more fully discussed in Appendix A.

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The Data Book is organized by chapters. Each chapter discusses a variable important to the determination of energy use. The first chapter presents some historical and definitional data. Inventories of municipal, commercial, and residential buildings are provided, and historical consumption trends for various fuels are included.

Chapter 2 discusses appliances by energy source. Energy use is partially determined by the stock of existing appliances, and this chapter provides a comprehensive inventory of household appliances, heating equipment, and cooling equipment. A similar inventory for the commercial sector is not included because such data do not appear to be available.

For several of the major appliances, Chapter 3 presents a detailed analysis of the efficiency ratings and attempts, where possible, to give a sales-weighted efficiency rating for the population of such appliances.

The number and frequency of usage of energy-using appliances is dependent on the number and type of housing units, and, ultimately, on the number of households as well as on the total population. Thus, comprehensive data on demographic trends and indicators are presented in Chapter 4.

It is not sufficient just to know the number and types of buildings and residences; it is also important to know their "energy efficiencies." Chapter 5 investigates factors which contribute to the determination of a building's energy use such as floor area and number of stories. Data about structural characteristics are particularly scarce (e.g., it would be worthwhile to have aggregate data about window area, but apparently such information is not available).

Chapter 6 acknowledges that not only total population and number of households, but also economic determinants are important factors in energy use. It seems reasonable to hypothesize that there is a direct dependence between disposable income and type and number of housing units and appliances purchased. This chapter provides necessary data about economic indicators.

Chapter 7 presents the best-available aggregate data on energy use by sector and fuel type. It suffers from some data inavailability, as usage is not equally well documented for all fuels.

Chapter 8, the last chapter, is self-explanatory. It contains a review of various existing energy-related studies; those included were chosen on a basis of availability, current applicability, and comprehensiveness. Time limitations precluded the inclusion of all studies, and no lack of quality in the omitted studies is implied. It is especially important to emphasize that many of these previous studies were not solely data-gathering efforts, but involved considerable modeling of one form or another. Certain of these studies forecast energy use and some of the forecasts have been included. Again, it is important to note that Chapter 8 is a significant break with the rest of the book insofar as it contains the results of modeling efforts and various estimation procedures.

The Buildings Energy Use Data Book represents the staff's first edition of selected residential/commercial energy use statistics and the staff of the Data Book acknowledges that many important data have been omitted either consciously or unknowingly from this document.

Future editions are planned which will incorporate some of these missing data and will continue the attempt to present a consistent, clearly documented, compilation of energy use data.

None of the data included in the Data Book are the results of primary data-gathering efforts by ORNL, and though every effort has been made to present only the most reliable data, neither ORNL nor DOE can endorse the validity of the statistics presented.

Users of the Data Book are encouraged to comment on errors, omissions, emphases, and organization of this report to one of the authors.

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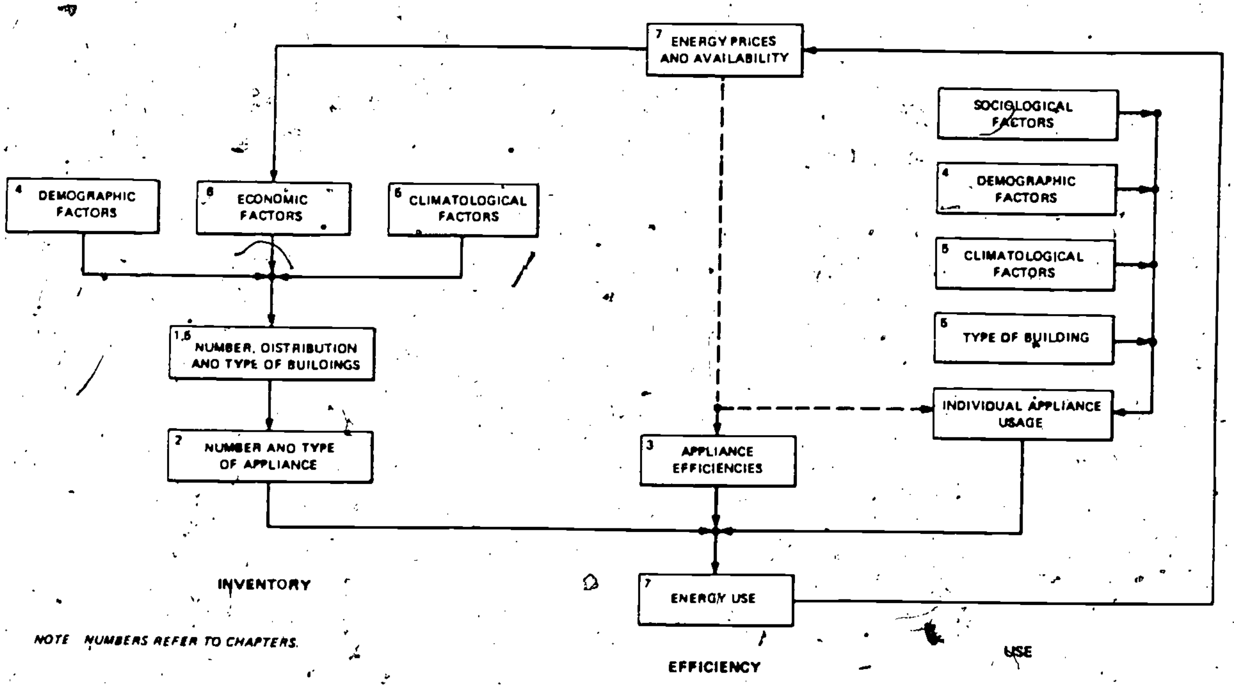
Selected Aspects of Residential/Commercial Energy Use

A document such as the Data Book is most difficult to summarize: the data are diverse and not always strictly comparable. The staff of the Data Book has selected material (predominantly from Chapters 2, 4, and 7) and consolidated it in the following five pages. Two caveats are in order. First, the items do not and cannot summarize all the data contained in this document. Of necessity, many results have been excluded. Second, since the data are not always strictly comparable, careful use of the footnotes is advised.

The Energy Use Determinant Flow Chart graphically displays the relationship between various factors which determine energy use. Specifically, knowledge of the stock of appliances and heating and cooling equipment, their efficiencies, and their levels of usage is sufficient to calculate energy use in buildings. Thus the chart is organized according to these categories.

ORNL-DWG 77-21377

ENERGY USE DETERMINANT FLOW CHART BY DETERMINANT AND CHAPTER



NOTE NUMBERS REFER TO CHAPTERS.

Energy Use by the Residential-Commercial Sector, 1975 by Energy Source[a]
(10¹² Btu and percent of total energy use)

Petroleum products and natural gas liquids				Total[b] petroleum products and natural gas liquids	Coal	Natural gas	Total fossil fuel	Electricity	Total energy use
Kerosine	Distillate fuel oil	Residual fuel oil	Liquefied gases						
				Delivered Energy					
244	2796	962	686	4688	282	7377	12343	3783[c]	16126
1.5%	[illegible]	6.0%	4.3%	29.1%	1.8%	48.0%	76.5%	23.5%[c]	100%
				Primary Energy[d]					
244	2796	962	686	4688	282	8504[e]	13474	12651[f]	26125
0.9%	10.7%	3.7%	2.6%	17.9%	1.1%	32.6%	51.6%	48.4%	100%

Additional data: p. 191.

[a] It is important to note the lack of comparable sector definitions across fuels. Specifically, this table has been calculated on the basis of data presented in Energy Perspectives. It is imperative that the reader understand that the sectoral definitions are not entirely consistent across fuels. Petroleum products consumption data presented in Energy Perspectives are derived from Bureau of Mines statistics, and that portion of these fuels consumed for heating purposes has been allocated to the residential-commercial sector. Residential-commercial consumption of coal has been defined by Energy Perspectives to be the amount of coal included under the Weekly Coal Report heading "retail deliveries." The Edison Electric Institute's categories "small light and power" and "other public authorities" have been summed and then equated with the commercial sector for purposes of reporting electric energy used (electric energy is given in term of point of use, that is, converted at 3412 Btu/kWhr). The American Gas Association's category "commercial customer" has been used to determine commercial gas sales.

[b] Asphalt has been deleted from the petroleum products totals compiled by Energy Perspectives. It is felt that asphalt is used at most marginally in buildings.

[c] Energy content calculated at point of use, i.e. 3412 Btu/kWhr.

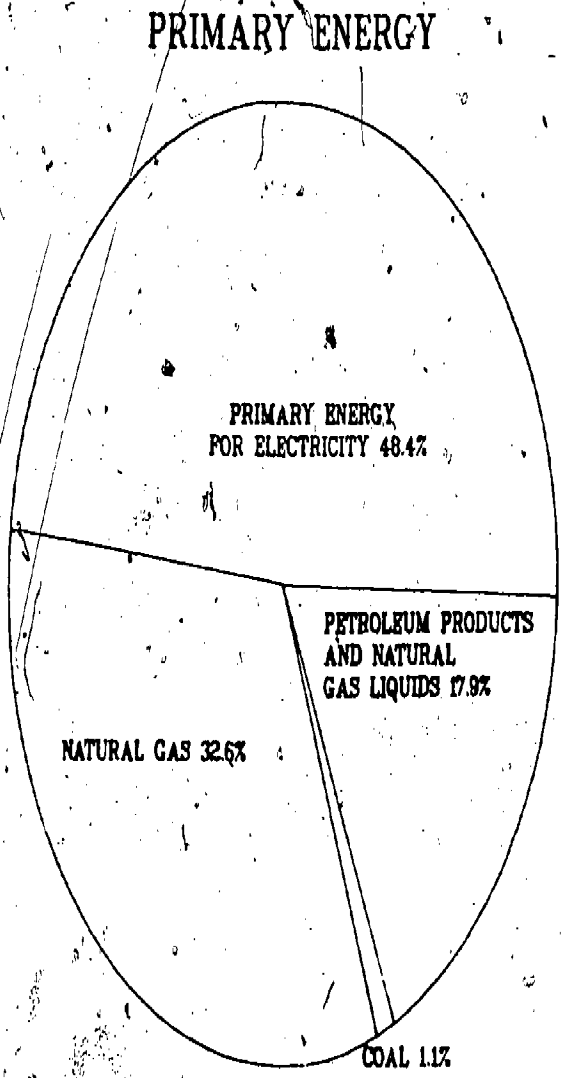
[d] Primary energy has been assumed to equal delivered energy for all energy sources other than electricity and natural gas. This assumption may not be valid, but it is necessitated since the transmission-distribution losses for other energy sources other than electricity and natural gas are unknown.

[e] The primary energy for natural gas has been calculated in terms of 15.3% extraction, transmission-distribution losses, which is the figure arrived at by considering the ratio of the sum of the categories "losses and waste," "field use," and "lost in transmission and unaccounted for" to the category "net marketed production," (p. 22, Gas Facts, 1975).

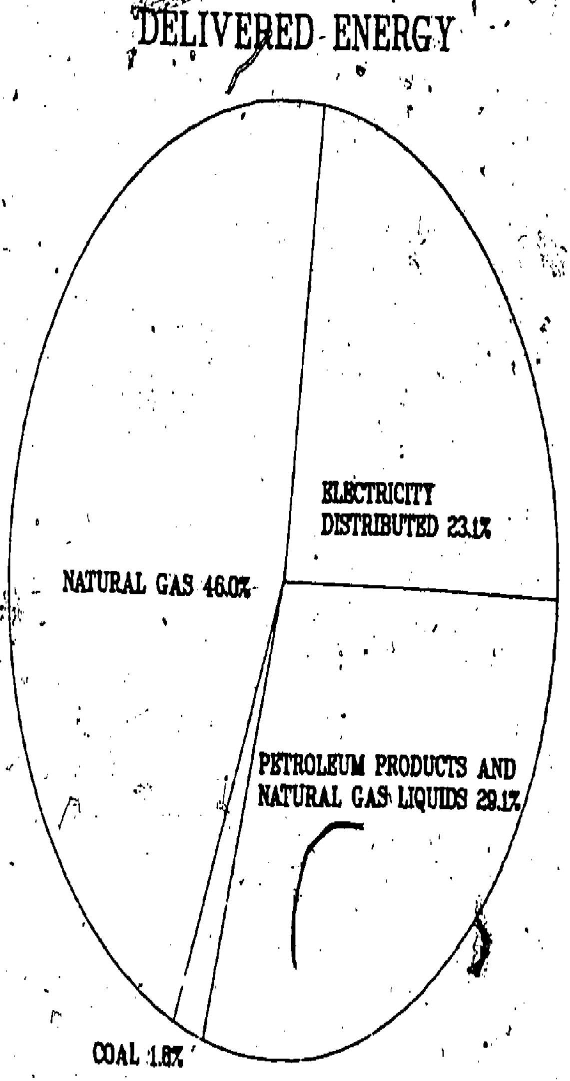
[f] The primary energy for electricity has been calculated in terms of 10,383 Btu/kWhr (the average heat rate estimated by the Edison Electric Institute for 1975) and 9% transmission-distribution losses.

Source: W. Dupree et al., U.S. Department of the Interior, Energy Perspectives 2, Washington, D.C., June 1976, p. 65.

ONE OF THE PRINCIPAL DIFFICULTIES ENCOUNTERED IN MONITORING ENERGY USE IS THE INADEQUATE DOCUMENTATION OF CONVERSION FACTORS AND WHETHER USE IS EXPRESSED IN TERMS OF PRIMARY ENERGY (WHICH INCLUDES GENERATION AND TRANSMISSION-DISTRIBUTION LOSSES) OR DELIVERED ENERGY.



Energy (Primary) Use by the Residential-Commercial Sector, 1975 by Energy Source

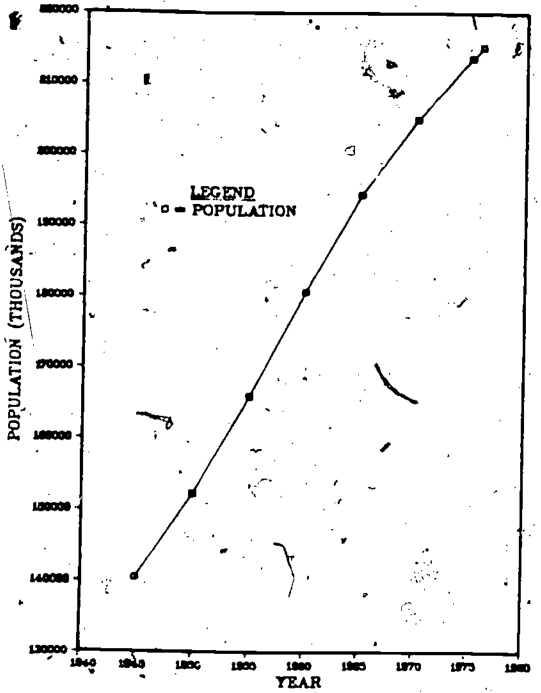


Energy (Delivered) Use by the Residential-Commercial Sector, 1975 by Energy Source

Source: W. G. Dupree et al., U.S. Department of the Interior, Energy Perspectives 2, Washington, D.C., June 1976, p. 65.

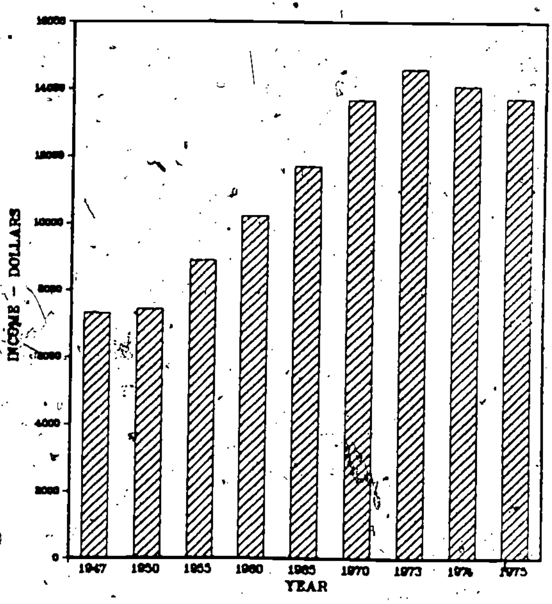
Demographic Trends

POPULATION OF THE UNITED STATES 1945 – 1976



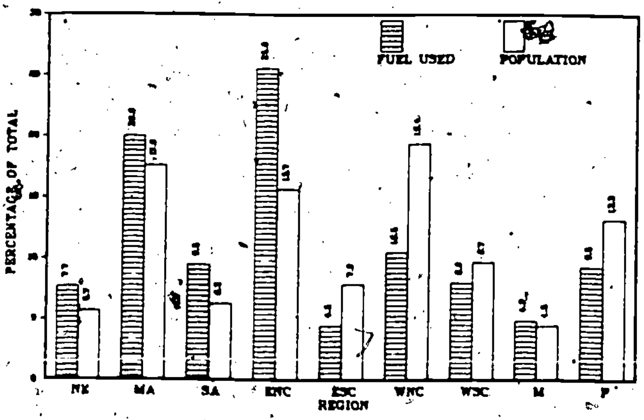
Source: U.S. Department of Commerce, Bureau of the Census, Current Population Reports: Population Estimates and Projections, Series P-25, No. 704, Washington, D.C., January 1977, Table D.

MEDIAN INCOME OF FAMILIES, 1975 (constant 1975 dollars)



Source: U.S. Department of Housing and Urban Development, Executive Office of the President, Committee on Community Development, 1976 Report on National Growth and Development, The Changing Issues for National Growth, the Domestic Council, Washington, D.C., February 1976, Figure II-1.

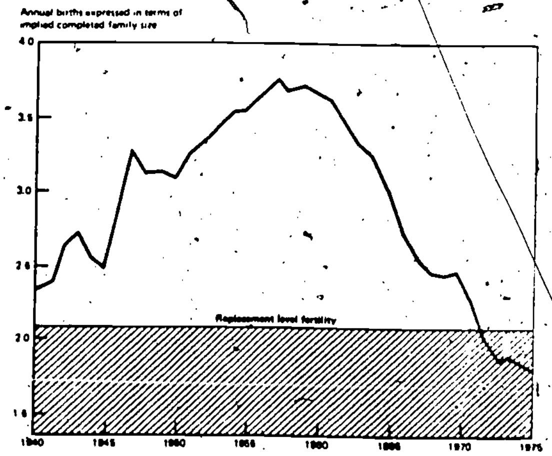
REGIONAL PERCENTAGE DISTRIBUTION OF FUEL USED IN THE HOUSEHOLD AND COMMERCIAL SECTORS AND POPULATION - 1974



See Appendix C for definition of Region.

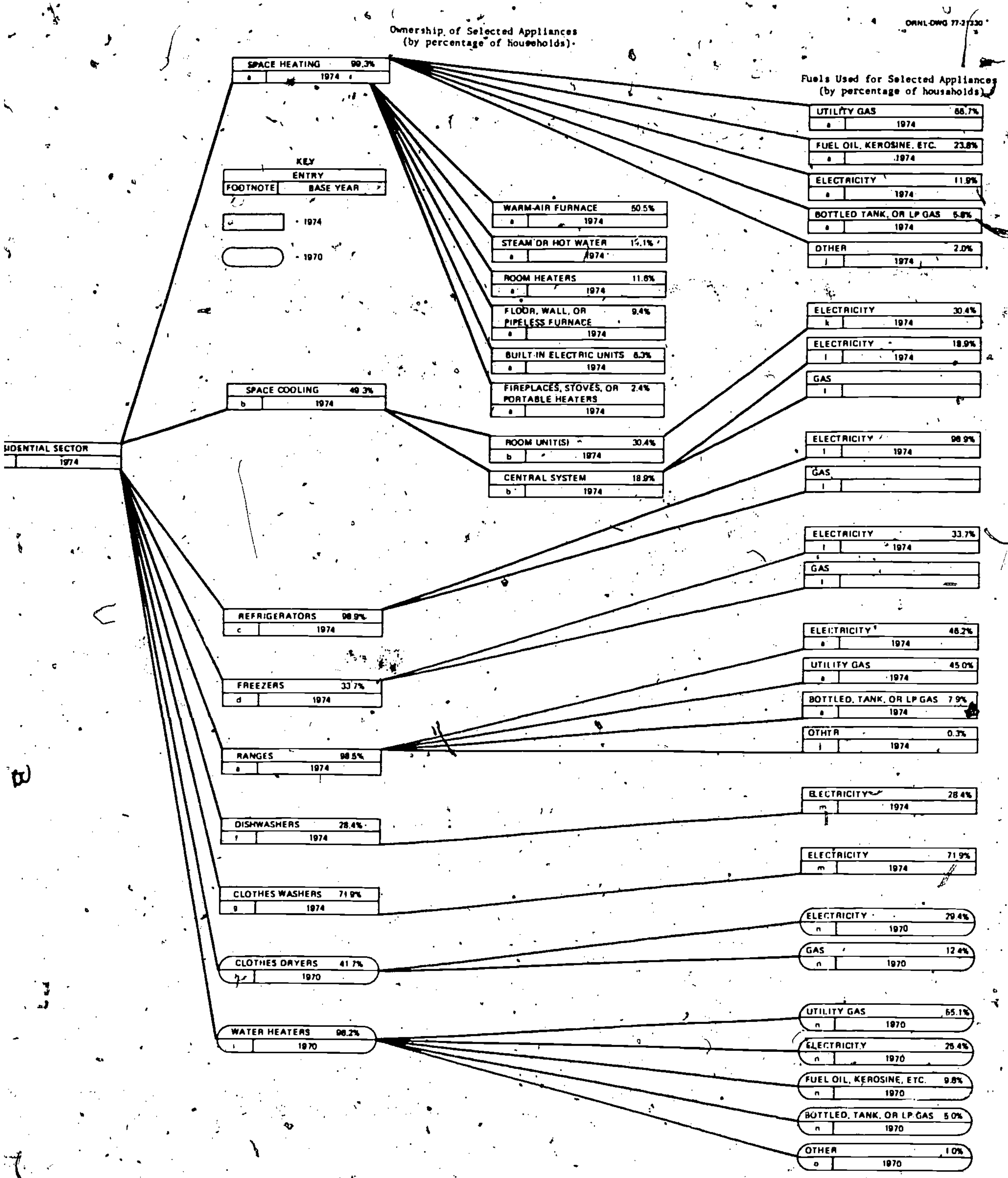
Source: U.S. Department of Commerce, Bureau of the Census, Statistical Abstract of the United States: 1976, 97th Annual Edition, Washington, D.C., July 1976, Table 10; L.H. Crump, U.S. Department of the Interior, Bureau of Mines, Fuels and Energy Data: United States by States and Census Divisions, 1974, Information Circular 8739, Washington, D.C., 1977, pp. 22-31.

TOTAL FERTILITY RATE: 1940 TO 1975



Source: U.S. Department of Commerce, Bureau of the Census, Statistical Abstract of the United States: 1976, 97th Annual Edition, Washington, D.C., July 1976, Table No. 650.

APPLIANCE OWNERSHIP AND ASSOCIATED FUEL SOURCES



[a] Source: Annual Housing Survey: 1974.

Note: Includes "all occupied housing units" as defined in the Annual Housing Survey: if a person or group of persons is living in it at the time of enumeration or if the occupants are only temporarily absent. In 1974, this was 70,830,000 units and 63,445,000 in 1970. These are recognized by the Bureau of Census as the number of households in the U.S. for the years given. Fuels may not add due to rounding.

[b] Source: Annual Housing Survey: 1974.

Note: Information is available only as "all year-round housing units," defined in the Annual Housing Survey as: all occupied units plus vacant units which are intended for year-round use. In 1974, this was 75,886,000 units.

[c] Source: The Survey of Purchases and Ownership.

Note: This category contains electric refrigerators and refrigerator-freezer combination units (no gas).

[d] Source: The Survey of Purchases and Ownership.

Note: a freezer is a separate appliance (not combined with a refrigerator) used to freeze and store food.

Note: This category contains electric refrigerators and refrigerator-freezer combination units (no gas).

[d]Source: The Survey of Purchases and Ownership.

Note: A freezer is a separate appliance (not combined with a refrigerator) used to freeze and store food.

[e]Source: The Survey of Purchases and Ownership.

Note: The kitchen range may be either electric or gas. Wood-burning stoves, hot plates, table stoves, or other portable heating equipment are not included.

[f]Source: The Survey of Purchases and Ownership.

Note: Includes built-in or large portable unit which washes dishes, utensils, and pans automatically. Portable dishwashers that sit on tables or counter tops are excluded.

[g]Source: The Survey of Purchases and Ownership.

Note: Washing machines operate on a regular house current and include wringer types, automatic, semiautomatic, and combination washer/dryer units.

[h]Source: The 1970 Census of Housing.

Note: This information is also available for 1974, but 1970 data is presented here for comparability of fuel used. (The Survey of Purchases and Ownership reports 52.6% of housing units have clothes dryers available in 1974.)

[i]Source: The 1970 Census of Housing.

Note: The assumption was made that units reporting no water heating fuels have no water heaters.

[j]Source: Annual Housing Survey: 1974.

Note: Includes coal or coke, wood, and other categories.

[k]It is assumed that all room units use electricity. It is important to note that a housing unit may own/use more than one room unit.

[l]A small portion of appliances/equipment use gas. The number, however, is assumed to be negligible, and the entire fuel use figure is allocated to electricity.

[m]Assumed 100% electricity.

[n]Source: The 1970 Census of Housing. Fuels may not add due to rounding.

[o]Source: The 1970 Census of Housing.

Note: Includes coal or coke, wood, and other categories.

Chapter 1

Introduction

M. A. Smith

Edition 1 of the Buildings Energy Use Data Book is a review of some basic data sources describing those components of energy use/conservation in the residential and commercial economic sectors. The Data Book is organized so that each chapter discusses a specific determinant of energy use: economic indicators, population determinants, fuel prices, appliance saturations and efficiencies, and buildings' structural characteristics. The User's Guide presents a detailed discussion of data sources and discrepancies. Also, the Bibliography lists a wide selection of documents related to residential and commercial energy.

A knowledge of basic data availability or unavailability is crucial to policy makers effecting conservation measures. For this reason, Edition 1 is directed toward reviewing available sources and discussing data gaps. (In some cases, data unavailability is suggested by a lack of presentation or discussion.) In those cases where two or more sources are available, an attempt is made to discuss any obvious numerical discrepancies. Some very basic analyses have been performed that usually involve computations for the purposes of graphical display (such as average annual growth rates or percentage totals).

Edition 1 of the Data Book is strictly a descriptive text. No attempt has been made to model or forecast energy use or to suggest policy for conservation measures.

Chapter 1 is intended to be a very general review of residential and commercial energy use. Two specific tasks have been outlined for this chapter: a discussion of 1) definitional problems through a buildings inventory and of 2) energy use by fuel in the residential/commercial sector.

The chapter begins with a discussion of commercial sector definitional discrepancies. More specifically, public and private agencies define "commercial" according to their own particular perspective. For example, gas is used extensively in the process of drying grain, and the American Gas Association defines agriculture as a commercial activity, as opposed to the majority of reporting agencies. This nonstandardization of a commercial definition reflects on other sectors as well. In some cases, large multifamily apartment complexes are defined as commercial rather than residential (Edison Electric Institute, American Gas Association), usually when those buildings are gang-metered.

A count of physical structures within the commercial sector is not available. The Bureau of the Census, County Business Patterns, (which concentrates on employment statistics) indicates "reporting units" by activity. This data undoubtedly understates a commercial buildings inventory, and Table 1.3 is an attempt to approximate the underestimation. The County Business Patterns excludes information on government employees and on self-employed individuals.

The basis for many of the commercial activity discussions is the Standard Industrial Classification Manual (SIC). Both Major Group and Group Number divisions are discussed throughout Chapter 1. (The SIC definitions are presented in Appendix A.)

Information on residential housing is kept regularly by several public agencies such as HUD and the Bureau of the Census. Three basic kinds of housing are identified: single-family homes, multifamily dwellings, and mobile homes and trailers. Pertinent information is available concerning vacancy rates, new construction, alterations, and repairs.

Table 1.10 gives a detailed discussion of the change in the housing inventory from 1970 to 1973, as computed by the Bureau of Census.

A brief discussion of fuel use in a combined residential/commercial sector is presented in Table 1.12. A 1960—1976 annual series is presented to indicate historical trends, as well as a monthly breakdown of several of the more recent years.

An important determinant of energy use is "public consciousness." That is, public opinions or attitudes toward energy problems undoubtedly influence aggregate consumption patterns. For example, it is essential to recognize the existence of an energy crisis before the general public initiates conservation practices. Public attitudes can be influenced by education and adverstisement of the national situation. Education should also include the practicality of energy-consuming measures in the individual household.

The Opinion Research Corporation has conducted a series of surveys for the Federal Energy Administration concerning public attitudes toward energy-related issues. The surveys were conducted by telephone from 1974 through 1976. Each survey encompasses either approximately 500 or 600 responses, and demographic characteristics of the respondents are collected. Each survey (or set of surveys) asks different energy-related questions ranging from the national situation to appliance purchases to home insulation potentials. Examples of the surveys have not been presented here for proprietary reasons. However, more information can be obtained by contacting the author or the Opinion Research Corporation (Princeton, New Jersey).

Table 1.1. Definitions of the Commercial Sector by Public and Private Agencies

	Agriculture, forestry, fishing (SIC 7–9)[a]	Contract construction (SIC 15–17)	Transportation (SIC 41–47)	Communications (SIC 48)	Public utilities (SIC 49)	Wholesale trade (SIC 50)	Retail trade (SIC 52–59)	Finance, insurance real estate (SIC 60–67)	Services (SIC 70–89)	Public administration (SIC 91–97)	Multiple-family rental housing
National Research Council			x	x		x	x	x	x	x	
Stanford Research Institute[b]	x	x				x	x	x	x	x	
Federal Energy Administration				x	x	x	x	x	x	x	
American Gas Association	x		x	x	x	x	x	x	x	x	x
Edison Electric Institute[c]						x	x	x	x	x	x
Oak Ridge National Laboratory Energy Conservation Section			x	x	x	x	x	x	x	x	

[a] SIC definitions are given in Appendix A.

[b] The Stanford Research Institute report avoids a specific definition of the commercial sector, looking at fuel use and end use to explain aggregate consumption.

[c] The Edison Electric Institute's definition of the commercial sector depends on the definition of the individual utilities. Some utilities use the SIC codes described in Appendix A. Others include multiple-family rental housing units which are gang-metered. Utilities may also define the sector according to kilowatt hours consumed, rather than actual activity of the industry.

Sources: S.H. Clark, Stanford Research Institute, Patterns of Energy Consumption in the United States, Office of Science and Technology, Executive Office of the President, Washington, D.C., January 1972, p. 63; J.R. Jackson and W.S. Johnson, Commercial Energy Use: A Disaggregation by Fuel, Building Type, and End Use, ORNL/CON-14 to be published by Oak Ridge National Laboratory, Oak Ridge, Tenn.; National Academy of Sciencies, National Research Council, Committee on Measurement of Energy Consumption, Energy Consumption Measurement: Data Needs for Public Policy, Washington, D.C., 1977, pp. 56-58; Edison Electric Institute, Statistical Committee, Glossary of Electric Utility Terms, Publication No. 70-40, New York, 1970, pp. 16-17; American Gas Association, Department of Statistics, Gas Facts, Arlington, Va., 1976, p. 194.

DATA ON THE NUMBER OF COMMERCIAL BUILDINGS ARE NOT GENERALLY AVAILABLE. A CLOSE APPROXIMATION MAY BE FOUND IN THE COUNTY BUSINESS PATTERNS (CBP). HOWEVER, 1974 CBP DATA ARE NOT CONSISTENT WITH PREVIOUS YEARS. IN PRE-1974 DATA FOR NONMANUFACTURING ESTABLISHMENTS, EMPLOYERS ARE COUNTED ONCE IN EACH COUNTY FOR EACH INDUSTRY IN WHICH THEY OPERATE, REGARDLESS OF THE NUMBER OF ESTABLISHMENTS OPERATED. THIS SUGGESTS THAT THE CBP STATISTICS UNDERSTATE ACTUAL ESTABLISHMENTS (AND, THEREFORE, NUMBER OF BUILDINGS). IN 1974, THE REPORTING UNITS ARE ACTUAL ESTABLISHMENTS DEFINED AS "A SINGLE PHYSICAL LOCATION WHERE BUSINESS IS CONDUCTED OR WHERE SERVICES OR INDUSTRIAL OPERATIONS ARE PERFORMED." THE DISCREPANCY BETWEEN CBP AND ACTUAL COMMERCIAL BUILDINGS INVENTORY IS NOT KNOWN (SEE TABLE 1.3).

Table 1.2. *County Business Patterns* Commercial Inventory by SIC
(total reporting units)

SIC	Description	1970	1971	1972	1973	1974
52–59	Retail trade	1,034,857	1,026,416	1,031,013	1,056,311	1,195,852
50	Wholesale trade	297,211	293,568	291,569	291,837	355,774
60–67	Finance, insurance, real estate	326,779	320,856	329,731	341,043	369,904
70	Hotels and other lodging	51,403	51,444	51,302	52,327	46,005
75	Auto repair, services, and garages	70,336	71,582	73,275	76,841	83,005
80	Medical and other health	214,767	218,900	223,732	231,495	246,611
81	Legal services	68,500	69,360	70,456	73,885	79,139
82	Education	32,951	34,670	37,074	39,577	25,393
41–47	Transportation	104,150	104,328	105,538	110,093	111,136
48	Communication	12,599	12,601	12,639	12,760	22,036
49	Electric, gas, sanitary services	10,614	10,822	11,254	11,716	12,261
78, 79, 84	Amusement and recreation	49,870	49,109	49,088	50,910	58,451
86	Non-profit membership	124,246	125,141	128,515	132,719	129,665
72	Personal services	178,537	172,894	166,095	163,479	166,200
	Public administration	NA	NA	NA	NA	NA
73, 76, 89	Miscellaneous[a]	193,969	196,423	201,192	217,272	268,472[b]
	Total	2,770,789	2,758,114	2,782,473	2,862,265	3,169,904

NA – Not available – see Tables 1.5 and 1.6.

[a] Includes administrative and auxiliary category.

[b] Includes social services (SIC 83) in 1974 series.

Source: U.S. Department of Commerce, Bureau of the Census, *County Business Patterns*, 1974, United States Summary, CPB-74-1, Washington, D.C., 1975, Table 1A (also previous years).

THE TEXT WITH TABLE 1.2 INDICATES THAT THE COUNTY BUSINESS PATTERNS STATISTICS UNDERSTATE THE ACTUAL NUMBER OF COMMERCIAL BUILDINGS. A COMPARISON OF CBP DATA WITH OTHER GOVERNMENTAL AND PRIVATE AGENCIES WILL REVEAL THIS UNDERESTIMATION. COUNTY BUSINESS PATTERNS DOES NOT INCLUDE SELF-EMPLOYED BUSINESSES. THEREFORE, OTHER REPORTS "WITH PAYROLL" WILL BE CLOSER TO THE CBP REPORT THAN "ALL ESTABLISHMENTS." FOR EXAMPLE, CBP PROVIDES APPROXIMATELY 1.0 MILLION "REPORTING UNITS" OF RETAIL TRADE IN 1972. THE CENSUS APPROXIMATES 1.3 MILLION RETAIL TRADE ESTABLISHMENTS WITH PAYROLL, WHILE THERE WERE ABOUT 1.9 MILLION TOTAL ESTABLISHMENTS INCLUDING SELF-EMPLOYED.

Table 1.3. Comparison of Commercial Buildings Inventory Sources

SIC No.	Description	County Business Patterns (reporting units)	Other, with payroll (number)	Other, all establishments (number)	Year
52–59	Retail trade	1,031,013	1,264,922[a]	1,912,871[a]	1972
554	Gasoline service stations	147,164	183,385[a]	226,459[a]	1972
51	Wholesale trade	291,569	369,791[b]		1972
701	Hotels, motels, tourist courts	34,156	40,837[c]	58,688[c]	1972
701	Hotels, motels, tourist courts	34,638	45,150[d]		1974
722–6, 729	Personal services	116,654	135,569[c]	406,038[c]	1972
75	Auto repair, services, garages	73,275	90,536[c]	168,959[c]	1972
76	Miscellaneous repair services	38,586	46,677[c]	148,925[c]	1972
81	Legal services	70,456	77,282[c]	144,452[c]	1972
866	Religious organizations	46,096	83,548[e]		1972

Sources: [a] U.S. Department of Commerce, Bureau of the Census, 1972 Census of Retail Trade – Summary and Subject Statistics, Vol. 1, Washington, D.C., July 1976, Table 1.

[b] U.S. Department of Commerce, Bureau of the Census, 1972 Census of Wholesale Trade – Summary and Subject Statistics, Vol. 1, Washington, D.C., August 1976, Table 1.

[c] U.S. Department of Commerce, Bureau of the Census, 1972 Census of Selected Service Industries – Summary and Subject Statistics, Washington, D.C., Dec. 1975, Table 1.

[d] Harris, Kerr, Foster and Company, Trends in the Hotel/Motel Business, 1975 Edition, New York, 1975, p. 3.

[e] C. H. Jacquet, Jr. (ed.), Yearbook of American Churches, 1972 Edition, Council Press, New York, 1972, Table 1-B.

Table 1.4. County Business Patterns Commercial Inventory by Activity, 1974

SIC No.	Activity	Total reporting units
	Transportation	
41	Local and interurban passenger transit	13,163
421	Trucking, local and long distance	65,657
422	Public warehousing	5,230
423	Trucking terminal facilities	989
44	Water transportation	5,810
45	Transportation by air	4,582
46	Pipeline transportation	395
47	Transportation services	13,713
	Communication	
481	Telephone communication	12,585
482	Telegraph communication	1,512
483	Radio and television broadcasting	5,614
489	Other communication services	2,226
	Electric, gas, and sanitary services	
491	Electric companies and systems	3,570
492	Gas companies and systems	1,754
493	Combination companies and systems	772
494	Water supply	2,813
495	Sanitary services	57
497	Irrigation systems	347
	Wholesale trade	
501	Motor vehicles and automotive equipment	35,000
502	Furniture and home furnishings	8,987
503	Lumber and construction materials	14,952
504	Sporting goods, toys and hobby goods	5,767
505	Metals and minerals, except petroleum	7,814
506	Electrical goods	21,386
507	Hardware, plumbing and heating equipment	16,618
508	Machinery, equipment, and supplies	72,855
511	Paper and paper products	10,242
512	Drugs, proprietaries, and sundries	3,521
513	Apparel, piece goods, and notions	11,250
514	Groceries and related products	34,736
515	Farm product raw materials	13,647
516	Chemicals and allied products	6,324
517	Petroleum and petroleum products	28,697
518	Beer, wine, and distilled beverages	6,356
	Retail trade	
52	Building materials and garden supplies	60,801
53	General merchandise	43,252
54	Food stores	160,233
55	Automotive dealers and service station	237,861
56	Apparel and accessory stores	110,563
57	Furniture and home furnishing stores	79,661
58	Eating and drinking establishments	261,480
59	Miscellaneous retail stores	233,686
	Finance, insurance and real estate	
60	Banking	37,031
61	Credit agencies other than banks	51,883
62	Security, commodity brokers, and services	8,331
63	Insurance carriers	24,020
64	Insurance agents, brokers, and service	66,225
65	Real estate	162,986
66	Combined real estate, insurance	7,721
67	Holding and other investment	10,810
	Services	
70	Hotels and other lodging places	46,005
72	Personal services	166,200
73	Business services	121,646
751	Automobile rentals	7,387
752	Automobile parking	6,929
753	Automobile repair shops	61,507
754	Automobile services, except repair	7,060
76	Miscellaneous repair services	44,010
78	Motion pictures	15,045
79	Amusement and recreation	42,610
801	Health services, offices	232,183
805,808	Nursing, personal care, and outpatient facilities	15,839
807	Medical and dental laboratories	8,516
806	Hospitals	5,522
809	Health and other allied services	3,629
81	Legal services	79,139
82	Educational services	25,393
83	Social services	36,492
84	Museums, botanical, zoological gardens	796
86	Nonprofit membership organizations	129,665
891	Engineering and architectural services	28,119
893	Accounting, auditing, and bookkeeping	29,061
892	Nonprofit research agencies	2,016

Source: U.S. Department of Commerce, Bureau of the Census, County Business Patterns, 1974, United States Summary, CBP-74-1, Washington, D.C., Table 1B.

Table 1.5. Number of State and Local Governments, 1972[a] (excluding school districts)

State governments	50
Local governments	62,437
Counties	3,044
Municipalities	18,517
Townships	16,991
Special districts	23,885

[a] This data is a count of governmental units, not state and local buildings.

Source: U.S. Department of Commerce, Bureau of the Census, <u>1972 Census of Governments</u>, Governmental organization, Vol. 1, Washington, D.C., July 1973, Table 1.

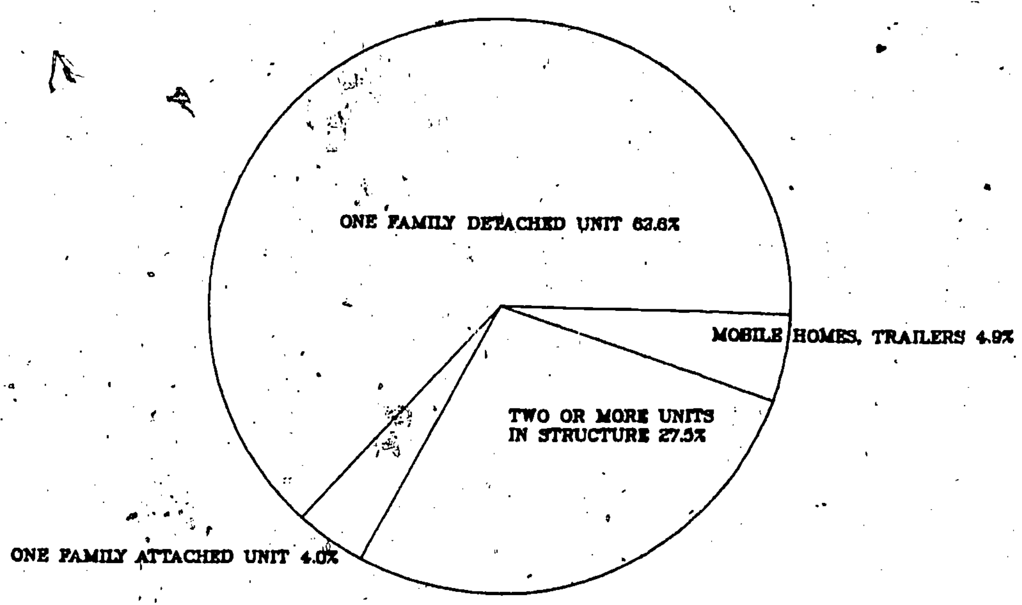
Table 1.6
Number of Federally Owned Buildings and Associated Floor Space

	Federally owned buildings	Floor area[a]	Floor area, leased	Percent of leased floor area[b]
		(10^6 ft^2)		
1970	410,587	2507	182	7.3
1971	406,528	2469	183	7.4
1972	403,323	2520	191	7.6
1973	403,409	2523	209	8.3
1974	401,335	2513	215	8.6
1975	398,737	2466	210	8.5

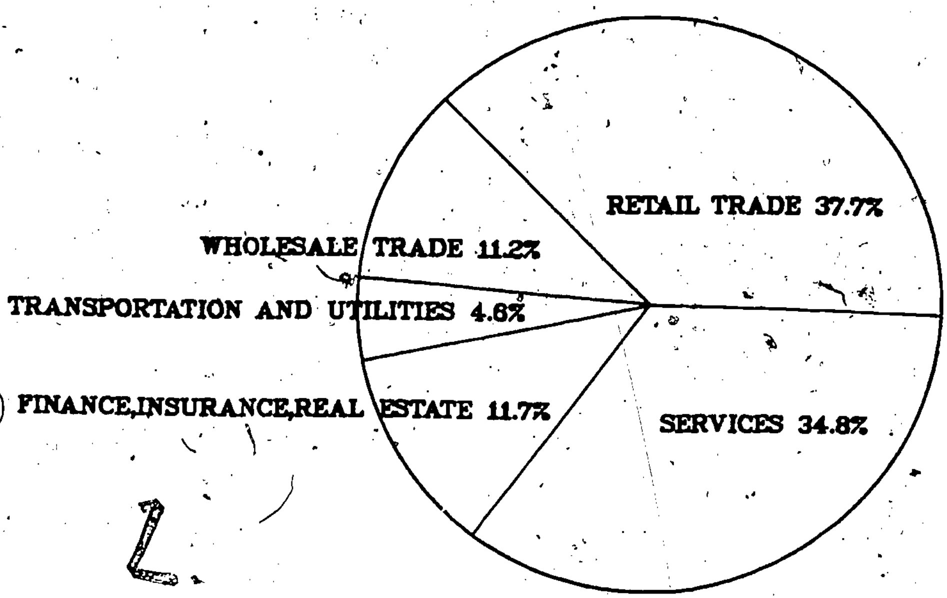
[a] Refers to floor area of buildings owned by the federal government.

[b] Calculated as the proportion of leased floor area to total floor area.

Source: U.S. Department of Commerce, Bureau of the Census, <u>Statistical Abstract of the United States: 1976</u>, 97th Annual Edition, Washington, D.C., 1976, Table No. 339.



Residential



Commercial

Figure 1.1. Relative Incidence of Residential and Commercial Buildings, 1974.

Sources: U.S. Department of Commerce, Bureau of the Census, Annual Housing Survey: 1975, United States and Regions, Part A — General Housing Characteristics, Washington, D.C., April 1977, Table A-1; County Business Patterns, 1974, United States Summary, CBP-74-1, Washington, D.C., 1975, Table 1A.

Table 1.7. Residential Housing Inventory
(10^3)

	1970	1973	1974	1975
One-unit detached	44,801	47,953	48,235	49,489
One-unit attached	1,990	3,334	3,049	3,129
Two or more units	18,836	20,728	20,887	21,594
Mobile home, trailers	2,073	3,278	3,715	3,342
Total	67,700	75,293	75,886	77,554
Vacancy rate, %[a]	6.3	6.5	6.7	6.5

[a] Vacancy rate data for 1970 and 1973 are from the Construction Review; otherwise data are available from the Annual Housing Survey, and were computed as:

$$\text{Vacancy rate} = \frac{\text{vacant year-round}}{\text{all year-round housing units}}.$$

This number is slightly misleading because it does not include seasonal or migratory vacant units.

Source: U.S. Department of Commerce, Bureau of the Census, Annual Housing Survey: 1975, United States and Regions, Part A — General Housing Characteristics, Washington, D.C., April 1977, Table A-1 (also previous years); A. Sabghir (ed.), U.S. Department of Commerce, Domestic and International Business Administration, Construction Review — Monthly Industry Report, Vol. 21, No. 4, Washington, D.C., May 1975, Table B-6.

Table 1.8: New Housing Units Completed and Mobile Home Shipments

	Privately owned units per structure				Publicly owned	Mobile home shipments	Total
	1 unit	2 units	3 and 4 units	5 or more			
1970	801,800	42,900	42,200	531,500	33,700	401,190	1,853,290
1971	1,014,000	50,900	55,200	586,100	34,100	496,570	2,236,870
1972	1,143,300	53,900	64,200	710,100	27,700	575,940	2,575,140
1973	1,174,100	58,600	61,900	719,200	19,400	566,920	2,600,120
1974	931,500	42,700	49,900	667,600	15,700	329,300	2,036,700
1975	866,500	30,700	28,600	371,100	16,000	212,690	1,525,590
1976	1,026,000	40,400	35,900	259,800	9,600	246,120	1,617,820

Source: A. Sabghir (ed.), U.S. Department of Commerce, Domestic and International Business Administration, Construction Review - Monthly Industry Report, Vol. 23, No. 3, Washington, D.C., April/May 1977, Table B-4, B-7 (also other years).

Table 1.9
Apartment Absorption Rates[a] by Census Region[b]

Region	Total[c] (number)	Percent	Percent absorbed after:			
			3 months	6 months	9 months	12 months
1971						
United States, total	333,027	100	68	85	92	95
Northeast	35,575	11	75	88	91	96
North Central	78,016	23	69	84	91	94
South	124,928	3[illegible]	65	85	92	96
West	94,508	28	67	83	92	96
1972						
United States, total	483,247	100	68	84	92	96
Northeast	63,151	13	74	89	95	98
North Central	119,658	25	66	80	88	93
South	178,111	37	70	86	94	98
West	122,327	25	64	84	92	96
1973						
United States, total	489,986	100	70	85	93	96
Northeast	59,492	12	74	88	94	96
North Central	130,012	27	67	82	91	95
South	195,009	40	72	88	94	97
West	105,473	22	66	84	92	96
1974						
United States, total	390,430	100	68	83	90	94
Northeast	36,149	9	68	84	91	95
North Central	88,296	23	72	87	93	96
South	190,513	49	65	81	89	93
West	75,472	19	69	84	91	96
1975						
United States, total	216,502	100	70	85	92	95
Northeast	30,242	14	63	77	85	90
North Central	53,908	25	74	88	93	97
South	89,141	41	68	83	91	95
West	43,211	20	73	90	95	97

[a] "Absorption Rate" refers to the amount of time or rate at which units in apartment buildings are rented.

[b] "Census Regions" and "Census Divisions" are described in Appendix C.

[c] Includes nonsubsidized, unfurnished, privately financed units in buildings with 5 or more units.

Source: U.S. Department of Commerce, Bureau of the Census, Market Absorption of Apartments, Current Housing Reports, Series H-130-76-5, Washington, D.C., May 1977, Table 2, (also previous years)

Table 1.10. Changes in the Housing Inventory
(10^3)

Area and subject	Total
All housing units, October 1973	75,969
All housing units, April 1970	70,138[a]
Increase:	
Number	5,831
Percent	8.3
Units added by new construction	8,000
Vacant—seasonal and migratory	21
1 unit in structure	3,770
2 units or more	2,799
Mobile home or trailer	1,411
Units lost, total[b]	2,169
Vacant—seasonal and migratory	76
1 unit in structure	1,302
2 units or more	591
Mobile home or trailer	200

[a] The 1970 Census of Housing data has been adjusted as follows. It is suggested by the 1970 Census Evaluation and Research Program that the original 1970 residential inventory was understated by approximately 1.5 million housing units. This is taken into account, along with the number of units added and lost. The difference in the 1970 Census of Housing after adjustment (70,184,000) and the AHS figures (70,138,000) is attributed to difference in survey procedure and sampling variability.

[b] Includes "whole—structure losses", which include only those housing units in structures where all units in the building had been removed. The degree of part—structure losses is not known.

Source: U. S. Department of Commerce, Bureau of the Census, Annual Housing Survey: 1973, United States and Regions, Part A — General Housing Characteristics, Washington, D. C., April 1975, Tables A, A—2, A—3.

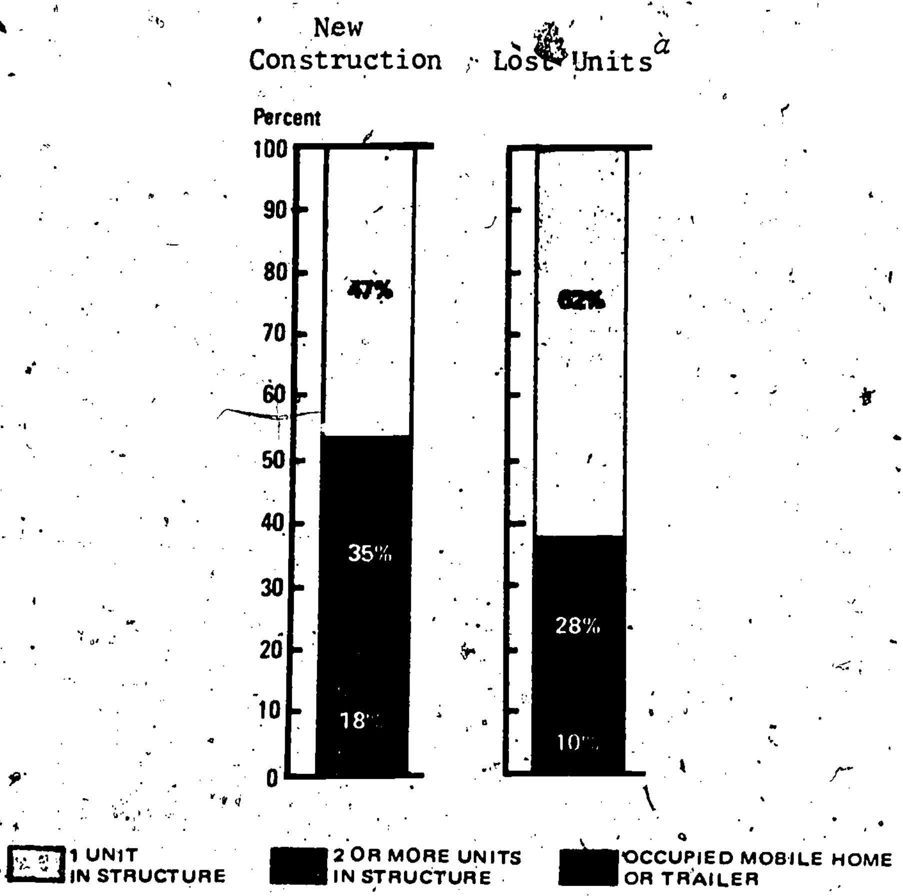


Figure 1.2. New Construction and Lost Units by Units in Structure, 1973 (percent).

[a] Includes "whole-structure losses," which include only those housing units in structures where all units in the building have been removed. The degree of part-structure losses is not known.

Source: U.S. Department of Commerce, Bureau of the Census, Annual Housing Survey: 1973, United States and Regions, Part A-General Housing Characteristics, Washington, D.C., April 1975, p. XXIII.

THE PERCENTAGE OF RECREATIONAL VEHICLES USED AS PERMANENT HOUSING IS UNKNOWN.

Table 1.11. Recreational Vehicle Shipment Trends
(units shipped)

Year	Motor homes	Camping trailers	Truck campers	Travel trailers	Total
1961		18,000	15,800	28,800	62,600
1962		23,000	16,700	40,600	80,300
1963		40,400	26,800	51,500	118,600
1964		52,000	34,800	64,200	151,000
1965	4,710	67,220	44,300	76,600	192,830
1966	5,710	72,300	54,500	87,300	219,810
1967	9,050	79,280	61,600	94,500	244,430
1968	13,200	125,200	79,500	115,200	333,100
1969	23,100	141,000	92,500	144,000	400,600
1970	30,300	116,100	95,900	138,000	380,300
1971	57,200	95,800	107,200	190,800	451,000
1972	116,800	110,200	105,100	250,800	582,900
1973	129,000	97,700	89,800	212,300	528,800
1974	68,900	55,200	45,400	126,300	295,800
1975	96,600	48,100	44,300	150,600	339,500

Source: Recreation Vehicle Industry Association, Facts and Trends, Chantilly, Va., 1976, p. 8.

Table 1.12. Energy Use by Fuel, Combined Residential/Commercial Sector (10^{12} Btu)

Year		Coal[a]	Petroleum[b]	Natural gas (dry)	Primary electric energy[f]	Electricity distributed	Residential/commercial		All sectors[d]	Percent by residential/commercial sectors (point-of-use)
							Total primary energy use	Total energy use[c] (point-of-use)	Total energy use (point-of-use)	
1960		983	4,923	4,268	3,958	1,262	14,132	11,436	38,220	29.9
1961		868	5,028	4,477	4,283	1,385	14,656	11,758	38,700	30.4
1962		872	5,227	4,849	4,582	1,490	15,530	12,438	40,522	30.7
1963		731	5,258	5,027	5,032	1,645	16,048	12,661	42,014	30.1
1964		609	5,191	5,343	5,466	1,792	16,609	12,935	43,458	29.8
1965		678	5,635	5,517	5,929	1,948	17,759	13,778	45,320	30.4
1966		677	5,766	5,945	6,403	2,101	18,791	14,489	47,666	30.4
1967		585	6,206	6,223	6,877	2,257	19,891	15,271	49,401	30.9
1968		529	6,129	6,451	7,499	2,467	20,608	15,576	52,157	29.9
1969		447	6,269	6,890	8,434	2,752	22,040	16,358	54,421	30.1
1970		427	6,453	7,108	9,239	3,000	23,227	16,988	55,913	30.4
1971		406	6,440	7,366	9,909	3,209	24,121	17,421	56,758	30.7
1972		308	6,667	7,613	10,682	3,478	25,270	18,066	59,123	30.6
1973	January	38	707	1,257	914	299	2,916	2,301	5,959	38.6
	February	32	653	1,113	871	285	2,669	2,083	5,488	38.0
	March	25	620	925	831	272	2,401	1,842	5,344	34.5
	April	16	527	745	773	253	2,061	1,541	4,847	31.8
	May	17	562	539	764	250	1,882	1,368	4,889	28.0
	June	17	511	354	853	279	1,735	1,161	4,480	25.9
	July	17	503	279	981	321	1,780	1,120	4,532	24.7
	August	18	560	253	1,015	332	1,846	1,163	4,741	24.5
	September	24	538	276	1,009	330	1,847	1,168	4,556	25.6
	October	28	592	344	877	287	1,841	1,251	4,950	25.3
	November	31	658	610	813	266	2,112	1,565	5,344	29.3
	December	33	648	882	828	271	2,391	1,834	5,649	32.5
	TOTAL	295	7,077	7,577	10,530	3,445	25,479	18,394	60,778	30.3
1974	January	40	662	1,158	912	297	2,772	2,157	5,636	38.3
	February	34	590	1,027	842	274	2,493	1,925	5,185	37.1
	March	27	569	902	823	268	2,321	1,766	5,151	34.3
	April	19	530	754	793	258	2,096	1,561	4,708	33.2
	May	16	497	499	780	254	1,792	1,266	4,583	27.6
	June	15	503	357	869	283	1,744	1,158	4,358	26.6
	July	14	507	293	971	316	1,785	1,130	4,482	25.2
	August	21	519	265	1,017	331	1,822	1,136	4,581	24.8
	September	25	513	278	968	315	1,784	1,131	4,511	25.1
	October	27	589	395	836	272	1,847	1,283	4,936	26.0
	November	27	583	569	808	263	1,987	1,442	5,004	28.8
	December	31	628	930	900	293	2,489	1,882	5,515	34.1
	TOTAL	297	6,688	7,427	10,519	3,424	24,931	17,836	58,624	30.4

Table 1.12. Energy Use by Fuel, Combined Residential/Commercial Sector (continued) (10^{12} Btu)

Year		Coal[a]	Petroleum[b]	Natural gas (dry)	Primary electric energy[f]	Electricity distributed	Residential/commercial		All sectors[d]	Percent by residential/commercial sectors (point-of-use)
							Total primary energy use	Total energy use[c] (point-of-use)	Total energy use (point-of-use)	
1975	January	35	627	1,124	943	310	2,729	2,096	5,709	36.7
	February	23	526	1,105	889	292	2,543	1,946	5,002	38.9
	March	22	546	1,018	864	284	2,450	1,870	5,123	36.5
	April	15	489	905	822	270	2,231	1,679	4,626	36.3
	May	12	444	522	788	259	1,766	1,237	4,221	29.3
	June	13	435	338	882	290	1,668	1,076	4,090	26.3
	July	16	463	294	1,007	331	1,780	1,104	4,209	26.2
	August	15	447	267	1,041	342	1,770	1,071	4,272	25.1
	September	21	484	281	998	328	1,784	1,114	4,297	25.9
	October	23	539	353	831	273	1,746	1,188	4,661	25.5
	November	24	503	523	831	273	1,881	1,323	4,627	28.6
	December	33	635	910	922	303	2,500	1,881	5,554	33.9
	TOTAL	255	6,135	7,640	10,818	3,554	24,848	17,584	56,388	31.2
1976	January	31	656	1,229	1,033	340	2,949	2,256	5,843	38.6
	February	20	575	1,106	954	314	2,655	2,015	5,121	39.3
	March	18	571	858	869	286	2,316	1,733	5,037	34.4
	April	21	500	704	821	270	2,046	1,496	4,621	32.4
	May	16	506	510	802	264	1,834	1,296	4,478	28.9
	June	15	489	369	869	286	1,742	1,159	4,377	26.5
	July	11	487	297	1,018	335	1,813	1,130	4,469	25.3
	August	15	506	275	1,048	345	1,844	1,141	4,423	25.8
	September	17	517	271	1,000	329	1,805	1,134	4,419	25.7
	October	20	567	397	860	283	1,844	1,267	4,885	25.9
	November	25	622	700	918	302	2,265	1,649	5,340	30.9
	December	37	726	1,078	1,018	335	2,859	2,176	6,132	35.5
	TOTAL	246	6,722	7,796	11,210	3,690	25,974	18,454	59,167	31.2
1977	January	36	712	1,353		369		2,470	6,215	39.7
	February	25	672	1,220		355		2,272	5,375	42.3
	March	19	605	849		318		1,791	5,120	35.0

[a] Bureau of Mines presents "anthracite" and "bituminous coal and lignite" categories summed here as "Coal."

[b] See User's Guide, Note 3. Asphalt and road oils are included in this accounting.

[c] Electricity lost through generation and transmission is not shown. The FEA suggests that 65% and 3% losses occur, respectively.

[d] Includes residential/commercial, industrial, and transportation sectors. Excludes generation and transmission losses.

[e] Pre-1973 data is from the Bureau of Mines, while 1973 begins the series of data from the FEA Monthly Energy Review. In 1976, a joint reporting system was established with FEA and BOM.

[f] Calculated by the author as:

$$\frac{\text{Heat rate}}{3412} \times \text{(Electricity distributed)}.$$

For further explanation, see User's Guide, Note 6.

Source: L. H. Crump, Division of Interfuels, U.S. Department of the Interior, Bureau of Mines, Historical Fuels and Energy Consumption Consumption Data, 1960-72, United States by States and Census Districts East of the Mississippi, Information Circular 8704, Washington, D.C., 1976, Table 1; J. Gaynor (ed.), Federal Energy Administration, Office of Energy Information alysis, Monthly Energy Review, NTIS UB-C-127-005, Washington, D.C., July 1977, pp. 57-59.

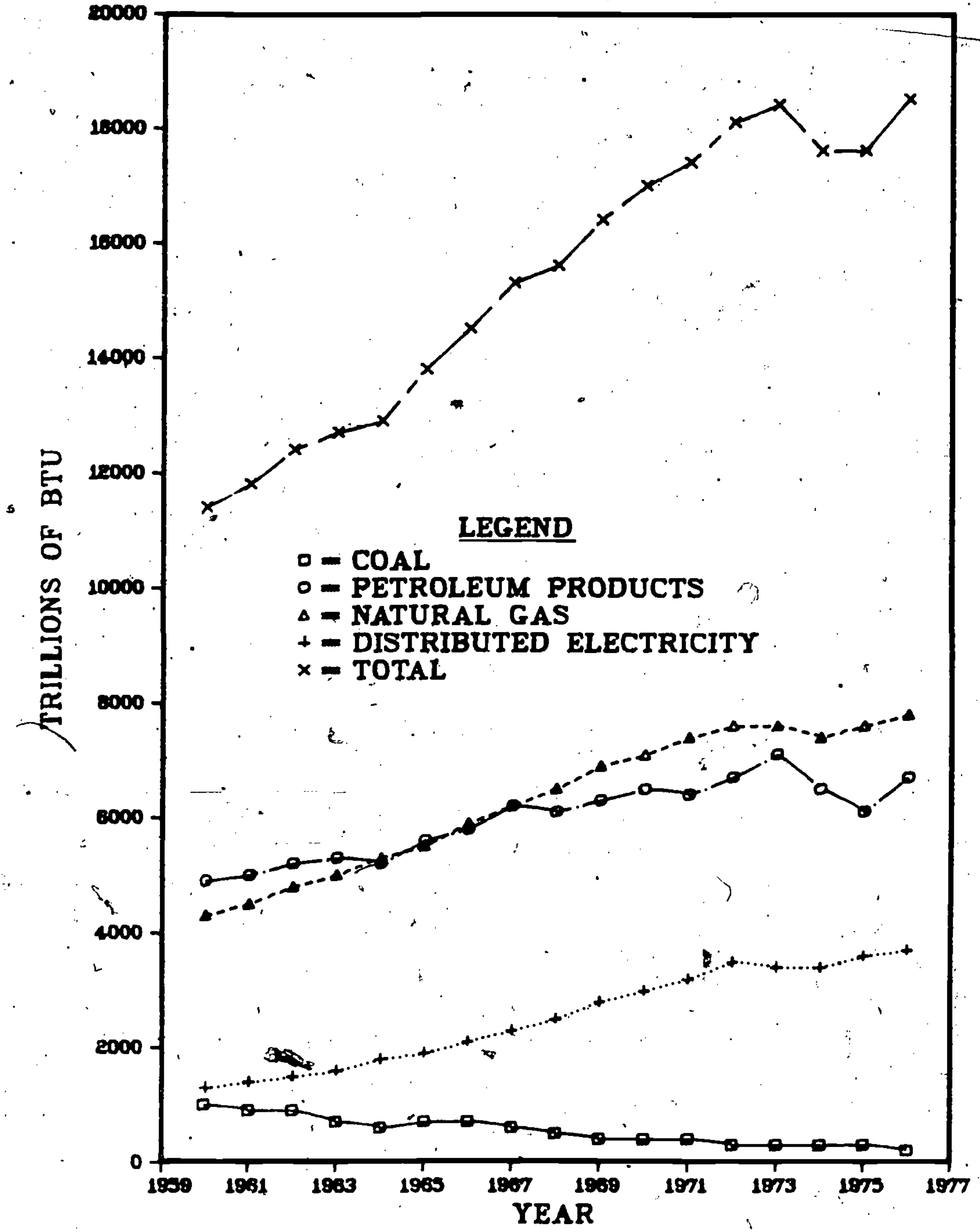


Figure 1.3. Residential/Commercial Energy Use by Fuel 1960–1976.

Sources: L. H. Crump. U.S. Department of the Interior, Bureau of Mines, Division of Interfuels, Historical Fuels and Energy Consumption Data, 1960–72, United States by States and Census Districts East of the Mississippi, Information Circular 8704, Washington, D.C., 1976, Table 1; J. Gaynor (ed.), Federal Energy Administration, Office of Energy Information Analysis, Monthly Energy Review, NTIS UB-C-127-005, Washington, D.C., July 1977, pp. 57–59.

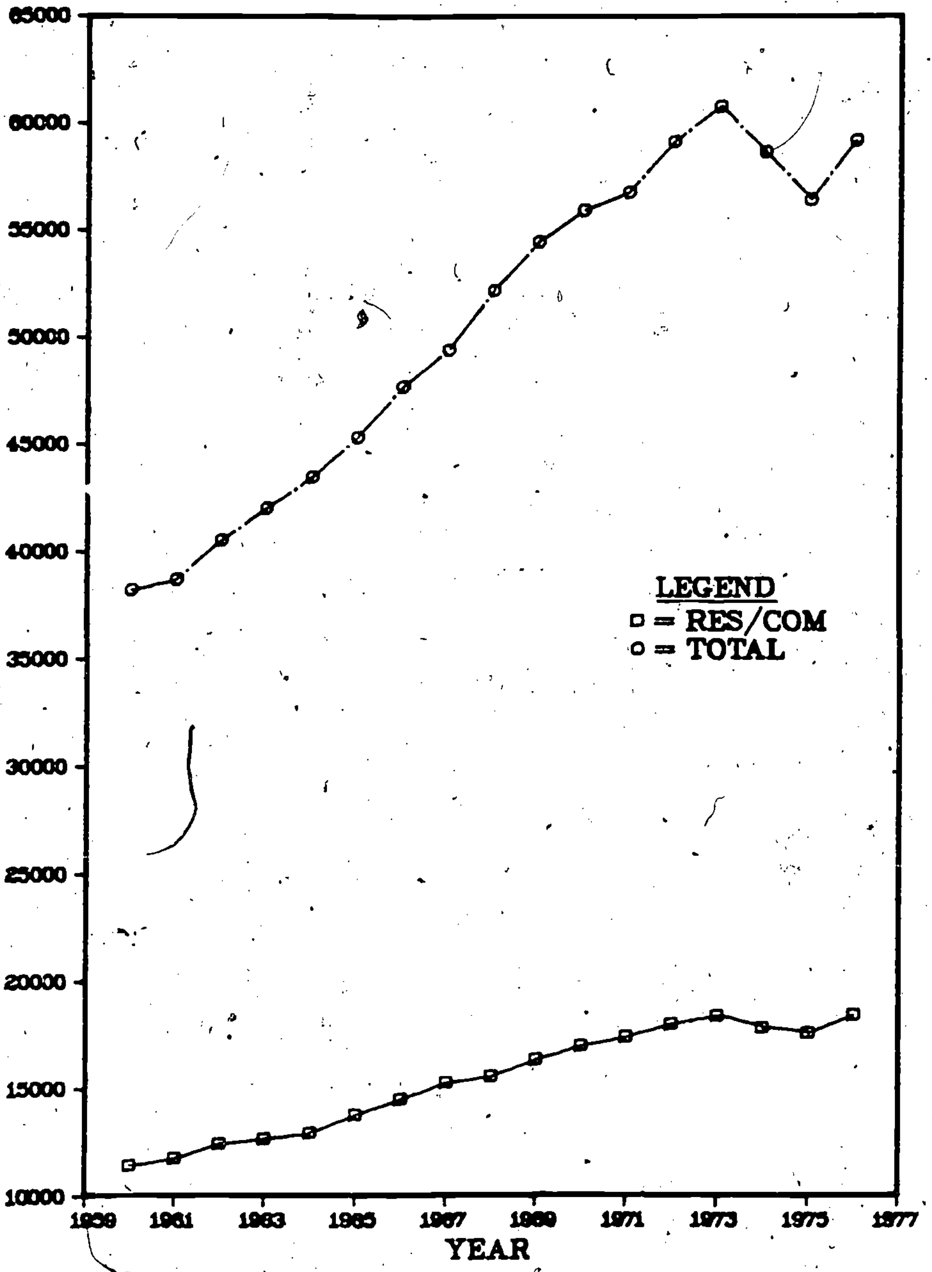


Figure 1.4. Residential/Commercial Energy Use vs. Total Use 1960–1976.

Sources: L. H. Crump, U.S. Department of the Interior, Bureau of Mines, Division of Interfuels, Historical Fuels and Energy Consumption Data, 1960–72, United States by States and Census Districts East of the Mississippi, Information Circular 8704, Washington, D.C., 1976, Table 1; J. Gaynor (ed.), Federal Energy Administration, Office of Energy Information Analysis, Monthly Energy Review, NTIS UB-C-127-005, Washington, D.C., July 1977, pp. 57–59.

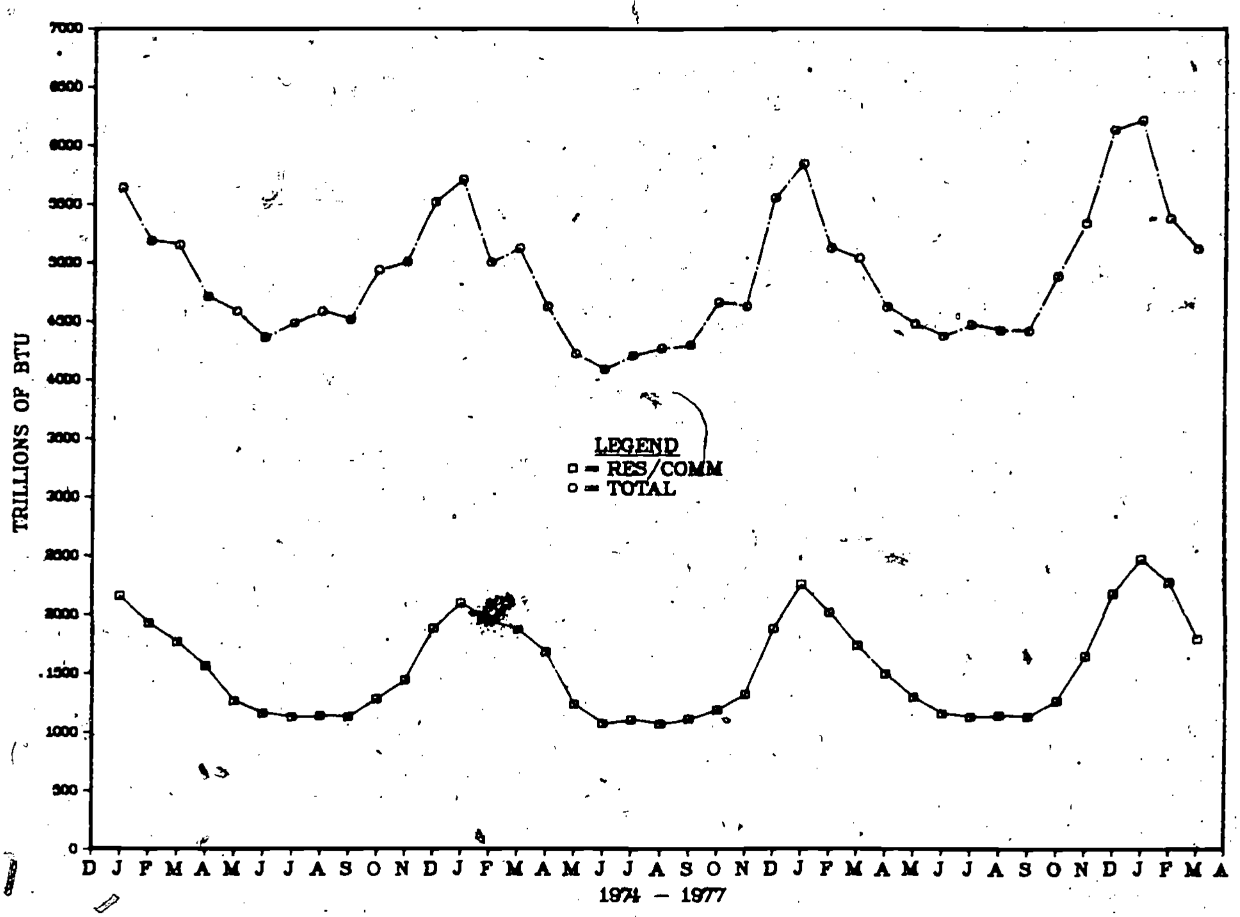


Figure 1.5
Monthly Residential/Commercial Energy Use vs. Total.

Source: L. H. Crump, U.S. Department of the Interior, Bureau of Mines, Division of Interfuels, Historical Fuels and Energy Consumption Data, 1960-72, United States by States and Census Districts East of the Mississippi, Information Circular 8704, Washington, D.C., 1976, Table 1; J. Gaynor (ed.), Federal Energy Administration, Office of Energy Information Analysis, Monthly Energy Review, NTIS UB-C-127-005, Washington, D.C., July 1977, pp. 57-59.

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Chapter 2

Appliances: An Inventory by Energy Source

M. A. Smith

Chapter 2 describes the inventory of fuel-using equipment. The chapter is divided into three sections: (1) manufacturers' shipments of appliances and equipment, (2) ownership of selected appliances and equipment in the residential sector, and (3) energy sources. It is important to distinguish between the two data sets. Factory shipment data do not generally include destination - that is, the residential versus commercial use of a particular appliance. An attempt is made to show export information to differentiate between exports and domestic purchases. Ownership information in this chapter is only in terms of residential appliances.

Tables 2.1 through 2.4 describe information concerning shipments of major household appliances. Time-series data of appliance shipments indicate consumer preference for a particular appliance or possible trends in inter-equipment substitution. Similar tables are presented describing heating and air conditioning equipment. Special emphasis has been placed on manufacturers' shipments of heat pumps. Shipments have increased considerably in the last five years. Heat pumps are generally less energy intensive than other space conditioning equipment; however, their usage is highly dependent on the geographic location of the housing unit (Table 2.8).

Factory shipment data should not be considered as an accurate enumeration of appliance ownership. This ownership information is obtained from two Bureau of Census Surveys only recently released: the Annual Housing Survey and the Survey of Purchases and Ownership. Data on ownership of household appliances and on space conditioning equipment by type is presented. Table 2.17 shows the consistency of the two surveys by comparing air conditioning data.

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In some cases, ownership of specific appliances is dependent on household income, as indicated by Figure 2.4. For example, of the "under $3,000" income group, 96.6% of the housing units have refrigerators. For the same income group, only 6.5% own dishwashers.

Specific data on commercial appliances and their usage rates are generally unavailable. In some cases, manufacturers' shipments are not reported to assure confidentiality of a specific manufacturer. The information available is usually inconsistent. Occasionally, commercial equipment is classified by tonnage or Btu category, rather than by commercial use of that piece of equipment.

Table 2.1. Major Household Appliances, 1976
(10^3 units shipped)

Appliance	Merchandising	Current Industrial Reports	Survey of Current Business
Ranges			
Electric	2463	2733.6[a]	2468
Gas	1825	1759.3[b]	1825
Refrigerators	5164	4911.7	4805
Freezers	1791	1482.6	1550
Dishwashers	3140	2983.1	3148
Food waste disposers	2515	2454.7	2513
Trash compactors	249	252.6	
Washers and dryers	8113	7645.1	7656
Electric water heaters	2616	2551.9	
Gas water heaters	3114	3267.5	3319
Room air conditioners	2962		2840

[a] Excludes microwave and drop-in ranges.

[b] Standard models only.

Sources: U.S. Department of Commerce, Bureau of Economic Analysis, Survey of Current Business, Vol. 57, No. 1, Washington, D.C., p. S-34; J. Lyons, A. Tyll, "Statistical and Marketing Report," Merchandising, Vol. 2, No. 3, New York, March 1977, pp. 39 and 43; U.S. Department of Commerce, Bureau of the Census, Current Industrial Reports, 1976, Major Household Appliances, MA-36F(76)-1, Washington, D.C., June 1977, Table 2 (also previous years).

THE FOLLOWING THREE TABLES SHOW INFORMATION FROM TABLE 2.1 IN GREATER DETAIL.

Table 2.2. Major Household Appliances, Current Industrial Reports
(10^3 units shipped)

Appliance	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976
Ranges										
Electric[a]	2019.9	2259.5	2306.0	2238.0	2572.4	3096.9	3603.7	3097.0	2190.2	2733.6
Gas[b]	NA	NA	NA	NA	NA	2355.9	2055.4	1675.9	1538.0	1759.3
Refrigerators	4779.5	5141.3	5279.8	5259.4	5543.7	6068.5	6527.3	5707.2	4552.5	4911.7
Freezers	1039.4	1064.0	1164.2	1304.5	1240.8	1355.4	2286.7	3060.8	2644.5	1482.6
Dishwashers	1581.8	1856.5	1998.7	1971.9	2269.3	2922.3	3439.0	3102.4	2463.3	2983.1
Food waste disposers	1498.5	1707.5	1825.5	1849.0	2119.2	2540.9	2817.9	2391.6	2002.2	2454.7
Trash compactors	NA	NA	NA	NA	NA	NA	455.2	474.5	224.4	252.6
Washers, dryers and combinations	NA	7690.1	7684.6	7437.5	7929.6	9062.7	9661.8	8427.2	6876.5	7645.1
Water heaters										
Electric	1398.5	1925.2	1924.1	1995.3	2210.8	2534.6	2806.6	2569.4	2246.7	2551.9
Gas	NA	NA	NA	NA	NA	3320.2	3041.3	2955.4	3194.2	3267.5

NA – Not available.

[a] Excludes microwave and drop-in ranges.

[b] Standard models only.

Source: U.S. Department of Commerce, Bureau of the Census, Current Industrial Reports, 1976, Major Household Appliances, MA-36F(76)-1, Washington, D.C., June 1977 (also previous years).

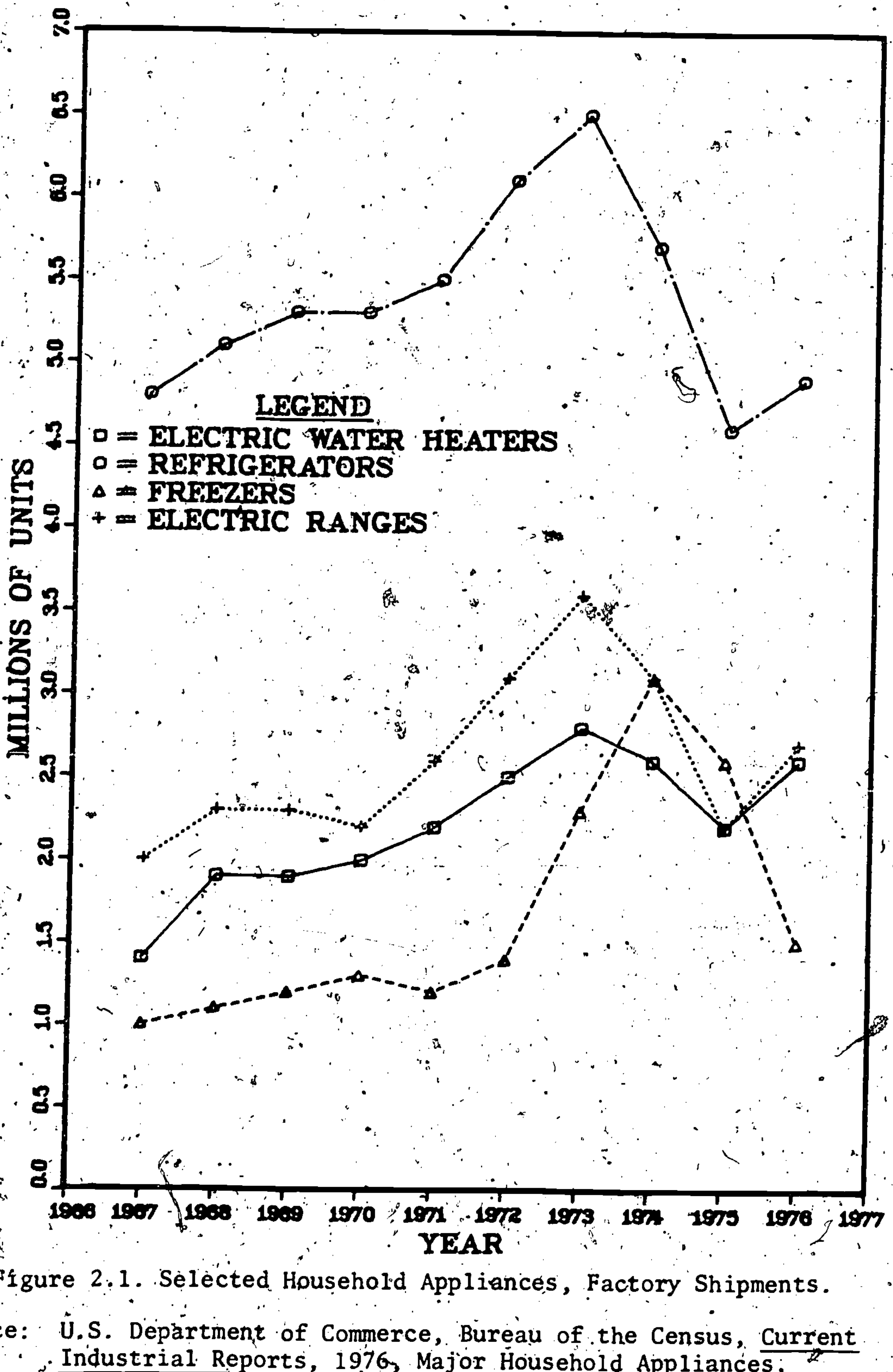

Figure 2.1. Selected Household Appliances, Factory Shipments.

Source: U.S. Department of Commerce, Bureau of the Census, Current Industrial Reports, 1976, Major Household Appliances, MA-36F(76)-1, Washington, D.C., June 1977 (also previous years).

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Table 2.3. Major Household Appliances, Merchandising
(10^3 units shipped)

Appliance	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1967–1973 average annual growth rate[a] (%)	1973–1976 average annual growth rate (%)
Ranges												
Electric	1,910	2,307	2,343	2,362	2,714	3,232	3,430	2,925	2,082	2,463	10.2	–10.5
Gas	2,123	2,286	2,471	2,362	2,549	2,661	2,481	1,950	1,618	1,825	2.6	–9.7
Smooth-top							210	300	275	267	*b*	8.3
Microwave ovens				30	100	325	440	635	840	1,485	*b*	50.0
Refrigerators[c]	4,713	5,151	5,296	5,286	5,691	6,315	7,103	6,357	4,895	5,164	7.1	–10.1
Freezers[c]	1,100	1,125	1,195	1,359	1,437	1,577	2,695	3,519	2,736	1,791	16.1	–12.7
Dishwashers	1,535	1,961	2,118	2,116	2,477	3,199	3,702	3,320	2,702	3,140	15.2	–5.3
Food waste disposers	1,357	1,812	1,943	1,977	2,292	2,771	2,974	2,553	2,080	2,515	14.0	–5.4
Trash compactors					100	210	320	315	233	249	*b*	–8.0
Washers[c,d]	4,366	4,520	4,422	4,094	4,609	5,107	5,979	5,338	4,478	4,747	5.4	–7.4
Dryers												
Electric	1,819	1,986	2,117	2,129	2,527	2,989	3,330	2,845	2,198	2,466	10.6	–9.5
Gas	829	876	905	852	850	936	926	739	672	708	1.9	–8.6
Compact							290	310	190	192	*b*	–12.8
Water heaters												
Electric	1,261	1,480	1,549	1,684	1,922	2,265	2,591	2,487	2,183	2,616	12.8	0.3
Gas	2,555	2,756	2,742	2,785	3,089	3,163	3,080	2,569	2,645	3,114	3.2	0.4
Air conditioners, room	4,129	4,026	5,459	5,887	5,438	4,508	5,346	4,564	2,670	2,962	4.4	–17.9
Phonographs	5,265	5,508	5,069	4,106	4,439	6,919	6,596	5,265	3,420	3,800	3.8	–16.8
Radios	31,684	34,322	39,414	34,049	34,105	42,149	37,652	33,230	25,276	28,300	2.9	–9.1
Television												
Black and white	5,435	5,551	4,975	4,546	4,874	8,145	7,033	5,941	4,968	5,196	4.4	–9.6
Color	5,224	5,827	5,524	4,822	6,181	8,378	9,263	7,830	6,485	7,700	10.0	–6.0

[a] Growth rates computed by the author.

[b] Growth rates were not computed due to lack of early data series.

[c] Includes "compact" appliance of that category for 1973–1976 data.

[d] Includes washer-dryer combinations for 1967–1969.

Source: J. Lyons, A. Tyll, "Statistical and Marketing Report," *Merchandising*, Vol. 2, No. 3, New York, March 1977, pp. 39 and 43.

Table 2.4. Electric and Gas Household Appliances
(10^3 units shipped)

	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976
Electric equipment										
Ranges[a]	1910	2307	2342	2362	2714	3232	3430	2925	2080	2468
Refrigerators	4713	5150	5296	5286	5691	6315	6774	5982	4577	4805
Freezers	1100	1124	1195	1358	1436	1576	2415	3220	2457	1550
Dishwashers	1586	1960	2118	2116	2477	3199	3702	3316	2702	3148
Food waste disposers	1356	1812	1943	1976	2292	2771	2974	2555	2080	2513
Washers	4323	4482	4378	4093	4608	5107	5504	4952	4228	4485
Dryers (including gas)	2642	2862	3022	2981	3377	3925	4256	3580	2869	3171
Air conditioners, room	4129	4026	5459	5886	5438	4508	5346	4564	2670	2840
Gas equipment										
Ranges	2123	2286	2471	2361	2549	2661	2481	1950	1618	1825
Water heaters	2555	2756	2742	2785	3088	3163	3080	2569	2645	3319
Warm air furnaces	1146	1428	1546	1471	1795	2066	1720	1476	1186	1554

[a] Over 2½ kilowatts.

Source: U.S. Department of Commerce, Bureau of Economic Analysis, 1975 Business Statistics, 20th Biennial Edition, Washington, D.C., May 1976, p. 161.

Table 2.5. Selected Heating Equipment, Factory Shipments[a]

	1967	1968	1969	1970	1971	1972	1973	1974	1975
Oil burners	513,154	532,613	523,815	573,404	606,391	797,957	791,897	567,317	695,207
Residential	483,444	505,107	499,169	546,923	581,341	753,344	732,497	510,543	586,625
Commercial and industrial	29,710	27,506	24,647	26,481	25,050	44,613	59,400	56,774	58,582
Domestic heating stoves	1,517,936	1,614,263	1,637,396	1,453,759	1,335,010	1,316,656	1,283,833	981,735	957,301
Gas	919,984	1,001,345	1,043,158	928,869	873,780	890,840	844,618	418,976	304,981
Wood[b]	171,111	167,511	142,617	103,113	93,978	86,319	88,161	123,798	126,698
Coal and wood[c]	155,331	157,596	160,141	145,473	150,204	141,882	151,115	240,926	394,237
Kerosene, gasoline, and fuel oil	271,510	287,811	291,480	276,304	217,048	197,615	199,939	198,035	131,385
Floor and wall furnaces	446,070	451,485	467,930	412,836	485,027	650,071	500,079	347,131	361,766
Gas-fired	429,655	434,956	451,828	397,730	471,558	639,293	491,015	340,754	355,080
Oil-fired	16,415	16,529	16,102	15,106	13,469	10,778	9,064	6,377	6,686
Gas-fired unit heaters[d]	191,510	184,588	218,103	176,473	156,166	180,173	203,733	164,938	112,560

[a] Factory shipment data on electric space heating equipment is not available from this source.

[b] Sheet-metal airtight types.

[c] Other than sheet-metal airtight types.

[d] 400,000 Btu per hour and under.

Source: U.S. Department of Commerce, Bureau of the Census, Current Industrial Reports: Selected Heating Equipment, Washington, D.C., annual, Table 3.

Table 2.6. Unitary Air Conditioners, Factory Shipments (units shipped)

	Single package Air conditioners	Year-Round (Single package and remote condenser type)	Split systems (Air conditioning condensing units only)	Heat pumps	Total
1967 - Total	106,274	88,728	768,359	79,725	1,043,086
Residential	29,712	38,302	585,491	60,520	714,025
Commercial	64,152	49,954	173,393	16,911	304,410
Export	12,410	472	9,475	2,294	24,651
1968 - Total	120,136	115,378	910,597	88,500	1,234,611
Residential	30,746	40,022	709,676	66,943	847,387
Commercial	75,174	74,326	188,648	18,664	356,812
Export	14,216	1,030	12,273	2,893	30,412
1969 - Total	135,380	146,742	1,255,585	97,318	1,635,025
Residential	33,049	56,612	1,017,431	67,478	1,174,570
Commercial	86,602	88,548	223,338	28,286	426,774
Export	15,729	1,582	14,816	1,554	33,681
1970 - Total	157,559	150,031	1,210,741	97,687	1,616,018
Residential	43,508	69,423	999,025	60,267	1,172,223
Commercial	96,349	78,285	190,291	34,843	399,768
Export	17,702	2,323	21,425	2,577	44,027
1971 - Total	195,737	183,561	1,415,300	82,281	1,876,879
Residential	89,559	95,313	1,156,394	67,147	1,408,413
Commercial	90,433	85,749	236,852	11,871	424,905
Export	15,745	2,499	22,054	3,263	43,561
1972 - Total	278,507	248,284	1,812,064	97,600	2,436,455
Residential	144,456	112,676	1,488,910	80,477	1,826,519
Commercial	118,700	131,777	302,925	12,409	565,811
Export	15,351	3,831	20,229	4,714	44,125
1973 - Total	361,975	275,775	2,081,668	120,016	2,839,434
Residential	216,530	101,718	1,742,263	87,035	2,147,546
Commercial	121,490	168,402	303,270	27,084	620,246
Export	23,955	5,655	36,135	5,897	71,642
1974 - Total	321,329	237,818	1,791,098	138,583	2,488,828
Residential	190,957	98,402	1,503,286	96,932	1,889,577
Commercial	100,387	132,269	236,109	31,082	499,847
Export	29,985	7,147	51,703	10,569	99,404
1975 - Total	200,232	150,272	1,105,340	166,653	1,622,497
Residential	89,879	68,626	88,068	128,005	1,174,578
Commercial	84,299	76,011	173,761	32,835	366,906
Export	26,054	5,635	43,511	5,813	81,013
1976 - Total	269,318	227,382	1,506,587	324,272	2,327,559
Residential	128,065	103,180	1,218,507	250,930	1,700,682
Commercial	92,482	107,748	196,702	61,596	458,528
Export	48,771	16,454	91,378	11,746	168,349

Source: Air-Conditioning and Refrigeration Institute, "Industry Tables of Unitary Shipments," Arlington, Va., June 1977, Table 5.

Table 2.7
Heat Pumps, Factory Shipments
(units shipped)

	Current Industrial Reports[a]	Air Conditioning and Refrigeration Institute
1960	47,501	47,501
1961	51,049	51,049
1962	61,813	61,813
1963	76,380	76,380
1964	76,785	76,785
1965	72,275	72,275
1966	81,992	82,217
1967	73,089	79,725
1968	78,792	88,500
1969	90,865	97,318
1970	88,180	97,687
1971	74,944	82,281
1972	80,843	97,600
1973	104,267	120,016
1974	122,561	138,583
1975	160,485	166,653
1976	313,551 (P)	324,272

[a] Information is also available by Btu classification.

P — Preliminary.

Sources: U.S. Department of Commerce, Bureau of the Census, Current Industrial Reports — Air Conditioning and Refrigeration Equipment, Washington, D.C., annual, Table 7; Air-Conditioning and Refrigeration Institute, "Industry Tables of Unitary Shipments," Arlington, Va., Table 13.

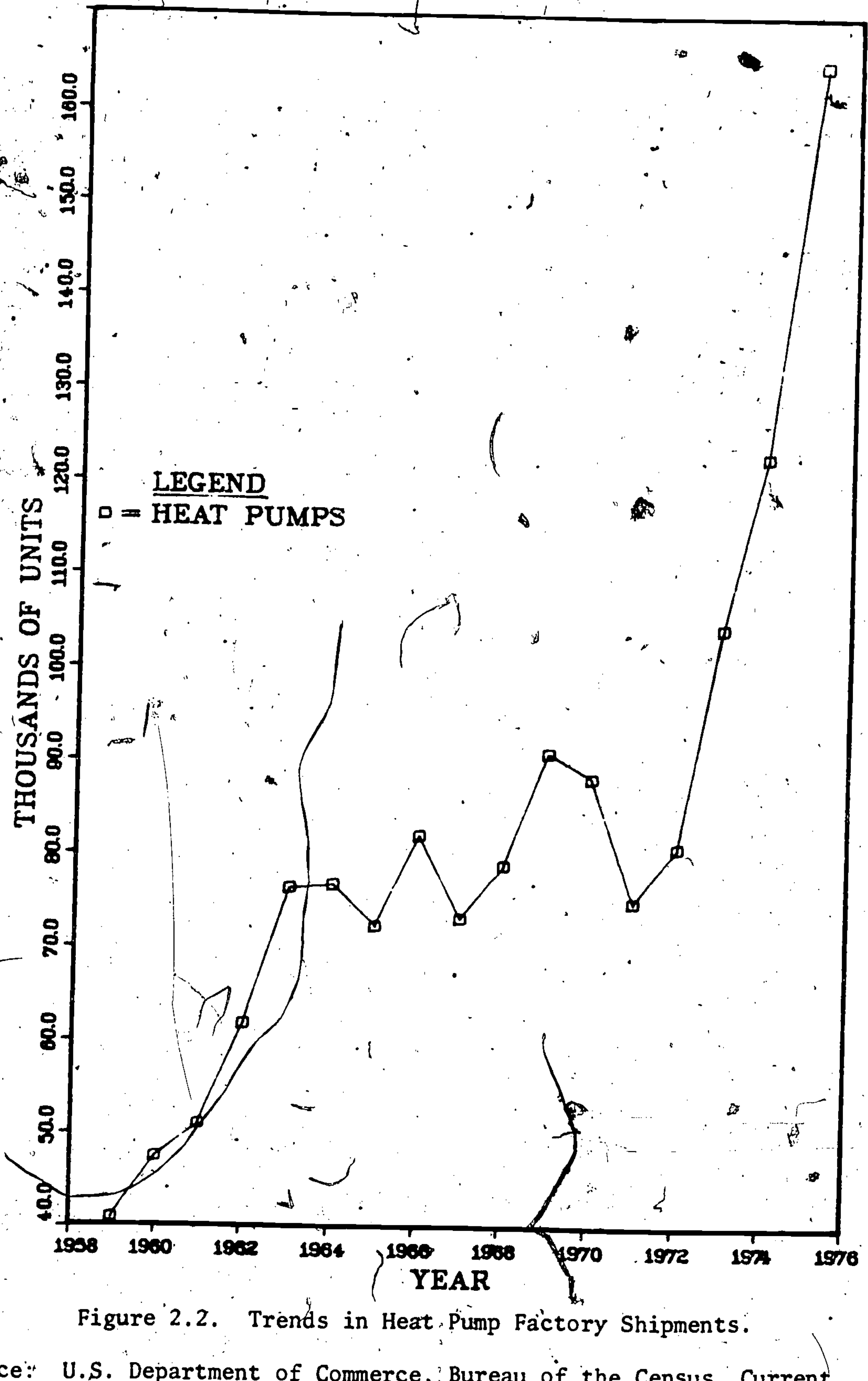


Figure 2.2. Trends in Heat Pump Factory Shipments.

Source: U.S. Department of Commerce, Bureau of the Census, Current Industrial Report — Air Conditioning and Refrigeration Equipment, Washington, D.C., annual, Table 7.

Table 2.8. Heat Pumps Added to New Housing Units by Census Division[a]

	New England	Middle Atlantic	East North Central	West North Central	South Atlantic	East South Central	West South Central	Mountain	Pacific	National Total
1972										
Total housing units added	50,523	64,362	80,471	29,393	310,864	85,2[illegible]	139,000	42,041	133,400	935,251
Heat pumps installed	57	582	929	611	57,675	5,077	2,596	16,629	3,413	87,569
Percent	0.1	0.9	1.2	2.1	18.6	6.0	1.9	39.6	2.6	9.4
1973										
Housing	44,343	72,843	102,061	35,578	373,842	102,396	149,286	50,781	107,469	1,038,599
Heat pumps	29	1,053	2,052	1,506	96,625	5,978	1,461	12,367	2,198	123,269
Percent	0.1	1.4	2.0	4.2	25.8	5.8	1.0	24.4	2.0	11.9
1974										
Housing	35,200	70,600	115,000	44,700	297,000	117,000	117,000	37,500	90,000	922,000
Heat pumps	265	621	2,300	1,760	25,400	8,560	1,150	16,700	2,150	58,900
Percent	0.8	0.9	2.0	3.9	8.6	7.3	1.0	44.5	2.4	6.4
1975										
Housing	21,200	50,800	84,000	39,400	237,000	87,000	76,900	37,800	23,600	714,000
Heat pumps	265	2,640	13,300	3,490	69,300	11,100	2,880	17,200	3,740	124,000
Percent	1.3	5.2	15.8	8.9	29.2	12.8	3.7	45.5	15.8	17.4

[a] "Census Regions" and "Census Divisions" are described in Appendix C.

Source: Edison Electric Institute, Conservation and Energy Management Division, Residential Space Heating Survey, New York, June 1977, pp. 35–36 (also previous years).

Table 2.9. Electric Lighting Fixtures
(10^3 units shipped)

	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976
Residential type	22,537	27,409	30,558	29,361	31,131	35,246	44,223	38,060	32,952	41,885
Commercial and institutional type	15,213	16,672	19,227	19,991	20,318	20,852	30,306	34,662	29,602	31,092

Source: U.S. Department of Commerce, Bureau of the Census, *Current Industrial Reports, 1976, Electric Lighting Fixtures*, MA-36L(76)-1, Washington, D.C., June 1977 (also previous years).

OF TOTAL MANUFACTURERS' FACTORY SHIPMENTS OF MAJOR APPLIANCES, A CERTAIN PERCENT ARE EXPORTED. THE FOLLOWING TABLE COMPARES SURVEY OF CURRENT BUSINESS FACTORY SHIPMENTS TO EXPORT ESTIMATES FOR 1976. APPARENTLY EXPORTS COMPRISE A SMALL PERCENTAGE OF FACTORY SHIPMENTS OF THE APPLIANCES SURVEYED.

Table 2.10. Exports of Selected Major Household Appliances, 1976

Appliance	Factory shipments	Exports	Percent exported
Ranges and ovens	2,468,000	63,142	2.6
Refrigerators	4,805,000	266,699	5.6
Freezers	1,550,000	36,395	2.3
Washing machines	4,485,000	183,639	4.1

Sources: U.S. Department of Commerce, Bureau of Economic Analysis, Survey of Current Business, Vol. 57, No. 2, Washington, D.C., 1977, p. S-34; U.S. Department of Commerce, Bureau of the Census, U.S. Exports — Schedule B Commodity Groupings; Schedule B Commodity by Country, FT410, Washington, D.C., April 1977, Table 2.

ANOTHER ESTIMATE OF APPLIANCE EXPORTS IS AVAILABLE FROM THE <u>CURRENT INDUSTRIAL REPORTS</u> BY DOLLAR VALUE OF SHIPMENTS ONLY. THESE VALUES WILL BE SLIGHTLY HIGHER THAN ACTUAL EXPORTED VALUE BECAUSE THE EXPORTED VALUE INCLUDES TRANSPORTATION COSTS TO THE POINT OF DEPARTURE. OF TOTAL MANUFACTURERS' SHIPMENTS, LESS THAN 5.0% IS EXPORTED. EXCEPTIONS ARE REFRIGERATORS AND DISHWASHERS.

Table 2.11. Exported Household Appliances
($ 10^6)

	1969	1970	1971	1972	1973	1974	1975	1976
Ranges, electric[a]	8.4	8.8	7.5	10.1	15.8	11.4	15.0	28.1
Refrigerators	26.6	20.5	20.5	24.2	42.2	84.8	72.6	85.5
Freezers	3.2	2.7	2.6	2.5	3.9	6.6	8.5	10.1
Dishwashers	6.4	6.6	8.8	11.1	20.6	34.0	30.0	41.3
Washers and dryers	15.7	14.3	11.6	20.0	23.5	21.9	36.9	46.9
Water heaters, electric	1.7	2.7	3.2	3.8	6.6	7.8	4.3	5.6
	(percent of factory shipments)							
Ranges, electric[a]	2.0	2.0	2.0	2.0	2.0	1.6	2.2	2.9
Refrigerators	3.0	2.0	2.0	2.0	3.3	6.7	6.5	6.6
Freezers	2.0	1.0	1.0	1.0	1.0	1.4	1.8	3.8
Dishwashers	2.0	3.0	3.0	3.0	4.7	6.2	8.0	7.1
Washers and dryers	2.0	2.0	1.0	2.0	2.0	1.9	3.5	3.8
Water heaters, electric	2.0	3.0	3.0	3.0	4.7	5.2	2.9	3.3

[a] Includes parts and accessories.

Source: U.S. Department of Commerce, Bureau of the Census, <u>Current Industrial Reports, 1976, Major Household Appliances</u>, MA-36F, Washington, D.C., June 1977, Table 3 (also previous years).

Table 2.12. Residential Heating Equipment in Use by Type
(10^3)

	1970	1973	1974	1975
Total year-round housing units	67,699	75,293	75,886	77,553
Warm-air furnace	28,772	36,043	37,629	38,964
Steam or hot water	13,820	14,635	14,301	14,554
Built-in electric units	3,520	4,464	4,864	5,061
Floor, wall, or pipeless furnace	5,878	7,447	7,085	6,994
Room heaters with flue	7,910	5,583	5,473	5,255
Room heaters without flue	3,949	4,161	3,742	3,689
Fireplaces, stoves, or portable heaters	3,269	2,130	2,069	2,341
None	581	830	723	695

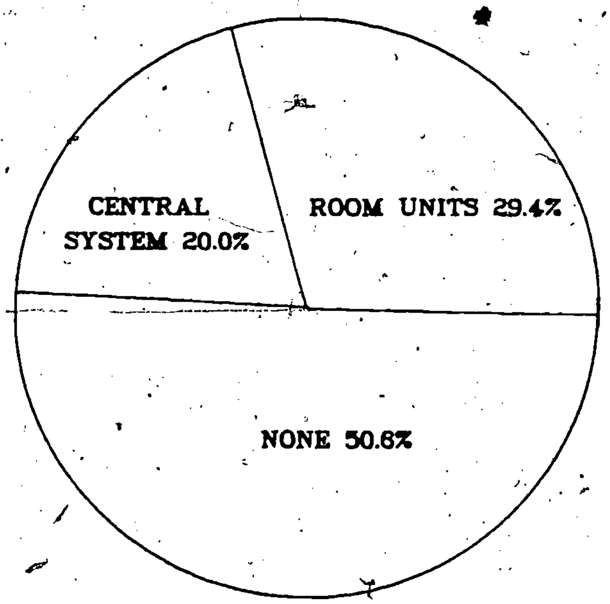
Source: U.S. Department of Commerce, Bureau of the Census, Annual Housing Survey: 1975, United States and Regions, Part A — General Housing Characteristics, Washington, D.C., April 1977, Table A-1 (also previous years).

Table 2.13. Residential Air Conditioning Equipment in Use by Type (10^3)

	1970	1973	1974	1975
Room unit(s)	16,939	22,630	23,065	22,781
Central system	7,263	12,628	14,362	15,536
None	43,492	40,035	38,459	39,236

Source: U.S. Department of Commerce, Bureau of the Census, Annual Housing Survey: 1975, United States and Regions, Part A — General Housing Characteristics, Washington, D.C., April 1977, Table A-1 (also previous years).

Space Cooling



Space Heating

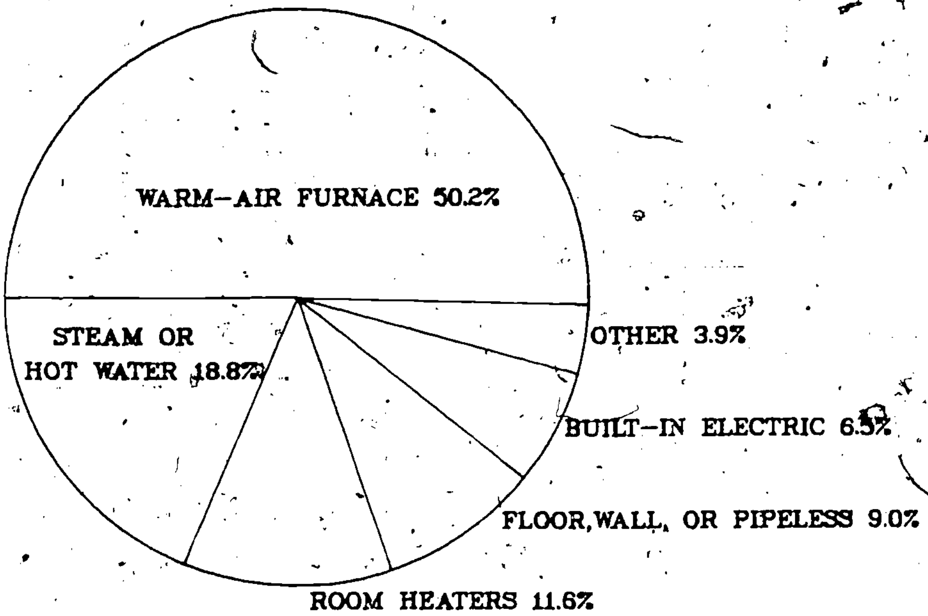


Figure 2.3. Percentage of Houses Using Space Conditioning Equipment by Type, 1975.

Source: U.S. Department of Commerce, Bureau of the Census, Annual Housing Survey: 1975, United States and Regions, Part A — General Housing Characteristics, Washington, D.C., April 1977, Table A-1 (also previous years).

Table 2.14. Market Saturation of Major Household Appliances[a]
(percentage)

	Appliance in housing unit		Owned by household	
	1973	1974	1973	1974
Ranges	98.2	98.5	75.5	75.2
Refrigerators	98.7	98.9	80.2	80.4
Freezers	32.1	33.7	31.7	33.4
Dishwashers	25.7	28.4	22.1	24.1
Washing machines	72.6	71.9	69.1	69.6
Clothes dryers	51.2	52.6	48.2	50.5

[a] Market saturation refers to the percentage of housing units owning or having available the specified appliance. The Survey of Purchases and Ownership (SOPO) is a subsample of the Annual Housing Survey. That is, the 1973 SOPO data refers to 17,169 housing units and 20,183 housing units in 1974.

Source: U.S. Department of Commerce, Bureau of the Census, Selected Data from the 1973 and 1974 Surveys of Purchases and Ownership, Washington, D.C., July 1976, Tables 6, 8, 12. (Revised)

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OWNERSHIP OF A GIVEN APPLIANCE MAY BE DEPENDENT ON HOUSEHOLD INCOME.

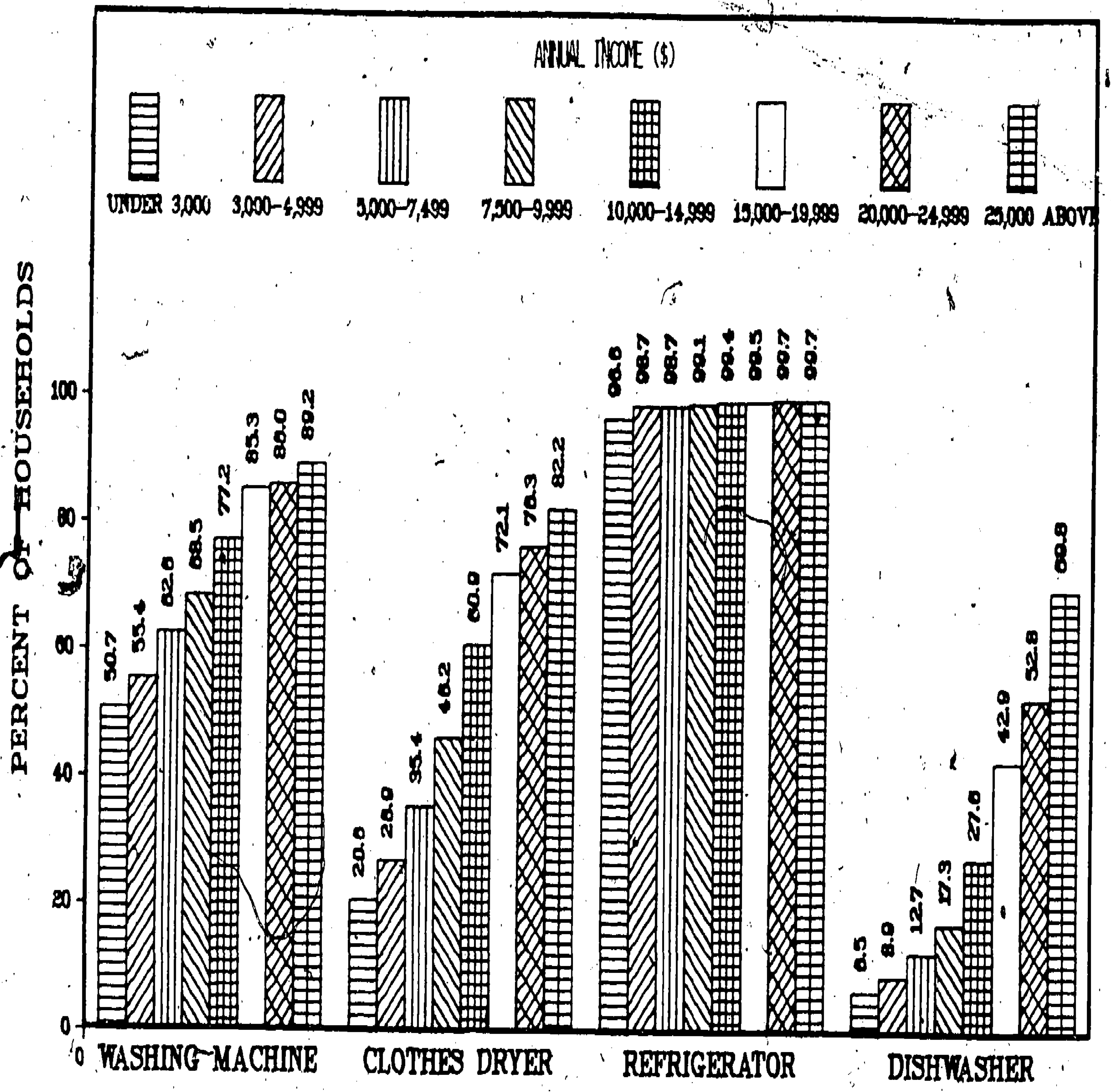


Figure 2.4. Appliance Ownership by Household Income, 1974

Source: U.S. Department of Commerce, Bureau of the Census, Selected Data from the 1973 and 1974 Surveys of Purchases and Ownership, Washington, D.C., July 1976, Table 6.

Table 2.15. Availability of Air Conditioning by Household Type[a] (percentage)

	1973	1974
Single-family, detached		
Room unit(s)	30.3	30.5
Central system	15.9	17.3
None	53.9	52.3
Single-family, attached		
Room unit(s)	29.3	29.8
Central system	14.4	14.5
None	56.3	55.7
Mobile homes		
Room unit(s)	36.4	34.4
Central system	22.3	20.1
None	41.3	45.5

[a] The Survey of Purchases and Ownership information shows percentages based on the total number of interviews. Specifically, the 1973 data describes a 17,169 universe and a 20,183 universe in 1974.

Source: U.S. Department of Commerce, Bureau of the Census, The 1973 and 1974 Surveys of Purchases and Ownership, Washington, D.C., July 1976.

Table 2.16. Number of Room Air Conditioners by Household Type[a] (percentage)

	1973	1974
Single-family, detached		
1 unit	19.0	19.6
2 units or more	11.2	10.8
Other[b]	69.7	69.5
Single-family, attached		
1 unit	21.4	21.8
2 units or more	7.9	8.0
Other[b]	70.7	70.2
Mobile homes		
1 unit	28.5	27.8
2 units or more	7.9	6.6
Other[b]	63.6	65.6

[a] The Survey of Purchases and Ownership information shows percentages based on the total number of interviews. Specifically, the 1972 data describe a 17,169 universe and 20,183 in 1974.

[b] Includes no air conditioners and a small percentage of not applicable.

Source: U.S. Department of Commerce, Bureau of the Census, The 1973 and 1974 Surveys of Purchases and Ownership, Washington, D.C., July 1976.

Table 2.17. Comparison of Air Conditioning Availability Data[a], 1974
(percent)

	Annual Housing Survey	Survey of Purchases and Ownership
Room unit(s)	30.4	30.5
Central system	18.9	16.7
None	50.7	52.7

[a] Annual Housing Survey data has been expanded to total housing (67,699,000). The *Survey of Purchases and Ownership* 1974 data is based on a 20,183 universe from raw interview data.

Sources: U.S. Department of Commerce, Bureau of the Census, *Annual Housing Survey: 1974, United States and Regions, Part A — General Housing Characteristics*, Washington, D.C., April 1976, Table A-1; U.S. Department of Commerce, Bureau of the Census, *1973 and 1974 Surveys of Purchases and Ownership*, Washington, D.C., July 1976.

Table 2.18. Fuels Used for Space Heating and Cooking

	Occupied units (10^3)				Percent distribution			
	1970	1973	1974	1975	1970	1973	1974	1975
All occupied units	63,445	69,337	70,830	72,523	100.0	100.0	100.0	100.0
House heating fuel								
Utility gas	35,014	38,461	39,471	40,933	55.2	55.5	55.7	56.4
Bottled, tank, or LP gas	3,807	4,422	4,143	4,146	6.0	6.4	5.8	5.7
Fuel oil, kerosine, etc.	16,473	17,235	16,835	16,299	26.0	24.9	23.8	22.5
Electricity	4,876	7,213	8,407	9,173	7.7	10.4	11.9	12.6
Coal or coke	1,821	800	741	573	2.9	1.2	1.0	0.8
Wood	794	604	658	852	1.3	0.9	0.9	1.2
Other	266	151	90	78	0.4	0.2	0.1	0.1
None	395	452	484	468	0.6	0.7	0.7	0.6
Cooking fuel								
Utility gas	31,244	31,924	31,890	32,493	49.2	46.0	45.0	44.8
Bottled, tank, or LP gas	5,314	5,720	5,561	5,440	8.4	8.2	7.9	7.5
Fuel oil, kerosine, etc.	303	87	81	76	0.5	*a*	*a*	*a*
Electricity	25,768	31,013	32,728	33,944	40.6	44.7	46.2	46.8
Coal or coke	157	37	36	23	0.2	*a*	*a*	*a*
Wood	405	210	206	230	0.6	0.3	0.3	0.3
Other	43	4	7	3	*a*	*a*	*a*	*a*
None	213	342	321	315	0.3	0.5	0.5	0.4

[a] Less than 0.1%.

Source: U.S. Department of Commerce, Bureau of the Census, Annual Housing Survey, 1975, United States and Regions, Part A—General Housing Characteristics, Washington, D.C., April 1977, Table A-1 (also previous years).

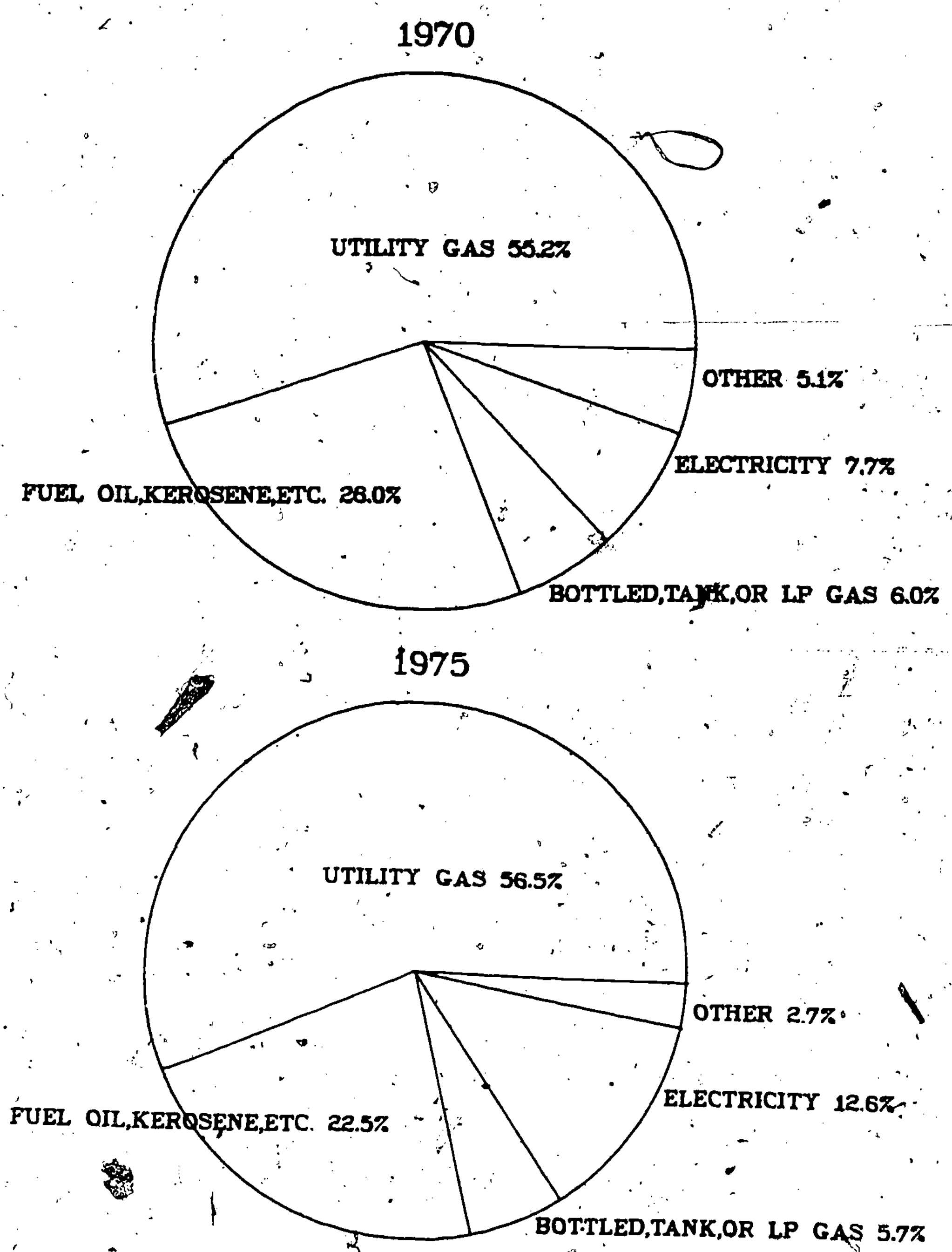
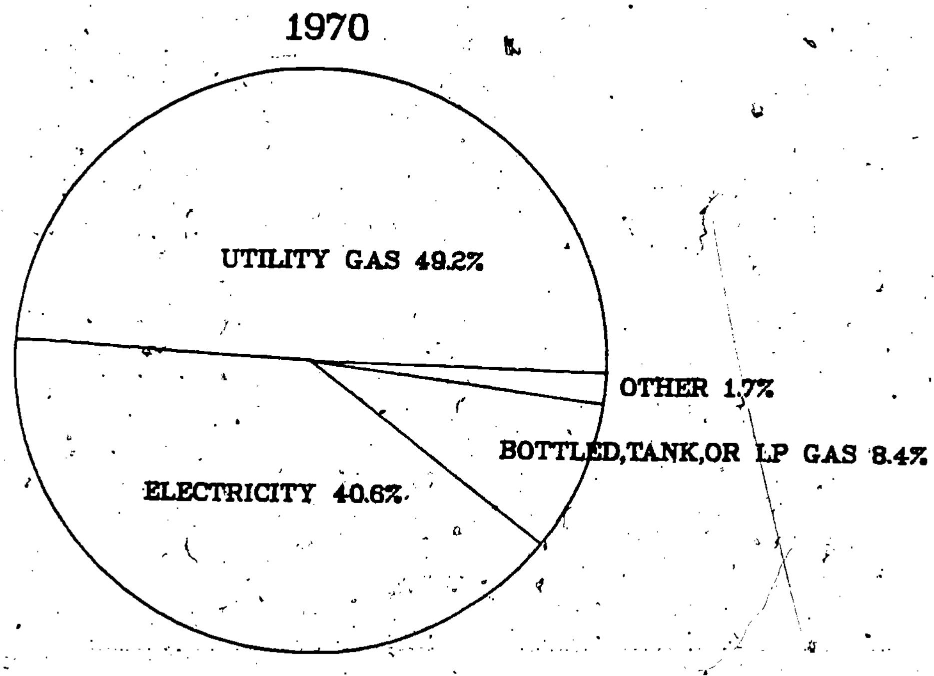


Figure 2.5. Fuels Used for Space Heating in Housing Units, 1970 and 1975.

Source: U.S. Department of Commerce, Bureau of the Census, Annual Housing Survey, 1975, United States and Regions, Part A — General Housing Characteristics, Washington, D.C., April 1977, Table A-1 (also previous years).



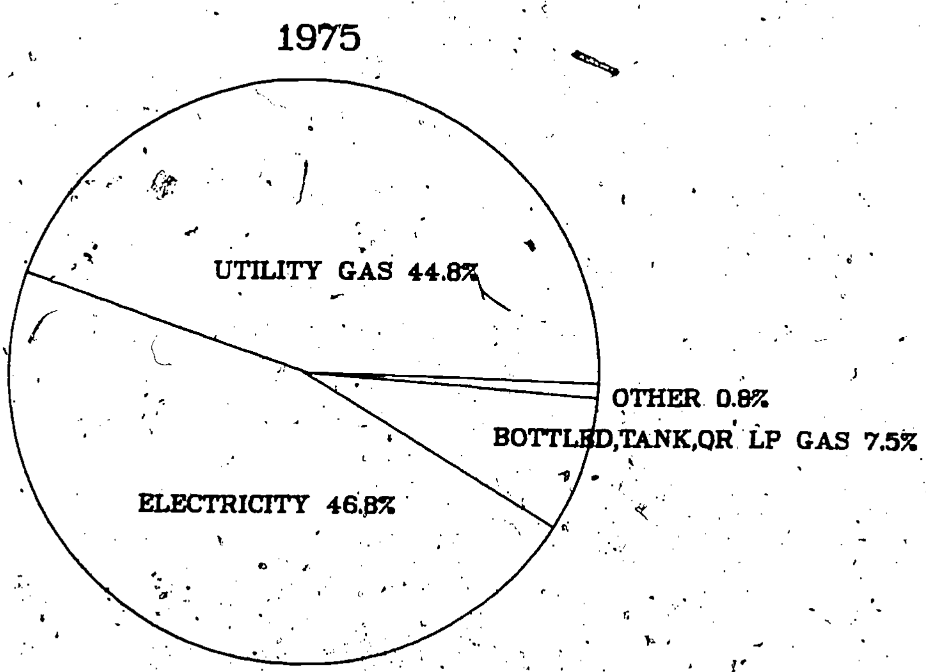


Figure 2.6. Fuels Used for Cooking in Housing Units, 1970 and 1975.

Source: U. S. Department of Commerce, Bureau of the Census, Annual Housing Survey, 1975, United States and Regions, Part A — General Housing Characteristics, Washington, D.C., April 1977, Table A-1. (Also previous years.)

Table 2.19. Energy Sources for Water Heating, 1970[a]
(10³ occupied units)

Census division[b]	Total occupied units	Utility gas	Liquid fuel	Coal or coke	Wood	Electricity	Bottled gas	Other fuels	None
United States[c]	63,447	34,959	6,200	459	47	16,103	3,144	132	2,401
New England	3,645	1,131	1,510	4	5	775	151	8	61
Middle Atlantic	11,834	5,729	3,854	210	3	1,539	301	61	137
East North Central	12,383	8,414	194	186	4	2,828	485	20	253
West North Central	5,154	3,160	53	6	2	1,205	535	10	182
South Atlantic	9,438	2,924	498	33	15	4,727	478	14	748
East South Central	3,868	1,431	5	9	4	1,682	211	2	524
West South Central	5,952	4,470	3	1	2	512	558	6	379
Mountain	2,518	1,705	11	6	4	576	151	2	63
Pacific	8,653	5,993	72	4	9	2,258	252	11	56

[a] Includes single-family, multifamily and mobile homes.

[b] "Census Regions" and "Census Divisions" are described in Appendix C.

[c] Figures may not add due to rounding.

Source: U.S. Department of Commerce, Bureau of the Census, 1970 Census of Housing, Detailed Housing Characteristics, United States Summary, Washington, D.C., 1972, pp. 254–255.

Table 2.20. Energy Sources for Clothes Drying, 1970[a]
(10^3 occupied units)

Census division[b]	Total occupied units	Gas-heated	Electrically heated	None
United States[c]	63,447	7,840	18,637	36,970
New England	3,645	262	1,150	2,234
Middle Atlantic	11,834	1,569	2,853	7,413
East North Central	12,383	2,667	3,970	5,745
West North Central	5,154	879	1,737	2,538
South Atlantic	9,438	374	2,545	6,518
East South Central	3,868	121	1,166	2,581
West South Central	5,952	680	1,461	3,811
Mountain	2,518	169	882	1,468
Pacific	8,653	1,119	2,872	4,662

[a] Includes single-family, multifamily, and mobile homes.

[b] "Census Regions" and "Census Divisions" are described in Appendix C.

[c] Figures may not add due to rounding.

Source: U.S. Department of Commerce, Bureau of the Census, *1970 Census of Housing, Detailed Housing Characteristics*, United States Summary, Washington, D.C., 1972, pp. 254–255.

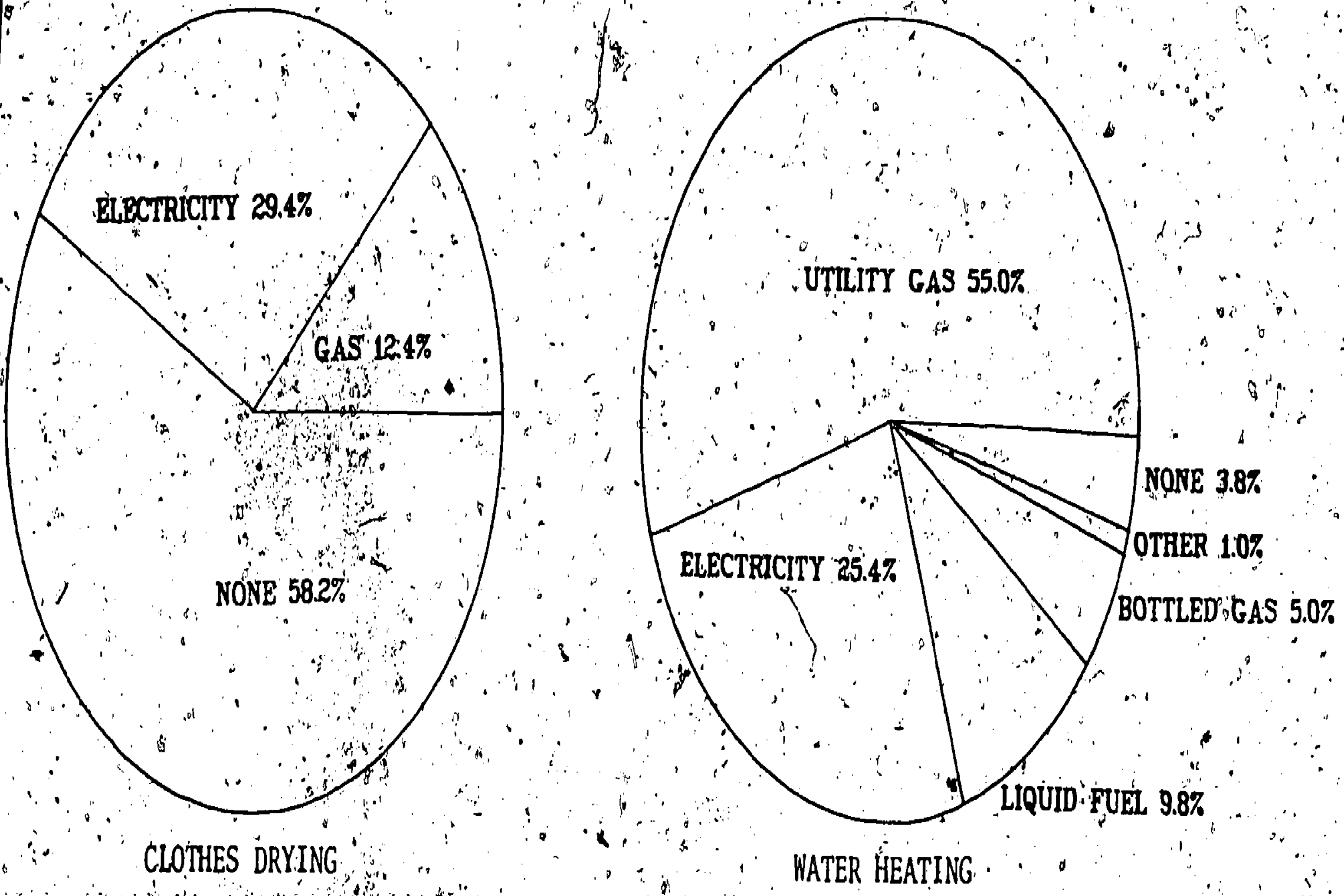


Figure 2.7. Fuels Used for Residential Clothes Drying and Water Heating by Number of Occupied Housing Units, 1970.

Source: U.S. Department of Commerce, Bureau of the Census, 1970 Census of Housing, Detailed Housing Characteristics, United States Summary, Washington, D.C., 1972, pp. 254-255.

Table 2.21. Fuels Used in Mobile Homes for Selected End Uses (percent)[a]

End use	1973	1974
Cooking		
Gas, pipe	28.3	27.2
Gas, bottled	49.5	49.3
Electric	21.7	23.2
Other[b]	0.4	0.2
Heating		
Gas, pipe	30.5	29.0
Gas, bottled	25.4	27.5
Electric	33.0	30.4
Fuel oil	10.1	12.3
Wood	0.1	0.2
None	0.7	0.6

[a] The *Survey of Purchases and Ownership* information shows percentages based on the total number of interviews of mobile home owners. Specifically, the 1973 data describes a 681 universe and a 1258 universe in 1974.

[b] Includes fuel oil, coal, coke, and wood.

Source: U.S. Department of Commerce, Bureau of the Census, *The 1973 and 1974 Survey of Purchases and Ownership*, Washington, D.C.

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Table 2.22. Fuels Used for Space Heating in New Single-Family Housing Units (by percent)

Region[a]		Type of heating fuel		
Homes (10^3)	Year	Electricity	Gas	Oil
		Northeast		
127,000	1966	13	48	36
127,000	1967	13	56	28
133,000	1968	15	51	33
122,000	1969	19	49	31
113,000	1970	24	43	31
134,000	1971	24	42	33
149,000	1972	29	36	33
155,000	1973	28	34	35
131,000	1974	38	29	32
113,000	1975	33	24	41
		North Central		
189,000	1966	7	83	10
214,000	1967	9	80	11
223,000	1968	8	78	13
183,000	1969	10	83	6
166,000	1970	13	80	7
208,000	1971	13	78	9
231,000	1972	16	74	9
255,000	1973	25	61	13
217,000	1974	36	51	12
215,000	1975	38	49	9
		South		
333,000	1966	28	56	11
365,000	1967	29	58	9
374,000	1968	32	57	7
342,000	1969	35	57	7
377,000	1970	39	57	5
467,000	1971	45	49	4
524,000	1972	52	42	4
514,000	1973	59	33	7
394,000	1974	67	27	4
358,000	1975	66	29	4
		West		
130,000	1966	24	73	2
139,000	1967	20	76	3
170,000	1968	23	74	2
163,000	1969	25	72	2
157,000	1970	22	76	1
204,000	1971	21	77	1
239,000	1972	26	72	1
251,000	1973	29	69	1
190,000	1974	33	66	*b*
181,000	1975	39	59	*b*

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[a] "Census Regions" and "Census Divisions" are described in Appendix C.

[b] Figures withheld by source because estimate did not meet publication standards on the basis of sample size.

Source: Edison Electric Institute, Conservation and Energy Management Division, Heating and Cooling Statistics of Marketing Interest on New Housing 1966–1975, New York, December 1976, pp. 4, 9-12.

Table 2.23. Type of Heating Fuel of Units in New Multifamily Buildings[a]

Type of heating fuel	Units (10³)			Percent distribution		
	1974	1975	1976	1974	1975	1976
United States, total	760	430	336	100	100	100
Electricity	455	253	200	60	59	59
Gas	269	141	111	35	33	33
Oil	29	29	22	4	7	7
Other types	7	7	3	1	2	1
Northeast[b], total	95	69	49	100	100	100
Electricity	42	24	21	44	35	42
Gas	27	17	11	28	24	22
Oil	21	23	15	22	34	32
Other types	6	5	2	6	8	4
North Central[b], total	152	93	83	100	100	100
Electricity	60	45	43	39	49	52
Gas	90	47	38	59	50	46
Oil	1	*b*	1	1	*b*	2
Other types	1	1	*b*	1	1	*b*
South[b], total	344	164	101	100	100	100
Electricity	263	129	77	76	78	76
Gas	73	30	18	21	18	18
Oil	7	5	6	2	3	6
Other types	*b*	*b*	1	*b*	*b*	1
West[b], total	170	103	103	100	100	100
Electricity	90	55	59	53	53	57
Gas	79	48	44	47	46	42
Oil	*c*	*c*	*c*	*c*	*c*	*c*
Other types	*c*	*c*	*c*	*c*	*c*	*c*

[a] Includes privately owned multifamily housing completions.

[b] "Census Regions" and "Census Divisions" are described in Appendix C.

[c] Fewer than 500 units or less than 0.5%.

Note: Totals may not add due to rounding.

Source: [illegible]S. Department of Commerce, Bureau of the Census, Characteristics of New Housing, Construction Reports, Series C-25, Washington, D.C., 1977, Table 17 (also previous years).

THE DEMAND FOR ENERGY FOR AIR CONDITIONING MAY BE A FACTOR NOT ONLY OF TEMPERATURE AND HUMIDITY BUT ALSO OF FINANCIAL RESOURCES. WHILE DWELLINGS MAY ROUTINELY BE CONSTRUCTED WITH HEATING UNITS, THIS MAY NOT BE THE CASE WITH AIR CONDITIONERS.

Table 2.24. Air Conditioning of Units in New Multifamily Buildings[a]

	Units (10^3)			Percent distribution		
	1974	1975	1976	1974	1975	1976
United States, total	760	430	336	100	100	100
With air conditioning	653	367	254	86	85	75
Without air conditioning	107	63	83	14	15	25
Northeast[b], total	95	69	49	100	100	100
With air conditioning	79	62	38	84	89	78
Without air conditioning	16	8	11	16	11	22
North Central[b], total	152	93	83	100	100	100
With air conditioning	134	83	71	88	88	85
Without air conditioning	NA	18	12	NA	12	15
South[b], total	344	164	101	100	100	100
With air conditioning	338	162	95	98	99	93
Without air conditioning	5	2	7	2	1	7
West[b], total	170	103	103	100	100	100
With air conditioning	101	61	53	60	59	51
Without air conditioning	69	42	51	40	41	49

[a] Consists of privately owned multifamily housing completions.

[b] "Census Regions" and "Census Divisions" are described in Appendix C.

Note: Totals may not add due to rouding.

NA - Not available.

Source: U.S. Department of Commerce, Bureau of the Census, <u>Characteristics of New Housing</u>, Construction Reports, Series C-25, Washington, D.C., 1977, Table 17 (also previous years).

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Chapter 3

Appliance Efficiencies

A. B. Rose

In 1970 13×10^{15} Btu of primary energy were used by major appliances* representing over 20% of total U.S. energy use. A knowledge of how this energy is used and how much is actually converted to useful work is a prerequisite for any estimation of the potential savings and for the final implementation of an energy savings program. In this chapter data on the energy efficiencies and power usages of household appliances are presented. In terms of the actual available data, a strong delineation exists between the appliances in use and the appliances manufactured in recent years.

Primarily due to the large number of appliances in existence and to the wide diversity of model types within each appliance category, very little data are available on the energy efficiencies and power usages of the appliances in actual use. Practically all that can be done is to make estimates of power usage based on several surveys done in recent years. A possible problem with load surveys of this nature is that the practical sample size is smaller than the number of different models in use within most appliance categories. Nevertheless the resulting data are most likely representative values for the appliance categories surveyed, although no real measure of their accuracy is possible.

Under various certification programs, the performance specifications and energy efficiencies for the vast majority of individual models of room air conditioners, unitary air conditioners, unitary heat pumps, freezers, refrigerators, and refrigerator-freezers are available. Unfortunately, the individual model sales data necessary for aggregation into meaningful categories are considered proprietary by manufacturers.

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*For the purpose of this narrative the term appliance includes water heaters, space heaters, furnaces, and air conditioners in addition to the customary household appliances.

and are not available. Therefore, any aggregate figures involve rather large possible errors, and the best that can be done is to make an accurate presentation of the potential errors, although it is likely that the actual errors incurred are *significantly* smaller.

Significant improvements in the data available are anticipated as the need for appliance efficiency is more widely realized. The Energy Conservation Program for Appliances under the auspices of the FEA (now part of DOE) is a prime example of a program working toward these ends. Until recently very little work has been done in the area of appliance efficiency and in the documentation thereof.

The chapter first presents an overview of the material in the form of a status summary of the proposed and final federal regulation promulgated along with the baseline 1972 appliance efficiencies and the 1980 efficiency improvement targets. Subsequent sections then provide supplementary and more in-depth information pertaining to the individual appliance categories. Wherever possible, data is presented to allow the calculation of energy use and a possible breakdown thereof when given the number of units or their capacity.

It should be noted that, throughout the chapter, only the design options to improve efficiencies as delineated by the FEA are presented. It was beyond the scope of the first edition of this document to delve into the subject area in great detail and the FEA/NBS options were only given this preemptive position as they are proposed to become parts of federal regulations. In practice several studies on particular appliance types are available and will be treated in later editions and supplements. For the reader particularly interested in this subject a special bibliography of relevant documents is presented in Appendix D.

THE ENERGY POLICY AND CONSERVATION ACT, AS AMENDED BY THE ENERGY CONSERVATION AND PRODUCTION ACT, REQUIRES THE IMPLEMENTATION OF A CONSERVATION PROGRAM FOR CONSUMER PRODUCTS OTHER THAN AUTOMOBILES.

Table 3.1. Federal Register Publication Dates of Rules Under The Energy Conservation Program for Appliances

Appliance category	Test procedures		Energy efficiency improvement targets	
	Proposed	Final	Proposed	Final[a]
Refrigerators and refrigerator-freezers	4-27-77	9-14-77	7-15-77	
Freezers	4-27-77	9-14-77	7-15-77	
Dishwashers	3-22-77	8-8-77	7-15-77	
Clothes dryers	4-27-77	9-14-77	7-15-77	
Water heaters	4-27-77	10-4-77	7-15-77	
Room air conditioners		6-1-77	7-15-77	
Home heating equipment (not including furnaces)	8-31-77[b] 5-11-77[c]		7-15-77	
Televisions	4-27-77	9-14-77	7-15-77	
Kitchen ranges and ovens	Rev. 7-8-77 6-16-77		7-15-77	
Clothes washers	5-17-77		7-15-77	
Humidifiers and dehumidifers	6-1-77		8-11-77	
Central air conditioners	6-14-77		8-11-77	
Furnaces	8-11-77			

[a] After the proposal of the improvement target a period of time is allowed for hearings and public review before the final target is promulgated. To date no final targets have been published.

[b] Vented.

[c] Unvented.

Sources: See p. 66.

Sources: U. S. National Archives, Library of Congress, Federal Register, Vol. 42, No. 55, Washington, D.C., March 22, 1977, pp. 15423–427; Federal Register, Vol. 42, No. 81, Washington, D.C., April 27, 1977, pp. 21576–593; Federal Register, Vol. 42, No. 91, Washington, D.C., May 11, 1977, pp. 23860–965; Federal Register, Vol. 42, No. 95, Washington, D.C., May 17, 1977, pp. 25329–335; Federal Register, Vol. 42, No. 105, Washington, D.C., June 1, 1977, pp. 27896–955; Federal Register, Vol. 42, No. 114, Washington, D.C., June 14, 1977, pp. 3[illegible]1–408; Federal Register, Vol. 42, No. 116, Washington, D.C., June 16, 1977 pp. 30627–637; Federal Register, Vol. 42, No. 131, Washington, D.C., July 8, 1977, pp. 35170 and 35171; Federal Register, Vol. 42, No. 136, Washington, D.C., July 15, 1977, pp. 36618–670; Federal Register, Vol. 42, No. 152, Washington, D.C., August 8, 1977, pp. 39964–969; Federal Register, Vol. 42, No. 155, Washington, D.C., August 11, 1977, pp. 40701–710 and 40826–845; Federal Register, Vol. 42, No. 169, Washington, D.C., August 31, 1977, pp. 43930–946; Federal Register, Vol. 42, No. 178, Washington, D.C., September 14, 1977, pp. 46140–154; Federal Register, Vol. 42, No. 192, Washington, D.C., October 4, 1977, pp. 54110–119.

BY LAW, EIA (FORMERLY FEA) WAS REQUIRED TO PRESCRIBE ENERGY EFFICIENCY IMPROVEMENT TARGETS FOR VARIOUS APPLIANCE CATEGORIES. THE ENERGY EFFICIENCY IMPROVEMENT TARGET TO BE ACHIEVED IN 1980 OVER THE BASE YEAR 1972 IS TO BE THE MAXIMUM WHICH IS TECHNOLOGICALLY AND ECONOMICALLY FEASIBLE, BUT THE AGGREGATES IS NOT TO BE LESS THAN 20%. THE TARGETS PROPOSED BY FEA ARE GIVEN IN THE TABLE BELOW. FOR MORE IN-DEPTH INFORMATION, THE SECTION ON THE INDIVIDUAL APPLIANCE CATEGORY SHOULD BE CONSULTED.

Table 3.2. Appliance Efficiency Improvement Targets

	Units of efficiency measure	1972 baseline end use efficiency measure	1980 efficiency improvement target (%)
Central air conditioners			
Single package	(Seasonal Btu/Whr)	6.2[a]	20
Split system		6.8[a]	27
Clothes dryers			
Electric	(lbs of clothes/kWhr)	2.64	8
Gas		1.96	18
Clothes washers	loads/kWhr	0.198	47
Dishwashers	loads/kWhr	0.243	25
Freezers	ft³/kWhr/day	4.32	30
Furnaces			
Home heating equipment			
Gas, vented	$\frac{\text{heat delivered – e[illegible]ergy used}}{\text{heat value o[illegible]sed}}$	0.53[a]	14
Oil, vented		0.41[a]	12
Humidifiers			
Room	lb/kWhr	46.4	0
Central	energy output/energy input	0.63	32
Dehumidifers	pt.kWhr	2.27	28
Kitchen ranges and ovens			
Electric			
range	$\frac{\text{energy into food}}{\text{energy used}}$	0.39	3
oven		0.15	5
cooking top		0.64	0
microwave oven		0.38	5
Gas			
range		0.10	104
oven		0.03	92
cooking top		0.17	113
Refrigerators and refrigerator-freezers	ft^{3b}/kWhr/day	3.80	47
Room air conditioners	Btu/Whr	6.51	30
Television sets			
Black and white	$\frac{\text{est. min. possible energy use}}{\text{units energy use}}$	0.35	186
Color			
Water heaters			
Electric	$\frac{\text{water heat content}}{\text{energy input}}$	0.80	18
Gas		0.44	25
Oil		0.46	23

[a] The baseline values are for 1975.

[b] This is not the rated, but rather an adjusted volume. See Note 10 of the User's Guide.

Source: U.S. National Archives, Library of Congress, Federal Register, Vol. 42, No. 136, Washington, D.C., July 15, 1977, pp. 36618-670.

Table 3.3. Estimated Energy Use of Various Electric Household Items

	Estimated annual electrical energy use (kWhr/unit)
Kitchen appliances	
Blender	15
Broiler	100
Coffee maker	106
Deep fryer	83
Frying pan	186
Hot plate	90
Mixer	13
Oven, microwave (only)	190
Roaster	205
Sandwich grill	33
Toaster	39
Trash compactor	50
Waffle iron	22
Waste disposer	30
Heating and cooling	
Air cleaner	216
Electric blanket	147
Dehumidifier	377
Fan (attic)	291
Fan (circulating)	43
Fan (rollaway)	138
Fan (window)	170
Heater (portable)	176
Humidifier	163
Laundry	
Iron (hand)	144
Health and beauty	
Germicidal lamp	141
Hair dryer	14
Heat lamp (infrared)	13
Sun lamp	16
Housewares	
Clock	17
Floor polisher	15
Sewing machine	11
Vacuum cleaner	46

Source: Federal Energy Administration, Office of Energy Conservation and Environment, Tips for Energy Savers, Washington, D.C., May 1977, p. 28.

Clothes Dryers

The FEA determined the efficiency improvement target given in Table 3.2 on the basis of the following design improvements.

Table 3.4. Clothes Dryer Design Options to Improve Efficiency

Design option	Production-weighted energy savings[a] (%)
Gas dryers	
Eliminate pilot	15
Electric dryers	
Add insulation	5
Improve electric heater	2
Total	7

[a] The production-weighted energy savings of 15% and 8% correspond to 18% and 8% efficiency improvements, respectively.

The representative annual use cycle, as determined by FEA, is 416 loads per year — regardless of the size of the dryer.

In a survey of 79 metered electric clothes dryers, the average energy use per dryer per day was found to be 2.642 and 2.786 kWhr/dryer/day for August and September 1976 respectively.

Sources: U.S. Nationa[illegible]ives, Library of Congress, Federal Register, Vol. 42, No. [illegible]6, Washington, D.C., July 15, 1977, pp. 36618 through 36670; Federal Register, Vol. 42, No. 81, Washington, D.C., April 27, 1977, pp. 21589 through 21593; Midwest Research Institute, Patterns of Energy Use by Electrical Appliances Study, Kansas City, Mo., December 10, 1976, p. 29.

Clothes Washers

The FEA determined the efficiency improvement target of Table 3.2 on the basis of the following improvements.

Table 3.5. Clothes Washer Design Options to Improve Efficiency

Design option	Production-weighted energy savings (%)
Eliminate warm rinse	23.6
Reduce warm water temperature setting	8.0
Total	32

Far over 90% of the energy use attributed to clothes washers is energy actually used by the water heater. In calculating the efficiency in Table 3.2, FEA used the following formula

$$\text{Energy Efficiency} = \frac{1}{\text{electrical energy in kWhr} + \text{water thermal energy}}$$

Where the water thermal energy was based on a temperature rise of 90°F, but assuming 100% water heater efficiency. If the water heater efficiencies are taken into account, the values change considerably.

Table 3.6. Clothes Washer Efficiency, Taking into Account Water Heater Efficiency, 1972

Clothes washer used in conjunction with	End-use energy efficiency (loads/kWhr)	Prime source[a] energy efficiency (loads/kWhr)
Electric hot water heaters	0.160	0.048
Gas-fired hot water heaters	0.089	0.085
Oil-fired hot water heaters	0.093	0.089

The representative annual use given by FEA for clothes washers is 416 loads per year.

[a] Including 30% electrical generation and distribution efficiency.

Sources: U.S. National Archives, Library of Congress, Federal Register, Vol. 42, No. 136, Washington, D.C., July 15, 1977, pp. 36618 through 36670; unpublished material from Federal Energy Administration and National Bureau of Standards.

Dishwashers

The FEA determined the efficiency improvement target given in Table 3.2 on the basis of the following design improvements.

Table 3.7. Dishwasher Design Options to Improve Efficiency

Design option	Production-weighted energy savings (%)
Add optional hot dry	3.0
Eliminate one rinse cycle	5.6
Change geometry	7.1
Improve fill controls	3.9
Total	20

If the water heater efficiency is fully taken into account, the efficiency figures change from the values in Table 3.2.

Table 3.8. Dishwasher Efficiency, Taking into Account Water Heater Efficiency, 1972

Dishwasher used in conjunction with	End use energy efficiency (loads/kWhr)	Prime source energy efficiency (loads/kWhr)
Electric hot water heaters	0.231	0.069
Gas-fired hot water heaters	0.136	0.112
Oil-fired hot water heaters	0.142	0.116

The representative annual use given by FEA is 416 loads per year.

In a survey of 35 metered dishwashers, the average energy use was 0.502 and 0.934 kilowatt hours per unit per day for August and September 1976 respectively.

Sources: U.S. National Archives, Library of Congress, Federal Register, Vol. 42, No. 136, Washington, D.C., July 15, 1977, pp. 36618 through 36670; Federal Register, Vol. 42, No. 152, Washington, D.C., August 8, 1977, pp. 39964 through 39969; Midwest Research Institute, Patterns of Energy Use by Electrical Appliances Study, Kansas City, Mo., December 10, 1976, p. 31.

Freezers

The FEA determined the efficiency improvement target given in Table 3.2 on the basis of the following design improvements.

Table 3.9. Household Freezer Design Options to Improve Efficiency

Design option	Production-weighted energy savings (%)
Improve compressor motor efficiency	9
Improve insulation	11
Provide on-off switch for anti-sweat heaters	3
Total	23[a]

[a] The production-weighted energy savings of 23% corresponds to an efficiency improvement of 30%.

Tables 3.10 to 3.13 provide a statistical summary of the performance characteristics of household freezers manufactured in 1976.

Sources: U.S. National Archives, Library of Congress, Federal Register, Vol. 42, No. 136, Washington, D.C., July 15, 1977, pp. 36618 through 36670;

Table 3.10. Household Freezer Performance Characteristics 1976[a]

Rated capacity category (ft^3)	Upright models (manual defrost)			Upright models (automatic defrost)			Chest models[b] (manual defrost)		
	Capacity range of units shipped (ft^3)	PF[c] range	Range of energy use $\left(\frac{\text{kWhr}}{\text{month}}\right)$	Capacity range of units shipped (ft^3)	PF[c] range	Range of energy use $\left(\frac{\text{kWhr}}{\text{month}}\right)$	Capacity range of units shipped (ft^3)	PF[c] range	Range of energy use $\left(\frac{\text{kWhr}}{\text{month}}\right)$
Under 8.4	4.5-6.0	3.18-3.10	59-68				5.3-8.4	2.61-5.76	37-69
8.5-10.4	9.0-10.4	3.75-4.16	72-75				9.0-10.3	3.58-4.48	69-78
10.5-12.4	11.3-12.0	3.32-4.34	83-110				11.0-12.0	4.24-4.34	76-85
12.5-14.4	12.9-14.4	4.17-6.55	60-95	13.2	3.09	128			
14.5-15.4	14.8-15.1	4.48-6.66	68-99	15.3	2.87-4.64	99-160	14.8-15.3	4.41-5.60	82-104
15.5-17.4	15.6-17.1	3.53-6.66	88-136	15.6-17.4	2.80-4.34	116-169	15.5	5.05	92
17.5-19.4	18.0-19.2	4.66-7.06	79-116	18.7	3.92	143	18.1-19.0	4.60-5.46	100-124
19.5-21.4	20.0-21.2	4.97-7.48	83-122	19.5-20.2	3.30-4.07	149-178	20.1-20.8	5.16-6.24	100-118
21.5-23.4	23.3	5.34	131	21.9	3.30	199	23.0-23.2	5.02-6.57	105-138
Over 23.5	27.4-31.1	5.49-6.85	120-170	30.4	3.72	245	24.7-28.0	5.25-6.84	114-160

[a] See Note 8 of the User's Guide for an explanation of the terms and the methodology used to derive them.

[b] No automatic defrost models were shipped.

[c] PF = Performance Factor in units of ft^3/kWhr/day. This Performance Factor is not identical to the Energy Factor promulgated by FEA in the Federal Register (Vol. 42, No. 178, 46141, September 14, 1977). The FEA, in order to allow direct comparisons to refrigerators and refrigerator-freezers, multiplied the ft^3 capacity by 1.73 to compensate for the lower temperature in freezers. To obtain the equivalent FEA Energy Factor, the PF must be multiplied by 1.73.

Source: Association of Home Appliance Manufacturers, 1977 Directory of Certified Refrigerators and Freezers, Chicago, Ill., June 1977.

Table 3.11. Automatic Defrost Household Freezer Performance Characteristics, 1976[a]

Rated capacity category (ft^3)	Midpoint of manufactured capacity range (ft^3)	Maximum error of midpoint (%)	Adjusted PF range (ft^3/kWh/day)	Adjusted PF midpoint (ft^3/kWh/day)	Adjusted PF′ midpoint ($ft^3/10^3$Btu/day)	Maximum error of PF and PF′ midpoints (%)	Maximum error in energy use (%)
Under 8.4							
8.5-10.4							
10.5-12.4							
12.5-14.4	13.20	0.0	3.09	3.09	0.272	0.0	0.0
14.5-15.4	15.30	0.0	2.87-4.64	3.76	0.330	30.8	23.6
15.5-17.4	16.50	5.8	2.93-4.27	3.60	0.317	22.9	18.6
17.5-19.4	18.70	0.0	3.92	3.92	0.345	0.0	0.0
19.5-21.4	19.85	1.8	3.35-4.00	3.68	0.323	9.7	8.8
Over 21.5	26.15	19.41	3.20-3.94	3.57	0.314	11.6	10.4

Table 3.12. Manual Defrost Household Freezer Performance Characteristics, 1976[a]

Rated capacity category (ft^3)	Midpoint of manufactured capacity range (ft^3)	Maximum error of midpoint (%)	Adjusted PF range (ft^3/kWh/day)	Adjusted PF midpoint (ft^3/kWh/day)	Adjusted PF′ midpoint ($ft^3/10^3$Btu/day)	Maximum error of PF and PF′ midpoints (%)	Maximum error in energy use (%)	Manufacturers shipments 1976
Under 8.4	6.45	43.3	2.80-5.23	4.02	0.353	43.4	30.3	182,300
8.5-10.4	9.70	7.8	3.73-4.22	3.98	0.350	6.6	6.2	114,000
10.5-12.4	11.50	4.5	3.14-4.54	3.84	0.338	22.3	18.2	65,700
12.5-14.4	13.65	20.8	4.31-6.83	5.57	0.490	29.2	22.6	
14.5-15.4	15.05	1.7	4.34-6.64	5.49	0.483	26.5	20.9	
15.5-17.4	16.30	5.16	3.60-5.56	4.58	0.403	27.2	21.4	
17.5-19.4	18.60	3.3	4.50-7.06	5.78	0.508	28.4	22.1	
19.5-21.4	20.6	3.0	5.07-7.45	6.26	0.550	23.5	19.0	
Over 21.5	27.05	17.6	4.7[illegible]-7.73	6.25	0.550	31.0	23.7	

[a] See Note 8 of the User's Guide for an explanation of the terms and the methodology used to derive them.

Sources: Association of Home Appliance Manufacturers, 1977 Directory of Certified Refrigerators and Freezers, Chicago, Ill., June 1977; U.S. Department of Commerce, Bureau of the Census, Current Industrial Reports - Major Household Appliances, Washington, D.C., June 1977.

Table 3.13. Household Freezer Performance Characteristics Aggregates, 1976

Rated capacity category (ft^3)	Mean of capacity range midpoints (ft^3)	Mean of PF midpoints (ft^3/kWhr/day)		Mean of adjusted PF′ midpoints ($ft^3/10^3$Btu/day)	Maximum error in energy use (%)		Manufacturers shipments 1976
		Adjusted	Unadjusted		Adjusted	Unadjusted	
All manual defrost models							
Under 12.5	8.39	3.96	3.96	0.348	17.5	42.7	362,000
12.5-15.4	14.93	5.50	5.52	0.483	21.1	22.9	
15.5-19.4	17.43	5.14	5.46	0.452	21.7	32.1	
Over 19.5	24.12	6.25	6.04	0.550	21.8	31.0	
All manual defrost	16.28	5.37	5.40	0.472	20.8	31.3	
All household freezers							
Under 12.5	8.39	3.96	3.96	0.348	17.5	42.7	362,000
12.5-15.4[b]	14.95	5.24	5.26	0.461	21.1	22.6	333,800
15.5-19.4[b]	17.45	4.96	5.22	0.436	19.8	28.1	380,100
Over 19.5[b]	24.04	5.84	5.67	0.513	19.8	29.3	406,700
All household freezers[b]	16.48	5.16	5.18	0.454	19.7	29.5	1,482,600

[a] See Note 8 of the User's Guide for an explanation of the terms and the methodology used to derive them.

[b] As no shipment figures for automatic defrost models are available by capacity ranges, it was assumed that the shipments were distributed evenly among the ranges and in proportion to the overall ratios of automatic to manual defrost freezers shipped.

Source: A. Neretin (ed.), Merchandising, Vol. 2, No. 3, Billboard Publications, New York, March 1977, p. 95; Association of Home Appliance Manufacturers, 1977 Directory of Certified Refrigerators and Freezers, Chicago, Ill., June 1977; U.S. Department of Commerce, Bureau of the Census, Current Industrial Reports - Major Household Appliances, Washington, D.C., June 1977.

Furnaces

Very little substantive data is available on the actual field performance of central furnace heating systems. Assuming correct installation and maintenance, the following are considered representative values of the seasonal performance.

Table 3.14. Central Furnace Heating Systems Representative Seasonal Performance

System	Seasonal performance end use efficiency (%)
Gas	53–64
Oil	52–64
Electric	81–98

Source: Gordian Associates, Inc., Heat Pump Technology — A Survey of Technical Developments, Market Propsects and Research Needs, Energy Research and Development Administration, New York, July 1977; Gordian Associates, Inc., Evaluation of the Air-to-Air Heat Pump for Residential Space Heating, Federal Energy Administration, New York, October 27, 1975; E. C. Hise and A. S. Holman, Heat Balance and Efficiency Measurements of Central, Forced-Air, Residential Gas Furnaces, ORNL-NSF-EP-88, Oak Ridge National Laboratory, Oak Ridge, Tenn., October 1975.

Home Heating Equipment (Excluding Furnaces)

The FEA determined the efficiency improvement target in Table 3.2 on the basis of the following design improvements.

Table 3.15. Vented Home Heating Equipment Design Options to Improve Efficiency

Design options	Production-weighted energy savings (%)	
	gas heaters	oil heaters
Improved heat transfer	7.6	5.0
Flue damper	3.5	3.3
Electric ignition	1.2	
Power burner		2.2
Total	12	10

The efficiency of unvented home heating equipment is considered to be 100% for electric systems and 92% for gas systems. The 8% loss for gas heaters is due to the removal of uncondensed water vapor through air changes.

The user should be aware that very little substantive data exist on the efficiency of home heating equipment and that practically all published values are of a somewhat speculative nature and are subject to limitation in their applicability. The efficiency of heating systems is, to a large extent, determined by the outside temperature ranges (the amount of cycling) and various installation parameters. Thus, the seasonal operating efficiency can vary from very low values to values approaching the nominal steady state operating efficiency of 60–70%. In the past, numerous discrepancies have been found between the theoretical operating values and the actual field measurements but very little work has been done to determine their source.

Sources: U.S. National Archives, Library of Congress, Federal Register, Vol. 42, No. 136, Washington, D.C., July 15, 1977, p. 36652; E. C. Hise, Seasonal Fuel Utilization Efficiency of Residential Heating Systems, ORNL-NSF-EP-22, Oak Ridge National Laboratory, Oak Ridge, Tenn., April 1975.

Refrigerators and Refrigerator-Freezers

The FEA determined the efficiency improvement target given in Table 3.2 on the basis of the following design improvements.

Table 3.16. Refrigerator and Refrigerator-Freezer Design Options to Improve Efficiency

Design option	Production-weighted energy savings (%)
Improve compressor motor efficiency	9
Eliminate condenser fan motor	1
Improve insulation	12
Improve door seals and cabinet throat design	4
Provide on-off switch for a anti-sweat heaters	6
Total	32[a]

[a] The production-weighted energy savings of 32% corresponds to an efficiency improvement of 47%.

Tables 3.17 to 3.20 provide a statistical summary of the performance characteristics of units manufactured in 1976. Table 3.21 provides information on the actual operating efficiency in 1972.

Sources: U.S. National Archives, Library of Congress, Federal Register, Vol. 42, No. 136, Washington, D.C., July 15, 1977, pp. 36618 through 36670.

Table 3.17. Household Refrigerator and Refrigerator-Freezer Performance Characteristics, 1976[a]

Rated capacity category (ft^3)	Refrigerators (manual defrost)			Refrigerator-freezers (partial automatic defrost)			Refrigerator-freezers (automatic defrost)		
	Capacity range of units shipped (ft^3)	PF[b] range (ft^3/kWhr/day)	Range of energy use $\left(\frac{\text{kWhr}}{\text{month}}\right)$	Capacity range of units shipped (ft^3)	PF[b] range (ft^3/kWhr/day)	Range of energy use $\left(\frac{\text{kWhr}}{\text{month}}\right)$	Capacity range of units shipped (ft^3)	PF[b] range (ft^3/kWhr/day)	Range of energy use $\left(\frac{\text{kWhr}}{\text{month}}\right)$
Under 6.4	1.5-6.0	1.0-5.14	28-48						
6.5-8.4	8.4	5.36	47						
8.5-9.4									
9.5-10.4	9.5-10.0	5.08-6.20	46-59						
10.5-11.4	11.3	3.32	102				11.0	4.34	76
11.5-12.4	11.5-12.2	6.1-7.34	47-59	11.6-12.3	4.72-7.63	48-95	12.0	3.13	115
12.5-13.4	12.5-13.0	7.21-8.60	45-52	13.1-13.2	3.61-3.63	109	12.9-13.1	2.93-3.45	114-132
13.5-14.4	13.7-14.0	5.75-9.79	42-73	13.6-14.4	3.58-8.29	51-119	13.9-14.2	2.92-4.90	87-144
14.5-15.4				14.6-15.0	4.61-5.62	80-95	15.0-15.2	2.87-3.91	116-157
15.5-16.4				15.6	8.67-9.18	51-54	15.5-16.0	3.14-5.71	84-149
16.5-17.4				17.0	6.46	79	16.2-17.1	3.13-5.49	94-159
17.5-18.4							17.6-18.4	3.32-5.93	89-159
18.5-19.4							18.5-19.3	3.00-5.61	101-191
Over 19.5							19.6-27.8	3.32-5.59	114-212

[a] See Note 8 of the User's Guide for an explanation of the terms and the methodology used to derive them.

[b] This is not identical to the Energy Factor promulgated by FEA in Vol. 42, No. 178, 46140-46145, Sept. 14, 1977, of the Federal Register. Also see Note 8 of the User's Guide.

Source: Association of Home Appliance Manufacturers, 1977 Directory of Certified Refrigerators and Freezers, Chicago, Ill., June 1977.

Table 3.18. Household Refrigerator-Freezer Performance Characteristics (automatic defrost), 1976[a]

Rated capacity category (ft³)	Midpoint of manufactured capacity range (ft³)	Maximum error of midpoint (%)	Adjusted PF[b] range (ft³/kWhr/day)	Adjusted PF[b] midpoint (ft³/kWhr/day)	Adjusted PF′[b] midpoint (ft³/10³ Btu/day)	Maximum error of PF[b] and PF′ midpoints (%)	Maximum error in energy use (%)	Manufacturers shipments, 1976
Under 8.5								
8.5-12.4	11.5	4.5	3.00-4.54	3.77	0.331	25.7	20.4	
12.5-14.4	13.55	5.0	2.82-4.67	3.75	0.329	32.8	24.7	
14.5-15.4	15.10	0.7	2.89-3.91	3.40	0.299	17.6	15.0	
15.5-16.4	15.75	1.6	3.17-5.63	4.40	0.387	38.8	28.0	
16.5-17.4	16.65	2.8	3.14-5.31	4.23	0.371	34.6	25.7	
17.5-18.4	18.00	2.3	3.40-6.07	4.74	0.416	39.3	28.2	259,000
18.5-19.4	18.90	2.2	2.97-5.61	4.29	0.377	44.4	30.8	497,700
Over 19.5	23.70	20.9	3.35-6.24	4.80	0.422	43.1	30.1	1,002,100

Table 3.19. Household Refrigerator and Refrigerator-Freezer Performance Characteristics (partial automatic and manual defrost), 1976[a]

Rated capacity category (ft³)	Midpoint of manufactured capacity range (ft³)	Maximum error of midpoint (%)	Adjusted PF[b] range (ft³/kWhr/day)	Adjusted PF[b] midpoint (ft³/kWhr/day)	Adjusted PF′[b] midpoint (ft³/10³ Btu/day)	Maximum error of PF[b] and PF′ midpoints (%)	Maximum error in energy use (%)	Manufacturers shipments, 1976
Under 8.5	4.95	230.0	3.09-5.30	4.20	0.369	35.8	26.3	117,400
8.5-12.4	10.90	14.7	3.21-7.11	5.16	0.454	60.7	37.8	
12.5-14.4	13.45	7.6	3.39-9.61	6.50	0.572	91.7	47.8	
14.5-15.4	14.8	1.4	4.67-5.55	5.11	0.449	9.4	8.6	
15.5-16.4	15.6	0.0	8.67-9.18	8.93	0.785	2.9	2.9	
16.5-17.4	17.0	0.0	6.46	6.46	0.568	0.0	0.0	
17.5-18.4								
18.5-19.4								
Over 19.5								

[a] See Note 8 of the User's Guide for an explanation of the terms and the methodology used to derive them.

[b] This is not identical to the Energy Factor promulgated by FEA in Vol. 42, No. 178, 46140-46145, Sept. 14, 1977, of the Federal Register. Also see Note 8 of the User's Guide.

Source: Association of Home Appliance Manufacturers, 1977 Directory of Certified Refrigerators and Freezers, Chicago, Ill., June 1977; U.S. Department of Commerce, Bureau of the Census, Current Industrial Reports – Major Household Appliances, Washington, D.C., June 1977.

Table 3.20. Household Refrigerator and Refrigerator-Freezer Performance Characteristics Aggregates, 1976[a]

Rated capacity category (ft³)	Mean of capacity range midpoints (ft³)	Mean of PF[b] midpoints (ft³/kWhr/day)		Mean of adjusted PF′[b] midpoints (ft³/10³ Btu/day)	Maximum error in energy use (%)		Manufacturers shipments 1976
		Adjusted	Unadjusted		Adjusted	Unadjusted	
Under 12.5[c]	10.34	4.13	4.07	0.363	24.6	38.9	780,200
12.5-14.4[c]	13.52	4.36	4.53	0.383	29.2	36.7	837,100
14.5-16.4[c]	15.38	4.50	4.51	0.396	17.3	19.1	759,200
16.5-17.4[c]	16.77	4.78	4.86	0.421	18.1	21.4	738,600
17.5-19.4	18.59	4.43	4.41	0.389	30.0	32.5	756,700
Over 19.5	23.70	4.80	4.46	0.422	30.1	51.7	1,002,100
Total	16.67	4.55	4.48	0.400	25.5	34.9	4,873,900

[a] See Note 8 of the User's Guide for an explanation of the terms and the methodology used to derive them.

[b] This is not identical to the Energy Factor promulgated by FEA in Vol. 42, No. 178, 46140-46145, Sept. 14, 1977, of the Federal Register. Also see Note 8 of the User's Guide.

[c] The breakdown of manufacturers shipments among automatic, partial automatic, and manual defrost models by cubic foot capacity group is not known. In order to keep the maximum possible error within reasonable bounds while aggregating, it was necessary to assume that the overall ratio of fully automatic to not fully automatic defrost units shipped would also hold in the individual categories where a mix exists.

Source: A. Neretin (ed.), Merchandising, Vol. 2, No. 3, Billboard Publications, New York, March 1977, p. 95; Association of Home Appliance Manufacturers, 1977 Directory of Certified Refrigerators and Freezers, Chicago, Ill., June 1977; U.S. Department of Commerce, Bureau of the Census, Current Industrial Reports – Major Household Appliances, Washington, D.C., June 1977.

IN ADDITION TO THE PRECEDING DATA BASED ON LABORATORY TESTS, INFORMATION FROM ACTUAL FIELD MEASUREMENTS OF ENERGY USE IS AVAILABLE FROM LOAD SURVEYS PERFORMED BY UTILITY COMPANIES. THE TABLE BELOW SUMMARIZES THE RESULTS OF STUDIES CONDUCTED FROM JUNE 1971 TO JUNE 1972 OVER SEVERAL SECTIONS OF THE NATION.

Table 3.21. Frost-Free Refrigerator-Freezer Energy Use Study Summary

Rated capacity group (ft^3)	No. of units sampled	PF (ft^3/kWhr/day)
12–13	10	2.70
14–15	70	2.78
16–17	122	3.03
18–19	72	2.56
20–21	38	2.63
22–23	16	2.78
24–25	13	3.13

Source: Midwest Research Institute, Patterns of Energy Use by Electrical Appliances Study, MRI Project No. 4098-E, Kansas City, Mo., December 10, 1976.

Room Air Conditioners

The FEA determined the efficiency improvement target given in Table 3.2 on the basis of the following design improvements.

Table 3.22. Room Air Conditioner Design Options to Improve Efficiency

Design option	Production-weighted energy savings (%)
Install a switch to cycle fan with compressor	5
Improve fan motor efficiency	3
Improve compressor efficiency	5
Improve cycle efficiency	10
Total	23[a]

[a] The production-weighted energy savings of 23% corresponds to an efficiency improvement of 30%.

In cooperation with the FEA Energy Conservation Program for Appliances, the Association of Home Appliance Manufacturers (AHAM) conducted a survey of 14 major manufacturers and found the weighted energy efficiency ratio for room air conditioners in 1972 to be 6.51.

Converting the 0.644 PF from Table 3.27 yields an energy efficiency ratio (EER) of 7.32 representing errors of 12.5% and 11.1% of the true and calculated values respectively. As anticipated, this is significantly less than the stated maximum possible errors of 35% and 26% respectively.

Outside of giving an indication of the type of results to be expected from such calculations, the above results serve to point out another significant aspect of room air conditioner shipments (sales) in the time frame. If shipments were evenly distributed among the EER categories, the full shipment-weighted average would coincide with the midpoint of the weighted categories. The fact that the weighted midpoint mean is above the shipment-weighted mean indicates that consumers favored the lower efficiency models (with associated lower initial purchase costs) over the more expensive high efficiency models.

Sources: U.S. National Archives, Library of Congress, Federal Register, Vol. 42, No. 136, Washington, D.C., July 15, 1977, pp. 36618 through 36670.

Table 3.23. 115 V Room Air Conditioners Performance Characteristics, 1972[a]

Rated capacity (Btu/hr)	Midpoint of capacity range (Btu/hr)	EER range (Btu/Whr)	PF range midpoint	PF′ range midpoint	Maximum error of midpoint (%)	Manufacturers shipments 1972	Maximum error in energy use (%)
Under 5999	4,800	5.0-8.7	2.01	0.602	37.0	NA	52.4
6000-6999	6,350	4.9-7.7	1.85	0.554	28.6	NA	29.4
7000-7999	7,400	5.0-8.7	2.01	0.602	37.0	NA	34.3
8000-8999	8,400	5.8-9.9	2.30	0.690	35.3	501,862	32.4
9000-9999	9,350	6.4-11.0	2.55	0.765	35.9	89,115	31.4
10,000-10,999	10,250	6.6-12.2	2.75	0.826	42.4	248,291	33.0
11,000-12,999	11,600	6.6-9.4	2.34	0.703	21.2	244,309	23.9
13,000-14,999	13,900	9.7-10.5	2.96	0.888	4.1	NA	8.7
15,000-16,999							
17,000-19,999							
20,000-22,999							
23,000-25,999							
Over 26,000							

Table 3.24. Higher Voltage Room Air Conditioners Performance Characteristics, 1972[a]

Rated capacity (Btu/hr)	Midpoint of capacity range (Btu/hr)	EER range (Btu/Whr)	PF range midpoint	PF′ range midpoint	Maximum error of midpoint (%)	Manufacturers shipments 1972	Maximum error in energy use (%)
Under 5,999	5,200	6.8	1.99	0.598	0.0	NA	0.0
6,000–6,999	6,250	5.4–7.1	1.83	0.550	15.7	NA	18.3
7,000–6,999	7,400	6.4–7.4	2.02	0.607	7.8	NA	13.4
8,000–8,999	8,400	5.5–7.3	1.88	0.563	16.4	34,336	19.8
9,000–9,999	9,400	4.9–7.5	1.82	0.545	26.5	117,167	26.3
10,000–10,999	10,400	4.6–8.7	1.95	0.585	44.6	46,341	36.1
11,000–12,999	11,950	4.4–8.7	1.92	0.576	48.9	159,551	44.3
13,000–14,999	13,900	4.4–10.0	2.11	0.633	63.6	NA	48.5
15,000–16,999	15,950	4.8–9.0	2.02	0.607	43.8	176,102	38.7
17,000–19,999	18,350	5.5–10.0	2.27	0.681	40.9	402,816	39.3
20,000–22,999	21,250	5.7–8.0	2.01	0.602	20.2	230,841	24.1
23,000–25,999	24,300	5.5–9.1	2.14	0.642	32.7	237,175	31.7
Over 26,000	31,000	6.0–9.3	2.24	0.673	27.5	130,796	44.9

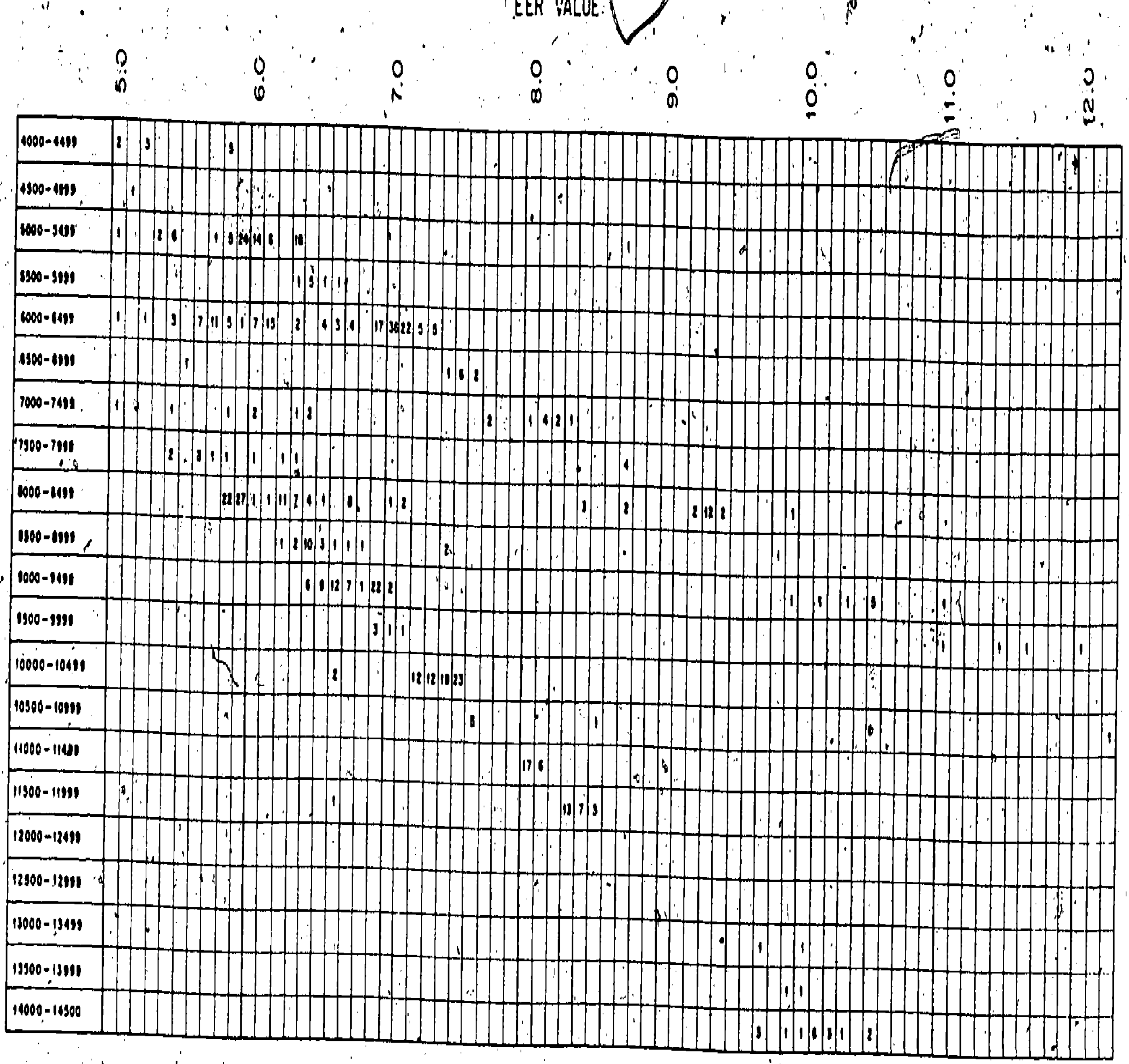
[a] See Note 7 of the User's Guide for an explanation of the calculation methodology and table headings.

NA — Not available

Sources: U.S. Department of Commerce, Bureau of the Census, Current Industrial Reports - Air-Conditioning and Refrigeration Equipment, Washington, D.C., August 1973; Association of Home Appliance Manufacturers, 1972 Directory of Certified Room Air Conditioners with Energy Efficiency Ratios, Chicago, Ill., May 1972.

Table 3.25. 115 V Room Air Conditioners, Number of Different Models Manufactured Per Capacity Group and EER Value, [illegible]

ORNL-DWG 77-18208



4000-4499	2 3 3
4500-4999	1
5000-5499	1 2 6 1 8 24 14 6 10 1
5500-5999	1 5 1 1 1
6000-6499	1 1 3 7 11 5 1 7 15 2 4 3 4 17 36 22 5 5
6500-6999	1 1 6 2
7000-7499	1 1 1 1 2 1 2 2 1 4 2 1
7500-7999	2 3 1 1 1 1 1 4
8000-8499	22 27 1 1 11 7 4 1 8 1 2 3 2 2 12 2 1
8500-8999	1 2 10 3 1 1 1 2 1
9000-9499	6 8 12 7 1 22 2 1 1 1 5 1
9500-9999	3 1 1 1 1 1 1
10000-10499	2 12 12 18 23
10500-10999	8 1 6 1
11000-11499	17 6
11500-11999	1 13 7 3
12000-12499	
12500-12999	
13000-13499	1 1
13500-13999	1 1
14000-14500	3 1 1 8 3 1 2

Source: Association of Home Appliance Manufacturers, 1972 Directory of Certified Room Air Conditioners With Energy Efficiency Ratios, Chicago, Ill., May 1972.

Table 3.26. All Room Air Conditioners Performance Characteristics, 1972

Rated capacity (Btu/hr)	Mean of midpoints of capacity ranges (Btu/hr)	Mean of PF range midpoints	Manufacturers shipments 1972	Maximum error in energy use (%)
Under 5,999	4,800	0.602	459,451	52.4
6,000-6,999	6,350	0.554	563,483	29.4
7,000-7,999	7,400	0.602	67,745	34.3
8,000-8,999	8,400	0.680	536,198	31.3
9,000-9,999	9,378	0.622	206,282	28.1
10,000-10,999	10,274	0.775	294,632	33.7
11,000-12,999	11,738	0.646	403,860	32.3
13,000-14,999	13,900	0.655	214,049	50.7
15,000-16,999	15,950	0.607	176,102	38.7
17,000-19,999	18,350	0.681	402,816	39.3
20,000-22,999	21,250	0.602	230,841	24.1
23,000-25,999	24,300	0.642	237,841	31.7
Over 26,000	31,000	0.673	130,756	44.9

Source: U.S. Department of Commerce, Bureau of the Census, Current Industrial Reports - Air-Conditioning and Refrigeration Equipment, Washington, D.C., August 1973; Association of Home Appliance Manufacturers, 1972 Directory of Certified Room Air Conditioners with Energy Efficiency Ratios, Chicago, Ill., May 1972.

Table 3.27. Room Air Conditioners Performance Characteristics Aggregates, 1972[a]

Rated capacity (Btu/hr)	Mean of midpoints of capacity ranges (Btu/hr)	Mean of PF range midpoints	Maximum error in energy use (%)	1972 manufacturers shipments
115 V models				
Under 7,000	5,350	0.598	71.1[b]	NA
7,000–7,999	7,400	0.602	37.0	NA
8,000–10,000	8,543	0.702	32.3	590,977
10,000–12,999	10,920	0.757	27.7	492,600
Over 13,000	13,900	0.888	8.7	NA
Higher voltage models				
Under 8,000	6,500	0.563	44.5	NA
8,000–9,999	9,173	0.549	25.0	151,503
10,000–12,999	11,601	0.578	42.6	205,892
13,000–14,999	13,900	0.633	48.5	NA
15,000–22,999	18,655	0.639	33.5	809,759
23,000 and over	26,681	0.654	36.7	367,931
8,000–12,999	10,572	0.567	35.3	357,395
Over 15,000	21,162	0.645	34.8	1,177,690
All room air conditioners				
Under 7,000	5,654	0.571	36.8	1,022,934
7,000–9,999	8,565	0.657	29.9	810,225
10,000–14,999	11,772	0.681	37.5	912,541
15,000–19,999	17,620	0.659	39.1	578,918
Over 20,000	24,587	0.636	32.0	598,772
All room air conditioners	12,333	0.644	35.0	3,923,390

[a] See Note 7 of the User's Guide for an explanation of the calculation methodology and table headings.

[b] This maximum error is extraordinarily large because no individual sales data exist for the subgroups.

NA – Not available.

Source: U.S. Department of Commerce, Bureau of the Census, Current Industrial Reports – Air-Conditioning and Refrigeration Equipment, Washington, D.C., August 1973; Association of Home Appliance Manufacturers, 1972 Directory of Certified Room Air Conditioners with Energy Efficiency Ratios, Chicago, Ill., May 1972.

Table 3.28. 115 V Room Air Conditioners Performance Characteristics, 1976[a]

Rated capacity (Btu/hr)	Midpoint of capacity range (Btu/hr)	EER range (Btu/Whr)	PF range midpoint	PF′ range midpoint	Maximum error of midpoint (%)	Manufacturers shipments 1976	Maximum error in energy use (%)
Under 5,999	4,900	5.4–9.1	2.12	0.637	34.3	492,264	53.8
6,000–6,999	6,400	5.6–10.7	2.39	0.717	45.5	NA	40.0
7,000–7,999	7,400	5.6–10.7	2.39	0.717	45.5	NA	40.0
8,000–8,999	8,300	5.6–10.5	2.36	0.708	43.7	202,837	35.3
9,000–9,999	9,450	6.4–11.6	2.64	0.791	40.6	81,670	35.3
10,000–10,999	10,300	7.0–11.6	2.73	0.818	32.9	138,693	28.5
11,000–12,999	11,800	7.6–9.6	2.52	0.756	13.2	132,547	19.7
13,000–14,999	13,500	9.2–10.2	2.84	0.853	5.4	NA	9.2
17,000–19,999							
20,000–22,999							
23,000–25,999							
Over 26,000							

Table 3.29. Higher Voltage Room Air Conditioners Performance Characteristics, 1976[a]

Rated capacity (Btu/hr)	Midpoint of capacity range (Btu/hr)	EER range (Btu/Whr)	PF range midpoint	PF′ range midpoint	Maximum error of midpoint (%)	Manufacturers shipments 1976	Maximum error in energy use (%)
Under 5,999							
6,000–6,999	6,500	7.8–8.0	2.32	0.695	1.3	NA	4.5
7,000–7,999	7,400	5.8–8.0	2.02	0.607	19.0	NA	22.6
8,000–8,999	8,450	5.6–8.2	2.02	0.607	23.2	27,617	25.5
8,000–9,999	9,400	4.9–8.2	1.92	0.576	33.7	73,470	30.8
10,00––10,999	10,400	5.0–8.5	1.98	0.593	35.0	25,821	31.0
11,000–12,999	11,900	5.1–8.7	2.02	0.607	35.3	147,073	36.4
13,000–14,999	13,950	5.4–9.2	2.14	0.642	35.2	NA	33.2
15,000–16,999	15,900	5.4–9.5	2.18	0.655	38.0	182,790	35.2
17,000–19,999	18,350	5.8–9.3	2.21	0.664	30.2	374,974	33.0
20,000–22,999	21,300	6.0–9.4	2.26	0.677	28.3	143,282	30.0
23,000–25,999	24,250	5.9–9.4	2.24	0.673	29.7	154,865	29.6
Over 26,000	30,600	5.9–8.1	2.05	0.615	18.6	72,316	36.2

[a] See Note 7 of the User's Guide for an explanation of the calculation methodology and table headings.

NA -- Not available.

Sources: U.S. Department of Commerce, Bureau of the Census, *Current Industrial Reports - Air-Conditioning and Refrigeration Equipment*, Washington, D.C., July 1977; Association of Home Appliance Manufacturers, *1977 Directory of Certified Room Air Conditioners*, Chicago, Ill., June 1977.

Table 3.30. All Room Air Conditioners Performance Characteristics, 1976

Rated capacity (Btu/hr)	Mean of midpoints of capacity ranges (Btu/hr)	Mean of PF range midpoints	Manufacturers shipments 1972	Maximum error in energy use (%)
Under 5,999	4,900	0.637	492,264	53.8
6,000-6,999	6,400	0.717	206,066	40.0
7,000-7,999	7,400	0.717	104,300	38.8
8,000-8,999	8,318	0.694	230,454	33.9
9,000-9,999	9,426	0.673	155,140	32.8
10,000-10,999	10,316	0.772	164,514	29.0
11,000-12,999	11,853	0.669	279,620	28.9
13,000-14,999	13,850	0.686	183,375	39.3
15,000-16,999	15,900	0.655	182,790	35.2
17,000-19,999	18,350	0.655	374,974	37.6
20,000-22,999	21,300	0.677	143,282	30.0
23,000-25,999	24,250	0.673	154,865	29.6
Over 26,000	30,600	0.615	72,316	36.2

Source: U.S. Department of Commerce, Bureau of the Census, Current Industrial Reports - Air-Conditioning and Refrigeration Equipment, Washington, D.C., July 1977; Association of Home Appliance Manufacturers, 1977 Directory of Certified Room Air Conditioners, Chicago, Ill., June 1977.

Table 3.31. Room Air Conditioners Performance Characteristics Aggregates, 1976[a]

Rated capacity (Btu/hr)	Mean of midpoints of capacity ranges (Btu/hr)	Mean of PF range midpoints	Maximum error in energy use (%)	1972 manufacturers shipments
115 V models				
Under 7,000	5,400	0.708	79.4[b]	NA
7,000–7,999	7,400	0.717	40.0	NA
8,000–10,000	8,630	0.732	35.3	284,507
10,000–12,999	11,033	0.784	23.6	271,240
Over 13,000	13,500	0.853	9.2	NA
Higher voltage models				
Under 8,000	7,050	0.607	29.7	NA
8,000–9,999	9,140	0.583	29.4	101,087
10,000–12,999	11,676	0.605	35.6	172,894
13,000–14,999	13,950	0.642	33.2	NA
15,000–22,999	18,314	0.665	32.8	701,046
23,000 and over	26,271	0.650	32.1	227,181
All room air conditioners				
Under 7,000	5,343	0.663	49.0	698,330
7,000–9,999	8,474	0.690	34.3	489,894
10,000–14,999	12,033	0.696	32.3	627,509
15,000–19,999	17,547	0.655	36.9	557,764
Over 20,000	24,349	0.659	31.4	370,463
All room air conditioners	12,478	0.670	35.3	2,743,960

[a] See Note 7 of the User's Guide for an explanation of the calculation methodology and table headings.

[b] The maximum error is extraordinarily large because no individual sales data exist for the subgroups.

NA — Not available.

Source: U.S. Department of Commerce, Bureau of the Census, Current Industrial Reports — Air-Conditioning and Refrigeration Equipment, Washington, D.C., July 1977; Association of Home Appliance Manufacturers, 1977 Directory of Certified Room Air Conditioners, Chicago, Ill., June 1977.

The EERs and Btu/hr ratings presented in the preceding tables are insufficient on their own for energy use calculations as they are derived from operation at 95°F outside temperature at rated capacity. In normal operation the outside temperature will vary and the compressor will cycle. How the EER value will vary with outside temperature depends on the type of fan operation during the cycling. At present very few room air conditioners are equipped with automatic fans.

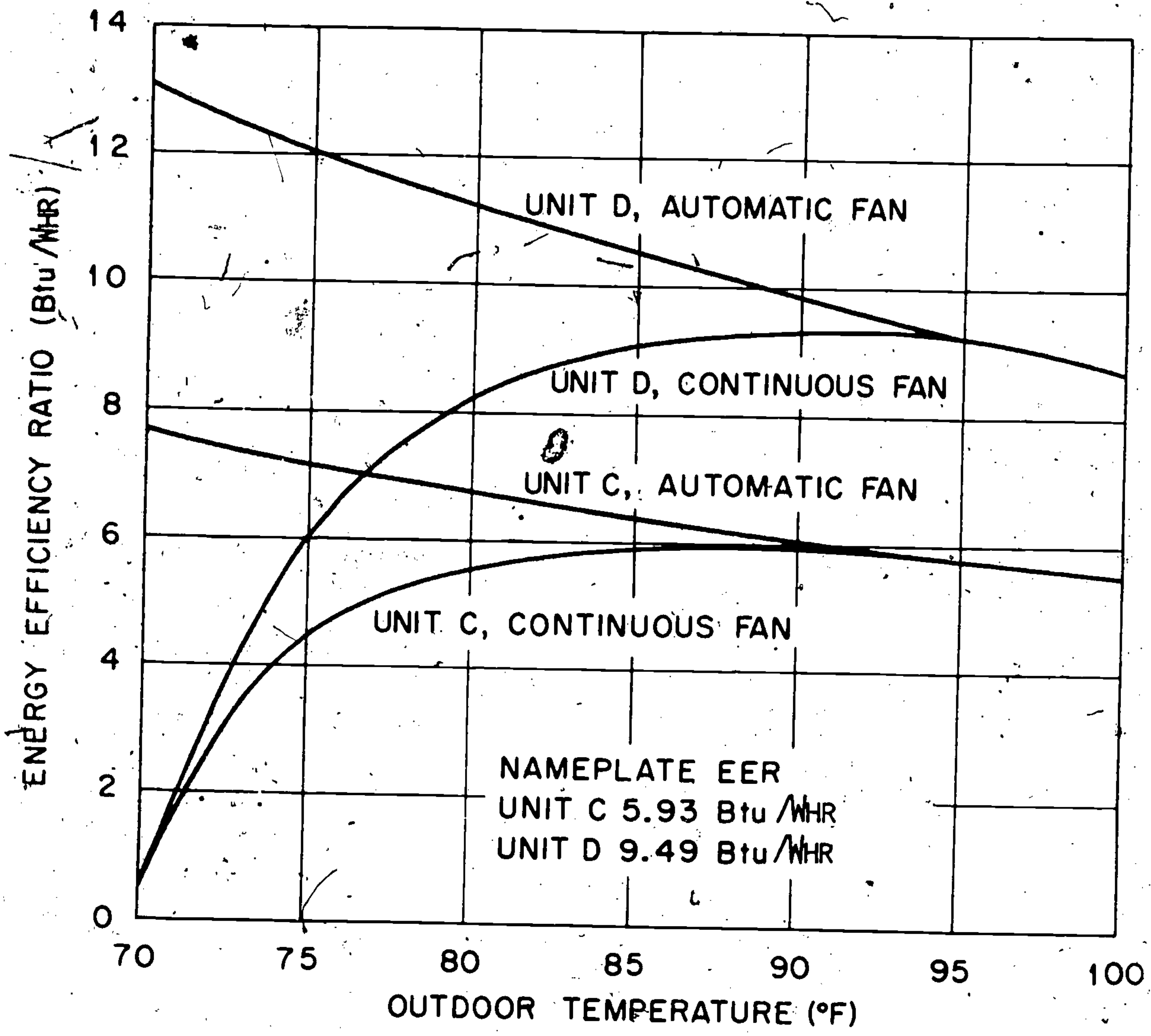


Figure 3.1. Calculated EER Variation with Outside Temperature for Two Representative Room Air Conditioners (indoor conditions: 78°F and 50% relative humidity — 40% outdoor relative humidity — house construction is that typical of houses built in the early 1960s).

Source: D. A. Pilati, Room Air-Conditioner Lifetime Cost Considerations: Annual Operating Hours and Efficiencies, ORNL-NSF-EP-85, Oak Ridge National Laboratory, Oak Ridge, Tenn., October 1975, p. 12.

The Federal Energy Administration specifies an annual average-use cycle of 750 hours of compressor operation based on the hours of air conditioner operation in 138 cities. For more detailed data, the maps below may be used.

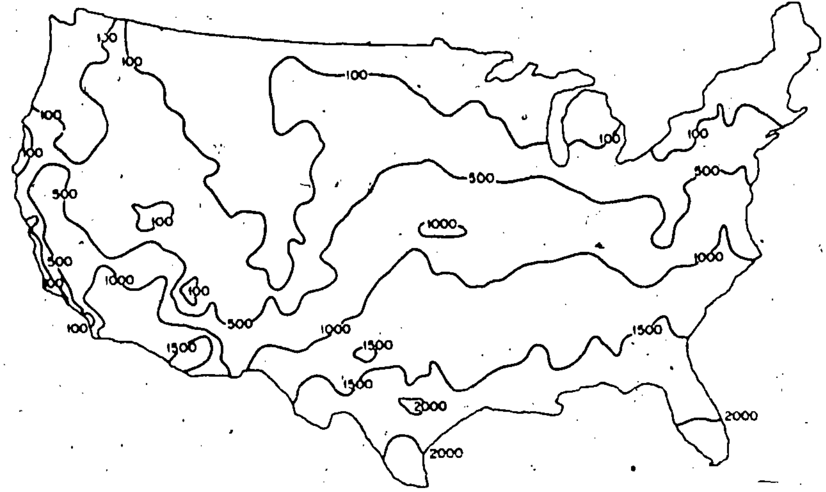


Figure 3.2. Annual Air Conditioner Compressor-Operating Hours Needed for Homes that are also Naturally Ventilated to Maintain Indoor Temperature at 78°F. (House construction typical for the early 1960s is assumed.)

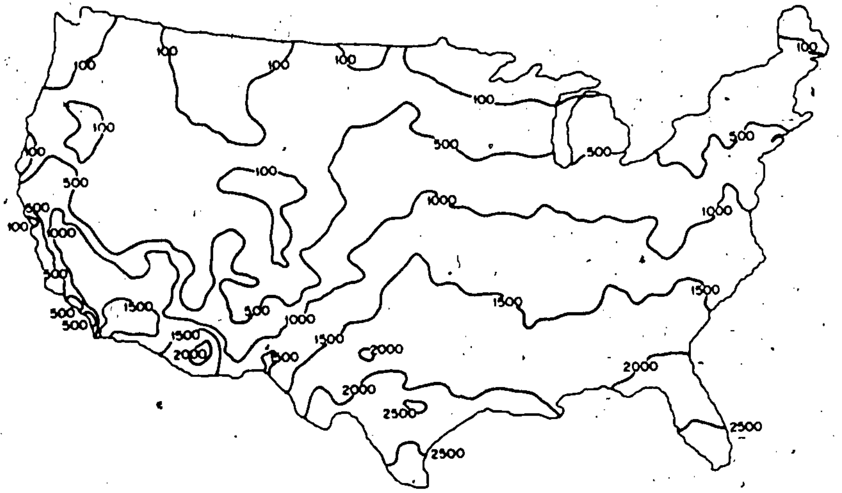


Figure 3.3. Annual Air Conditioner Compressor-Operating Hours for Homes that are not Naturally Ventilated to Maintain Indoor Temperature at 78°F. (Hours construction typical for the early 1960s is assumed.)

Source: D. A. Pilati, Room Air-Conditioner Lifetime Cost Considerations: Annual Operating Hours and Efficiencies, ORNL-NSF-EP-85, Oak Ridge National Laboratory, Oak Ridge, Tenn., October 1975, pp. 5 and 6; Federal Energy Administration, Energy Conservation Program for Appliances, Federal Register, Vol. 42, No. 105, Washington, D. C., June 1, 1977, p. 27897.

Table 3.32. Calculated Seasonal EERs for Several Cities

City	Unit A (5.45)[a]		Unit B (9.22)[a]		Unit C (5.93)[a]		Unit D (9.49)[a]	
	Continuous fan	Automatic fan	Continuous fan	Automatic fan	Continuous fan	Automatic fan	Continuous fan	Automatic fan
Atlanta	5.2	6.0	8.3	10.5	5.8	6.6	8.8	10.9
Chicago	5.0	5.9	7.8	10.2	5.5	6.4	8.3	10.5
Dallas	5.1	5.8	8.1	10.0	5.6	6.3	8.6	10.3
Miami	5.3	6.0	8.5	10.5	5.9	6.6	9.0	10.8
Minneapolis	4.9	5.8	7.5	10.1	5.4	6.4	8.0	10.4
New Orleans	5.3	6.0	8.5	10.5	5.9	6.6	9.0	10.9
New York	5.2	6.0	8.3	10.4	5.8	6.5	8.8	10.7
Phoenix	4.9	5.7	7.6	9.7	5.4	6.2	8.1	10.0
San Diego	5.1	6.1	8.0	10.6	5.7	6.7	8.6	11.0
Topeka	5.0	5.9	7.8	10.2	5.5	6.5	8.3	10.5

[a] Nameplate EER for unit is given in parenthesis.

Unit A = low capacity, low efficiency

Unit B = low capacity, high efficiency

Unit C = high capacity, low efficiency

Unit D = high capacity, high efficiency

Source: D. A. Pilati, Room Air-Conditioner Lifetime Cost Considerations: Annual Operation Hours and Efficiencies, ORNL-NSF-EP-85, Oak Ridge National Laboratory, Oak Ridge, Tenn., October 1975, p. 14.

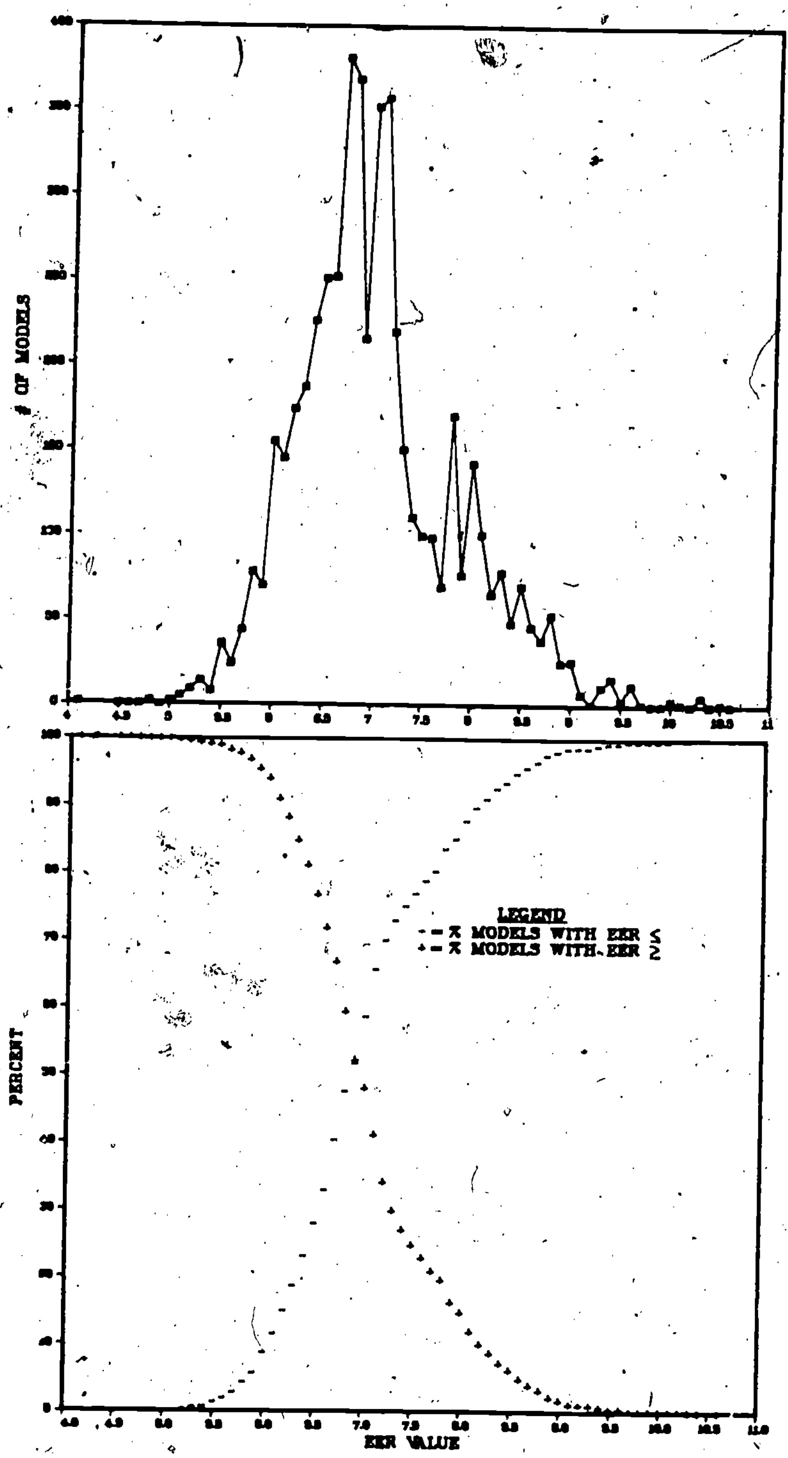


Figure 3.4. Unitary Air Conditioners with Cooling Coil Separated From Air-Cooled Condensing Unit, Models Manufactured vs. EER Rating, 1976.

Source: From unpublished data furnished by the Air-Conditioning and Refrigeration Institute, Arlington, Va.

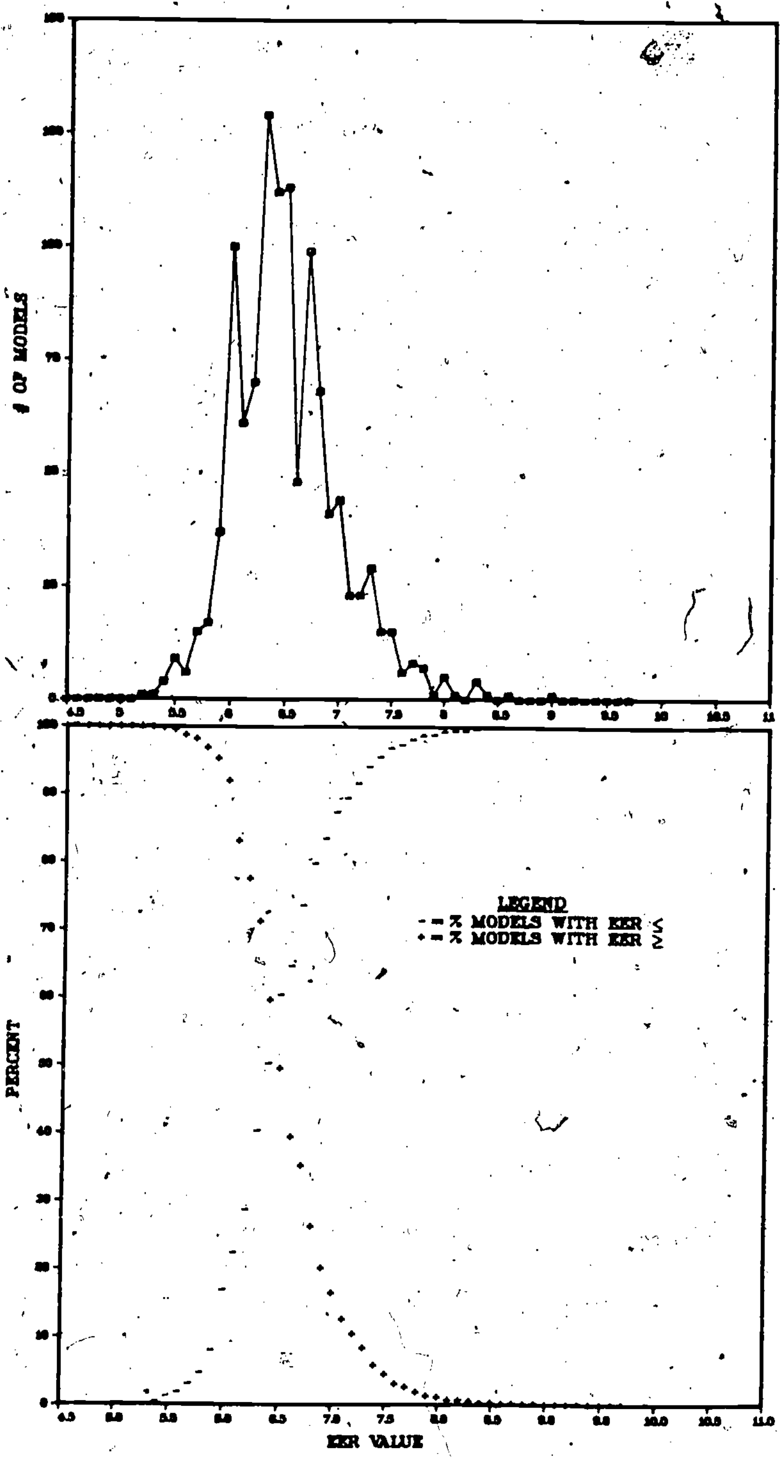


Figure 3.5. Single-Package, Air Cooled Unitary Air Conditioners, Models Manufactured vs. EER Rating, 1976.

Source: From unpublished data furnished by the Air-Conditioning and Refrigeration Institute, Arlington, Va.

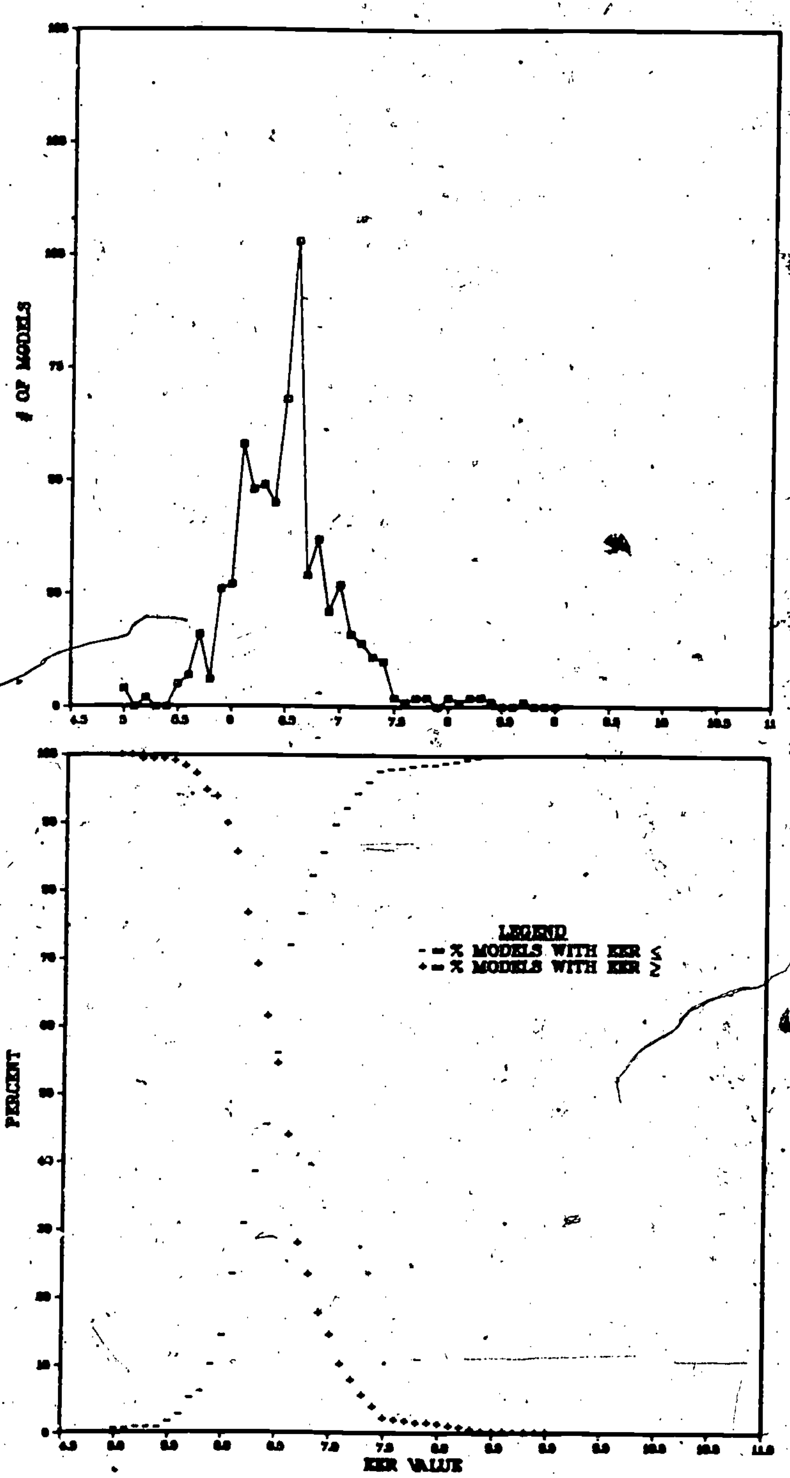


Figure 3.6. Unitary Air-Source Heat Pumps in Cooling Mode, Models Manufactured vs. EER Rating, 1976.

Source: From unpublished data furnished by the Air-Conditioning and Refrigeration Institute, Arlington, Va.

Table 3.33. Single Package Air Cooled Heat Pump Characteristics, 1976[a]

Rated cooling capacity category[b] (Btu/hr)	Number of units shipped	Cooling mode[c]			High-temperature heating[d]			Low-temperature heating[e]		
		Capacity range of units shipped (Btu/hr)	EER[f] range of units shipped (Btu/Whr)	Range of power use (watts)	Capacity range of units shippped (Btu/hr)	COP[g] range of units shipped	Range of power use (watts)	Capacity range of units shipped (Btu/hr)	COP[g] range of units shipped	Range of power use (watts)
16,500–21,900	1,834	17,000–21,000	6.1	2,790–3,440	18,000–21,000	1.9–2.0	2,780–3,080	12,000–12,500	1.5–1.6	2,290–2,350
22,000–26,900	16,284	22,000–26,000	5.2–7.7	3,120–4,230	21,000–27,000	1.8–2.5	2,390–3,750	10,500–16,000	1.2–1.8	2,160–3,180
27,000–32,900	17,997	27,000–32,000	5.5–7.6	3,620–4,910	25,000–34,500	1.9–3.2	2,750–4,270	14,000–20,500	1.2–1.8	2,280–3,710
33,000–38,900	31,230	33,000–38,000	5.6–7.2	4,870–6,270	34,000–41,000	1.9–2.7	4,060–5,250	18,500–26,000	1.2–1.9	3,240–4,770
39,000–43,900	12,605	39,000–43,000	5.9–7.8	5,510–6,780	40,000–49,000	2.2–2.8	4,850–5,990	21,000–29,000	1.6–1.8	3,850–5,130
44,000–53,900	12,054	44,000–53,000	5.6–7.9	6,200–7,860	47,000–54,000	2.2–2.8	5,530–6,630	24,000–31,000	1.4–1.9	4,170–6,180
54,000–64,900	11,016	55,000–63,000	5.6–8.3	7,110–9,820	52,000–65,000	2.4–2.8	6,100–7,940	29,000–39,000	1.4–1.9	4,720–6,730
65,000–96,900	3,249	65,000–95,000	7.0–8.5	8,670–13,570	66,000–100,000	2.4–3.0	7,440–12,220	37,500–58,000	1.5–2.0	6,110–11,340
Over 97,000	1,560	97,000–120,000	6.9–8.0	12,440–17,390	104,000–132,000	2.4–2.9	10,890–14,890	57,000–74,000	1.4–2.1	8,360–15,500

[a] See Note 9 of the User's Guide for a further explanation of the terms and methodologies.

[b] As heat pumps are usually sized for an application by their cooling capacity, all data are presented in relation to their cooling capacity category.

[c] Cooling from 95°F outdoor to 80°F indoor coil air temperatures (dry bulb).

[d] Heating from 47°F outdoor to 70°F indoor coil air temperatures (dry bulb).

[e] Heating from 17°F outdoor to 70°F indoor coil air temperatures (dry bulb).

[f] The Energy Efficiency Ratio is the ratio of the cooling capacity to the power input.

[g] The Coefficient of Performance is the ratio of the total heat output excluding supplementary heating coils, to the total electrical input. This is identical to the Performance Factor.

Source: Air-Conditioning and Refrigeration Institute, Directory of Certified Unitary Heat Pumps, Arlington, Va., 1977, pp. 82–118; Air-Conditioning and Refrigeration Institute, unpublished data, Arlington, Va.

Table 3.34. Single Package Air Cooled Heat Pump Performance Characteristics, Cooling Mode, 1976[a]

Rated cooling capacity category[b] (Btu/hr)	Midpoint of manufactured capacity range (Btu/hr)	Maximum error of midpoint (%)	Midpoint of PF (COP) range		Midpoint of PER range	Maximum-error in energy use (%)	
			Adjusted	Unadjusted		Adjusted	Unadjusted
16,500–21,900	19,000	11.8	1.81	1.79	0.542	10.5	11.8
22,000–26,900	24,000	9.1	2.06	1.89	0.617	9.7	30.2
27,000–32,900	29,500	9.3	2.08	1.92	0.623	15.1	26.8
33,000–38,900	35,500	7.6	1.90	1.88	0.570	12.7	21.0
39,000–43,900	41,000	5.1	1.98	2.01	0.593	10.3	19.7
44,000–53,900	48,500	10.2	2.05	1.98	0.615	11.7	29.2
54,000–64,900	59,000	7.3	1.95	2.04	0.584	9.6	28.1
65,000–96,900	80,000	23.1	2.22	2.27	0.665	22.1	35.0
Over 97,000	108,500	11.9	2.09	2.18	0.627	16.6	20.1

[a] See Note 9 of the User's Guide for an explanation of the terms and methodologies.

[b] As heat pumps are usually sized for an application by their cooling capacity, all data are presented by the cooling capacity categories.

Source: Air-Conditioning and Refrigeration Institute, Directory of Certified Unitary Heat Pumps, Arlington, Va., 1977, pp. 82–118.

Table 3.35. Single Package Air Cooled Heat Pump Performance Aggregate Characteristics for the Cooling Mode, 1976[a]

Rated cooling capacity category[b] (Btu/hr)	Mean of midpoints of manufactured capacity ranges (Btu/hr)	Mean of midpoints of PF (COP) ranges		Mean of midpoints of PF′ ranges	Maximum error in energy use (%)	
		Adjusted	Unadjusted		Adjusted	Unadjusted
16,500–32,900	26,487	2.06	1.90	0.617	12.6	27.5
33,000–38,900	35,500	1.90	1.88 ✓	0.570	12.7	21.0
39,000–64,900	49,092	1.99	2.01	0.597	10.5	25.8
Over 65,000	87,623	2.17	2.24	0.649	19.8	28.6
All units	39,303	2.00	1.97	0.599	12.4	25.9

[a] See Note 9 of the User's Guide for an explanation of the terms and methodologies.

[b] As heat pumps are usually sized for an application by their cooling capacity, all data are presented by the cooling capacity categories.

Source: Air-Conditioning and Refrigeration Institute, Directory of Certified Unitary Heat Pumps, Arlington, Va., 1977, pp. 82–118.

Table 3.36. Single Package Air Cooled Heat Pump Characteristics, High-Temperature Heating Mode, 1976[a]

Rated cooling capacity category[b] (Btu/hr)	Midpoint of manufactured capacity range (Btu/hr)	Maximum error of midpoint (%)	Midpoint of PF (COP) range		Midpoint of PF′ range	Maximum error in energy use (%)	
			Adjusted	Unadjusted		Adjusted	Unadjusted
16,500–21,900	19,500	8.3	1.96	1.95	0.588	5.1	11.1
22,000–26,900	24,000	14.3	2.42	2.15	0.725	22.2	32.9
27,000–32,900	29,750	19.0	2.61	2.55	0.783	21.5	49.3
33,000–38,900	37,500	10.3	2.41	2.30	0.722	12.7	29.5
39,000–43,900	44,500	11.3	2.44	2.50	0.731	10.5	24.6
44,000–53,900	50,500	7.4	2.46	2.50	0.737	9.2	20.3
54,000–64,900	58,500	12.5	2.49	2.60	0.746	13.1	21.2
65,000–96,900	83,000	25.8	2.63	2.70	0.789	24.3	39.7
Over 97,000	118,000	13.5	2.75	2.65	0.825	15.6	24.2

[a] Heating from 47°F outdoor to 70°F indoor coil air temperatures (dry bulb). See Note 9 of the User's Guide for an explanation of the terms and methodologies.

[b] As heat pumps are usually sized for an application by their cooling capacity, all data are presented by the cooling capacity categories.

Source: Air-Conditioning and Refrigeration Institute, Directory of Certified Unitary Heat Pumps, Arlington, Va., 1977, pp. 82–118.

Table 3.37. Single-Package Air Cooled Heat Pump Aggregate Characteristics for High-Temperature Heating Mode, 1976[a]

Rated cooling capacity category[b] (Btu/hr)	Mean of midpoints of manufactured capacity ranges (Btu/hr)	Mean of midpoints of PF (COP) ranges		Mean of midpoints of PF´ ranges	Maximum error in energy use (%)	
		Adjusted	Unadjusted		Adjusted	Unadjusted
16,500–32,900	26,637	2.50	2.35	0.749	20.9	39.5
33,000–38,900	37,500	2.41	2.30	0.722	12.7	29.5
39,000–64,900	51,632	2.46	2.54	0.738	10.9	21.9
Over 65,000	94,354	2.68	2.68	0.803	20.7	32.9
All units	40,814	2.47	2.44	0.741	14.3	28.7

[a] Heating from 47°F outdoor to 70°F indoor coil air temperatures (dry bulb). See Note 9 of the User's Guide for an explanation of the terms and methodologies.

[b] As heat pumps are usually sized for an application by their cooling capacity, all data are presented by the cooling capacity categories.

Source: Air-Conditioning and Refrigeration Institute, <u>Directory of Certified Unitary Heat Pumps</u>, Arlington, Va., 1977, pp. 82–118.

Table 3.38. Single Package Air Cooled Heat Pump Performance Characteristics, Low-Temperature Heating Mode, 1976[a]

Rated cooling capacity category[b] (Btu/hr)	Midpoint of manufactured capacity range (Btu/hr)	Maximum error of midpoint (%)	Midpoint of PF (COP) range		Midpoint of PF′ range	Maximum error in energy use (%)	
			Adjusted	Unadjusted		Adjusted	Unadjusted
16,500–21,900	12,250	2.1	1.55	1.55	0.465	1.3	5.4
22,000–26,900	13,250	26.2	1.51	1.50	0.453	19.2	51.4
27,000–32,900	17,250	23.2	1.79	1.50	0.537	24.0	47.9
33,000–38,900	22,250	20.3	1.69	1.55	0.507	18.9	47.4
39,000–43,900	25,000	19.0	1.67	1.70	0.500	14.1	26.1
44,000–53,900	27,500	14.6	1.63	1.65	0.488	19.4	31.9
54,000–64,900	34,000	17.2	1.80	1.65	0.539	17.5	35.0
65,000–96,900	47,750	[illegible].3	1.76	1.75	0.528	30.1	45.5
Over 97,000	65,500	14.9	1.77	1.75	0.531	29.9	37.9

[a] Heating from 47°F outdoor to 70°F indoor coil air temperatures (dry bulb). See Note 9 of the User's Guide for an explanation of the terms and methodologies.

[b] As heat pumps are usually sized for an application by their cooling capacity, all data are presented by the cooling capacity categories.

Source: Air-Conditioning and Refrigeration Institute, Directory of Certified Unitary Heat Pumps, Arlington, Va., 1977, pp. 82–118.

Table 3.39. Single Package Air Cooled Heat Pump Performance Aggregate Characteristics for Low-Temperature Heating Mode, 1976[a]

Rated cooling capacity category (Btu/hr)[b]	Mean of midpoints of manufactured capacity ranges (Btu/hr	Mean of midpoints of PF (COP) ranges		Mean of midpoints of PF ranges	Maximum error in energy use (%)	
		Adjusted	Unadjusted		Adjusted	Unadjusted
16,500–32,900	15,193	1.66	1.50	0.498	20.7	46.9
33,000–38,900	22,250	1.69	1.55	0.507	18.9	47.4
39,000–64,900	28,624	1.70	1.67	0.509	17.1	31.2
Over 65,000	53,508	1.76	1.75	0.529	30.0	42.4
All units	23,389	1.69	1.60	0.508	19.6	40.1

[a] Heating from 47°F outdoor to 70°F indoor coil air temperatures (dry bulb). See Note 9 of the User's Guide for an explanation of the terms and methodologies.

[b] As heat pumps are usually sized for an application by their cooling capacity, all data are presented by the cooling capacity categories.

Source: Air-Conditioning and Refrigeration Institute, Directory of Certified Unitary Heat Pumps, Arlington, Va., 1977, pp. 82–118.

Water Heaters

The FEA determined the efficiency improvement targets of Table 3.2 on the basis of the following design improvements.

Table 3.40. Water Heater Design Options to Improve Efficiency

Design option	Estimated production-weighted energy savings for water heater type[a] (%)		
	Electric	Gas-fired	Oil-fired
Increased or improved insulation	8.0	8.0	8.0
Reduced thermostat setting	6.0	5.0	5.0
Improved heat transfer		6.0	1.3
Reduced pilot rate		2.0	
Ignition improvements			2.0
Combustion and burner improvements			2.6
Heat trap	2.0	1.0	1.0
Total	15	20	19

[a] The values are not directly additive.

It should be noted that the efficiencies given in Table 3.2 are for end use energy. If a 30% electrical generation and distribution efficiency is included, the following percent efficiencies result.

Electric	24
Gas-fired	44
Oil-fired	46

The FEA states that the average hot water usage is 64.3 gallons per day, as determined by a survey of 50 gas and electric companies.

Sources: U.S. National Archives, Library of Congress, Federal Register, Vol. 42, No. 136, Washington, D.C., July 15, 1977, pp. 36618 through 36670; Federal Register, Vol. 42, No. 192, Washington, D.C., October 4, 1977, pp. 54110 through 54119.

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Chapter 4

Demographic Trends and Indicators

K. Haygood

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Chapter 4 supplies basic demographic data on the population of the United States and relates the data to building energy use. Employment and population trends and income figures are related to commercial and residential building energy use. The majority of the data came from the Bureau of the Census from their 1970 Census of Population and Housing and their Annual Housing Surveys.

The population of the United States has changed a great deal in the past 30 years. Though the population has increased at a slower rate in recent years, we still add more than 1,000,000 persons annually.* While the total number of persons will have an obvious affect on energy use, lifestyles also impact fuel consumption.

Due to more education, increased labor force participation, and higher marrying age, women may be delaying childbearing. If the large population of post World War II baby-boom females has children, there will be a large increase in energy demand that would not have been expected from watching birth rate and fertility trends from 1960 to 1976. The number of children born will relate to the time demands of careers and to the availability of one or more incomes to the family.

Figures show that the greatest region of population growth is the South. One explanation of this increase is that people move to where jobs are available. The national trend is toward more dependence on trucking (rather than rail) and many businesses have relocated to the

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*U.S. Department of Housing and Urban Development, Executive Office of the President, Committee on Community Development, 1976 Report on National Growth and Development, The Changing Issues for National Growth, the Domestic Council, Washington, D.C., February 1976, p. 18.

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South.* Smaller businesses not dependent on rail have opened up in the South, thus offering employment and causing more commercial and residential buildings to be built. The increased use of air conditioning in residential and commercial buildings has made the South a year-round attraction for new factories, businesses, tourists, and retirees.

Growth in the South could mean there are less people in the North using energy in building space heating. Space heating accounts for most of the energy used in the residential sector. One study, by Energy and Environmental Analysis, Inc. prepared for the Federal Energy Administration, states that, "51 percent of the population located in the four northern Census Regions consumes 62 percent of the national residential energy supply."† Figure 4.4 shows one estimate of energy used relative to the percentage of the United States population by region. This regional shift in population could help reduce the demand for energy for space heating in the United States.

Demographic data on families present some interesting facts that should be considered when analyzing energy use in the residential sector. Approximately 72% of residences in the United States in 1975 were owner-occupied. A homeowner may have more incentive to install insulation and other energy-saving materials than a renter.

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*U.S. Department of Housing and Urban Development, Executive Office of the President, Committee on Community Development, 1976 Report on National Growth and Development, The Changing Issues for National Growth, the Domestic Council, Washington, D.C., February 1976, p. 24.

†Energy and Environment Analysis, Inc., Energy Consumption Data Base, Vol. III, Household Sector, Federal Energy Administration, Arlington, Va., April 1977, p. 3.

Changing lifestyles are reflected in the fact that the number of households is growing faster than the population. More people are choosing to set up one- or two-person households. Each of these smaller households uses a higher per capita amount of energy than the traditional large family - due to loss of economies of scale in home heating and appliance energy use.

Rising incomes since 1947 have led to increased ownership of energy-using appliances that can make life more comfortable and enjoyable. Table 4.11 indicates that the direct relationship between level of income, age, residence, and the ownership of some appliances.

No attempt has been made in this Chapter to project future energy use in the residential and commercial sectors. The tables and figures presented, however, should give the Energy Use Data Book user an idea of what effect the population characteristics currently have on energy use, especially when analyzed with the detailed energy and fuel data provided elsewhere in this book.

Table 4.1. Population of the United States 1945–1976[a] (10^3)

Year	Population
1945	140,468
1950	152,271
1955	165,931
1960	180,671
1965	194,303
1970	204,878
1975	213,540
1976	215,118

[a] Includes Armed Forces overseas.

Source: U.S. Department of Commerce, Bureau of the Census, Current Population Reports: Population Estimates and Projections, Series P-25, No. 704, Washington, D.C., January 1977, Table D.

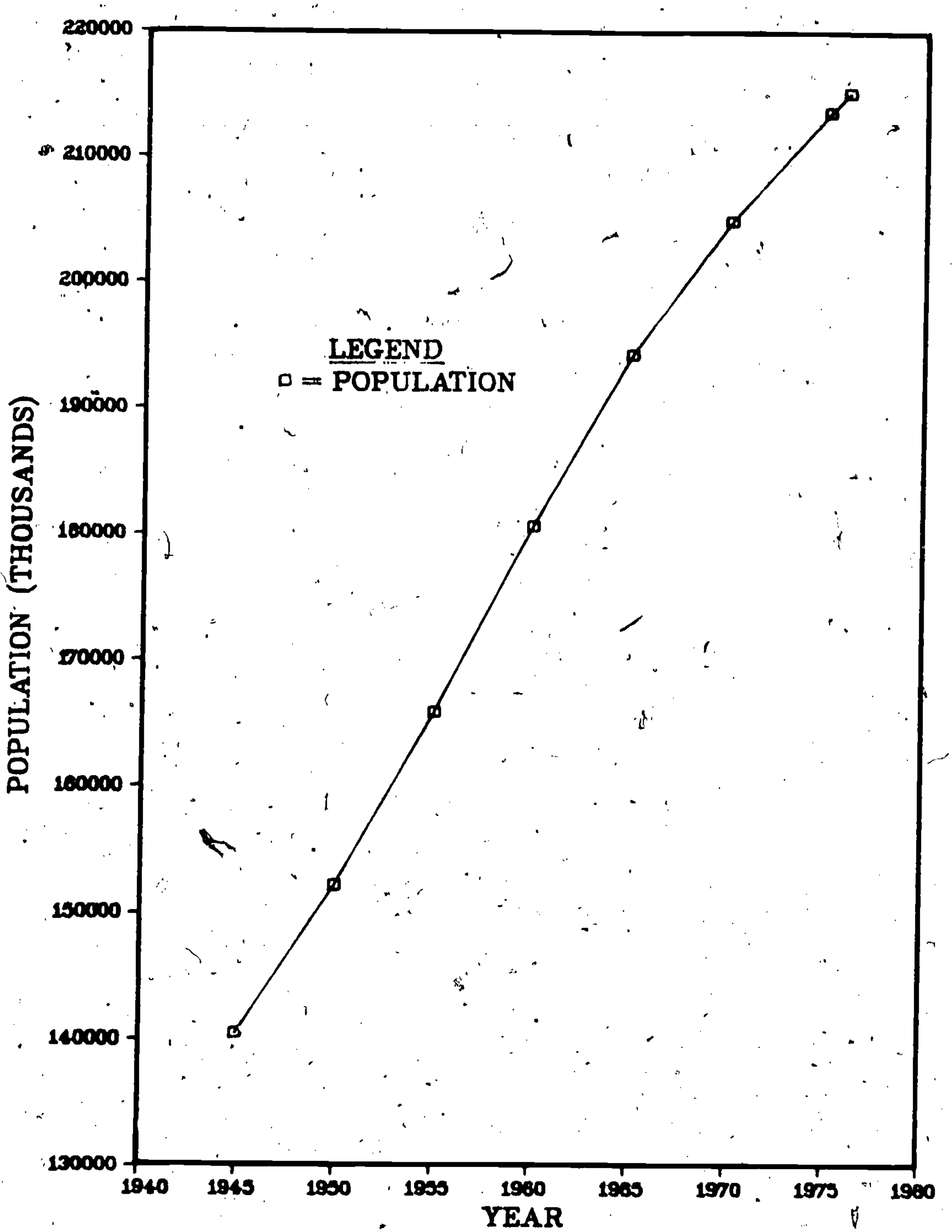

Figure 4.1. Population of the United States 1945–1976[a].

[a] Includes Armed Forces overseas.

Source: U.S. Department of Commerce, Bureau of the Census, Current Population Reports: Population Estimates and Projections, Series P-25, No. 704, Washington, D.C., January 1977, Table D.

IT IS IMPORTANT TO NOTE THAT THE NET GROWTH RATE DOES NOT TAKE INTO ACCOUNT ILLEGAL IMMIGRATION WHICH IS ESTIMATED BY HUD TO BE MORE THAN 800,000 PERSONS ANNUALLY.

Table 4.2. U.S. Annual Rates of Net Growth, Births, Deaths, and Net Immigration 1960 to 1975[a]
(rate per 1,000 mid-year population)

Year	Net growth rate[b]	Rate of natural increase	Birth rate	Death rate	Net legal immigration rate
1960	16.1[c]	14.4	23.8	9.5	1.8
1965	11.9[c]	10.1	19.6	9.4	1.9
1970	10.9	8.8	18.2	9.4	2.1
1971	9.7[c]	7.9	17.2	9.3	1.9
1972	7.8	6.2	15.6	9.4	1.6
1973	7.1	5.5	14.9	9.4	1.6
1974	7.5	5.8	14.9	9.1	1.7
1975	8.1	5.8	14.7	8.9	2.3

[a] Includes Alaska, Hawaii, and Armed Forces overseas.

[b] births - deaths = natural increase
natural increase + immigration = net growth

[c] Figures may not add due to rounding.

Source: U.S. Department of Housing and Urban Development, Executive Office of the President, Committee on Community Development, 1976 Report on National Growth and Development, The Changing Issues for National Growth, the Domestic Council, Washington, D.C., February 1976, Table II-1.

AROUND 1972, REPLACEMENT-LEVEL FERTILITY (2.1 ANNUAL BIRTHS EXPRESSED IN TERMS OF IMPLIED COMPLETED FAMILY SIZE) WAS REACHED. MAINTENANCE OF THE REPLACEMENT FERTILITY RATE OVER A NUMBER OF YEARS WILL CAUSE A STATE OF ZERO POPULATION GROWTH.

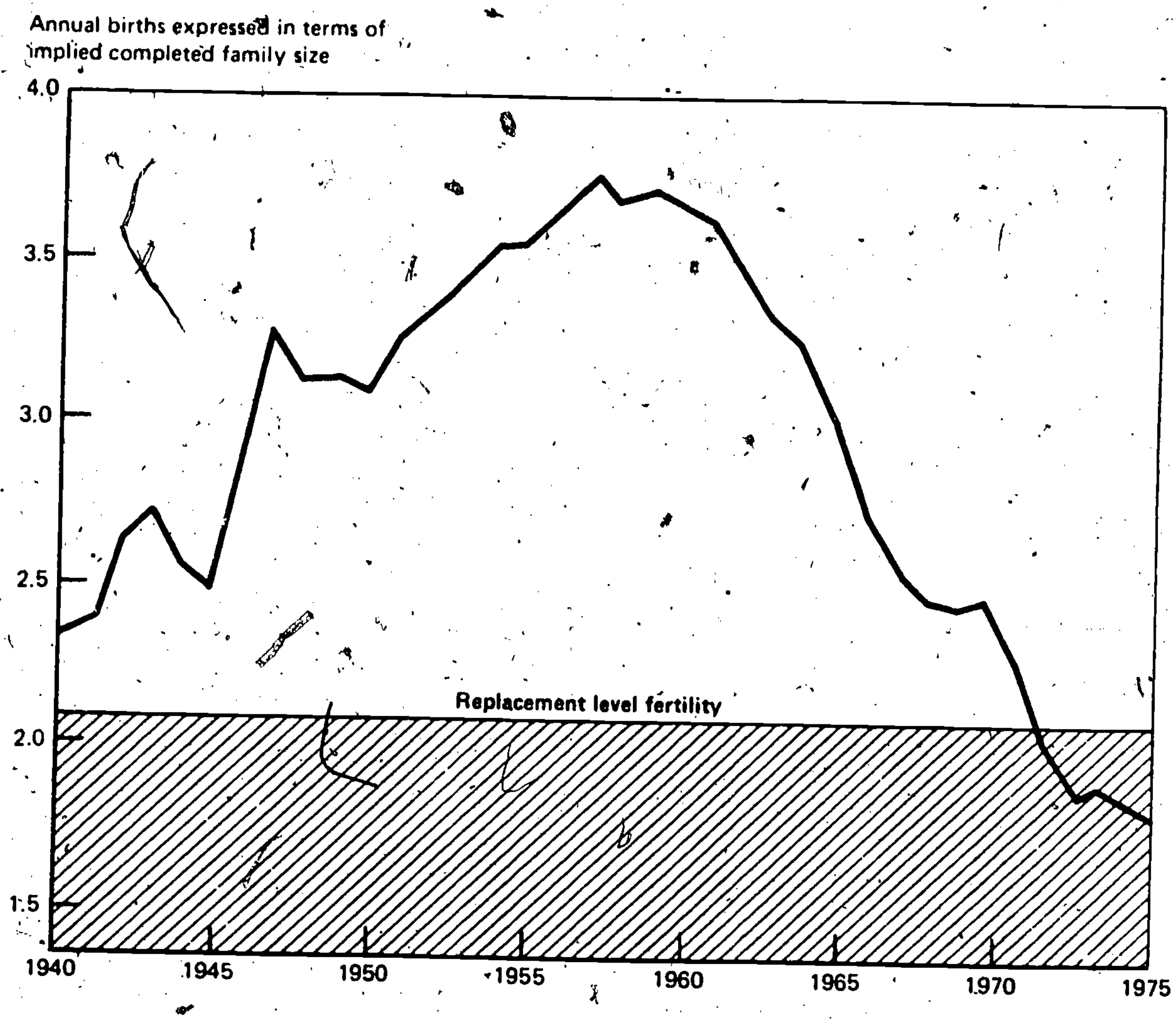

Figure 4.2. Total Fertility Rate Trend: 1940 to 1975[a]

[a] Fertility Rate: number of live births per 1,000 women aged 15-44.

Source: U.S. Department of Housing and Urban Development, Executive Office of the President, Committee on Community Development, 1976 Report on National Growth and Development, The Changing Issues for National Growth, the Domestic Council, Washington, D.C., February 1976, Figure II-1.

THE GROWTH OF THE NORTHEAST WAS ONLY 7% THAT OF THE SOUTH DURING THE PERIOD 1960 TO 1976. THOUGH THE WEST EXPERIENCED THE HIGHEST PERCENTAGE GROWTH, THE SOUTH GREW THE MOST IN ACTUAL NUMBERS OF PERSONS.

Table 4.3. Resident Population by Census Regions, 1970-1976[a]
(10^3)

Region	April 1, 1970 (Census)	July 1, 1975	July 1, 1976 (provisional)	Change 1970 to 1976	
				Number	Percent[b]
United States	203,305	213,032	214,659	11,354	5.6
Northeast	49,061	49,456	49,503	442	0.9
North Central	56,593	57,636	57,739	1,146	2.0
South	62,813	68,041	68,855	6,042	9.6
West	34,838	37,899	38,562	3,724	10.7

[a] "Census Regions" and "Census Divisions" are described in Appendix C.

[b] Percent of April 1, 1970 population.

Source: U.S. Department of Commerce, Bureau of the Census, Current Population Reports, Series P-25, No. 642, Washington, D.C., December 1976.

THE SOUTH AND WEST TOGETHER HAVE EXPERIENCED MORE THAN 80% OF THE NATIONAL POPULATION GROWTH SINCE 1970.

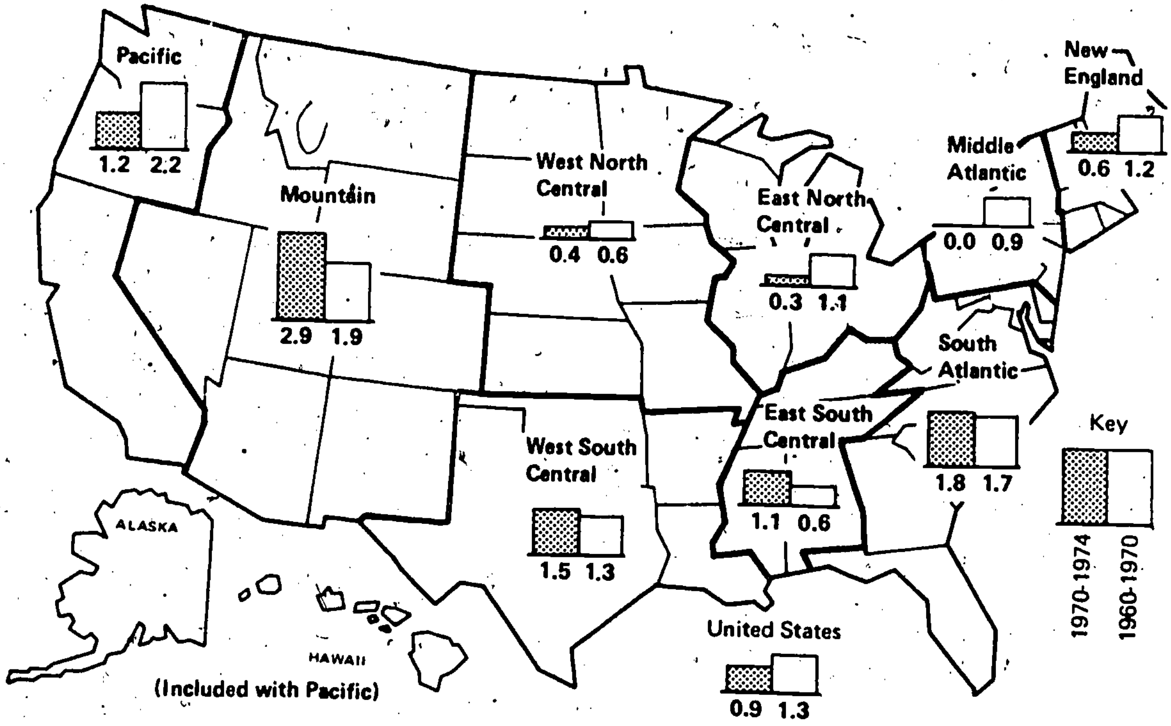

Figure 4.3. Average Annual Percent Change in Population for Census Divisions[a], 1960 to 1970 and 1970 to 1974.

[a] "Census Regions" and "Census Divisions" are described in Appendix C.

Source: U. S. Department of Housing and Urban Development, Executive Office of The President, Committee on Community Development, 1976 Report on National Growth and Development, The Changing Issues for National Growth, The Domestic Council, Washington, D. C., February 1976, Figure II-3.

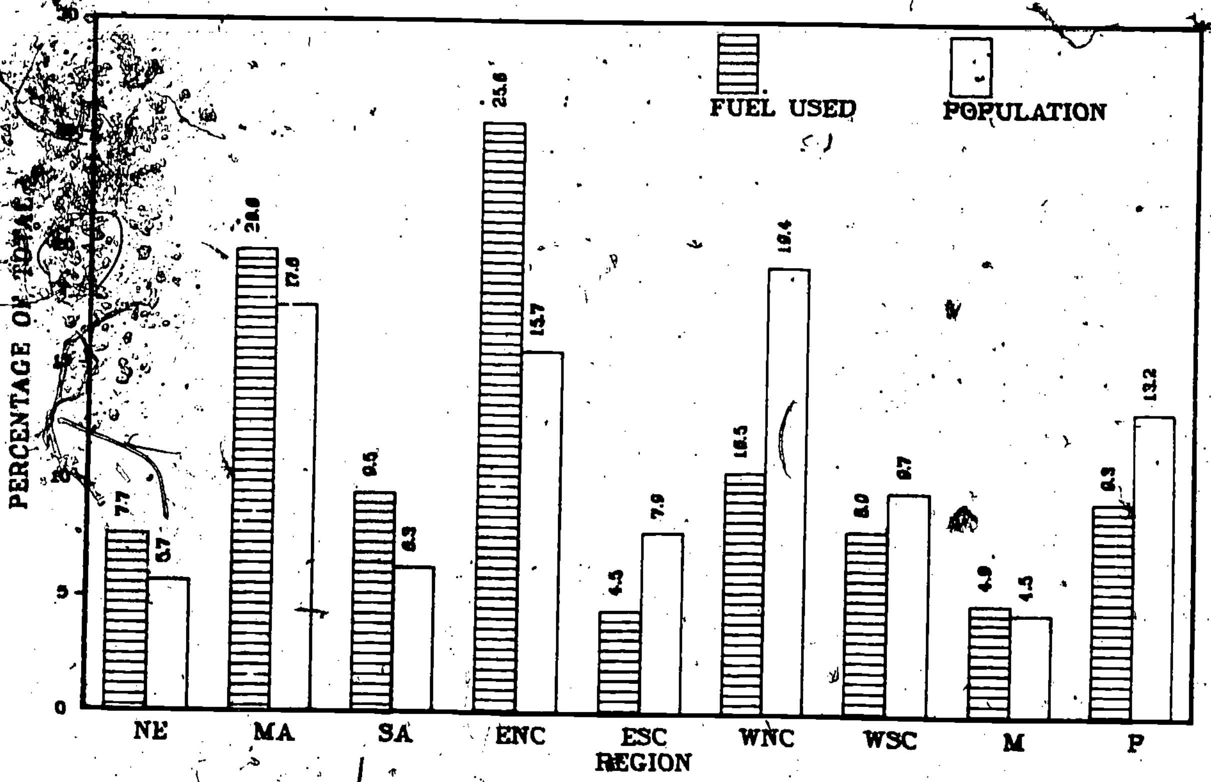

Figure 4.4. Household/Commercial Sector Fuel Use Compared to Population by Census Region[a] – 1974.

[a] "Census Regions" and "Census Divisions" are described in Appendix C.

Note: Total Fuel Consumption = 13.769 × 10^6 Btu.
Total U.S. Population = 211,381,000.

Sources: U.S. Department of Commerce, Bureau of the Census, Statistical Abstract of the United States: 1976, 97th Annual Edition, Washington, D.C., July 1976, Table 10; L. H. Crump, U.S. Department of the Interior, Bureau of Mines, Fuels and Energy Data: United States by States and Census Divisions, 1974, Information Circular 8739, Washington, D.C., 1977, pp. 22–31.

THE LARGE INCREASE IN THE 25-34 AGE GROUP FROM 1970 TO 1976 REFLECTS THE AGING OF THE POST-WAR BABIES.

Table 4.4. U.S. Population Age Structure[a]
April 1, 1970 and July 1, 1976
(10^3)

Age	Population		Percent distribution		Population change	
	April 1, 1970	July 1, 1976	April 1, 1970	July 1, 1976	1970 to 1976	Percent, 1970 to 1976
Total All Ages	204,335	215,118	100.0	100.0	+10,783	+5.3
Under 5 years	17,163	15,339	8.4	7.1	−1,824	−10.6
5 to 13 years	36,675	32,955	17.9	15.3	−3,720	−10.1
14 to 17 years	15,854	16,897	7.8	7.8	+1,043	+6.6
18 to 24 years	24,455	28,166	12.0	13.1	+3,711	+15.2
25 to 34 years	25,146	32,044	12.3	14.9	+6,898	+27.4
35 to 44 years	23,214	23,076	11.4	10.7	−138	−0.6
45 to 54 years	23,254	23,642	11.4	11.0	+389	+1.7
55 to 64 years	18,603	20,064	9.1	9.3	+1,462	+7.9
65 years and over	19,972	22,934	9.8	10.7	+2,962	+14.8

[a] Including Armed Forces overseas.

Source: U.S. Department of Commerce, Bureau of the Census, Current Population Reports: Population Estimates and Projections, Series P-25, No. 643, Washington, D.C., January 1977, Table A.

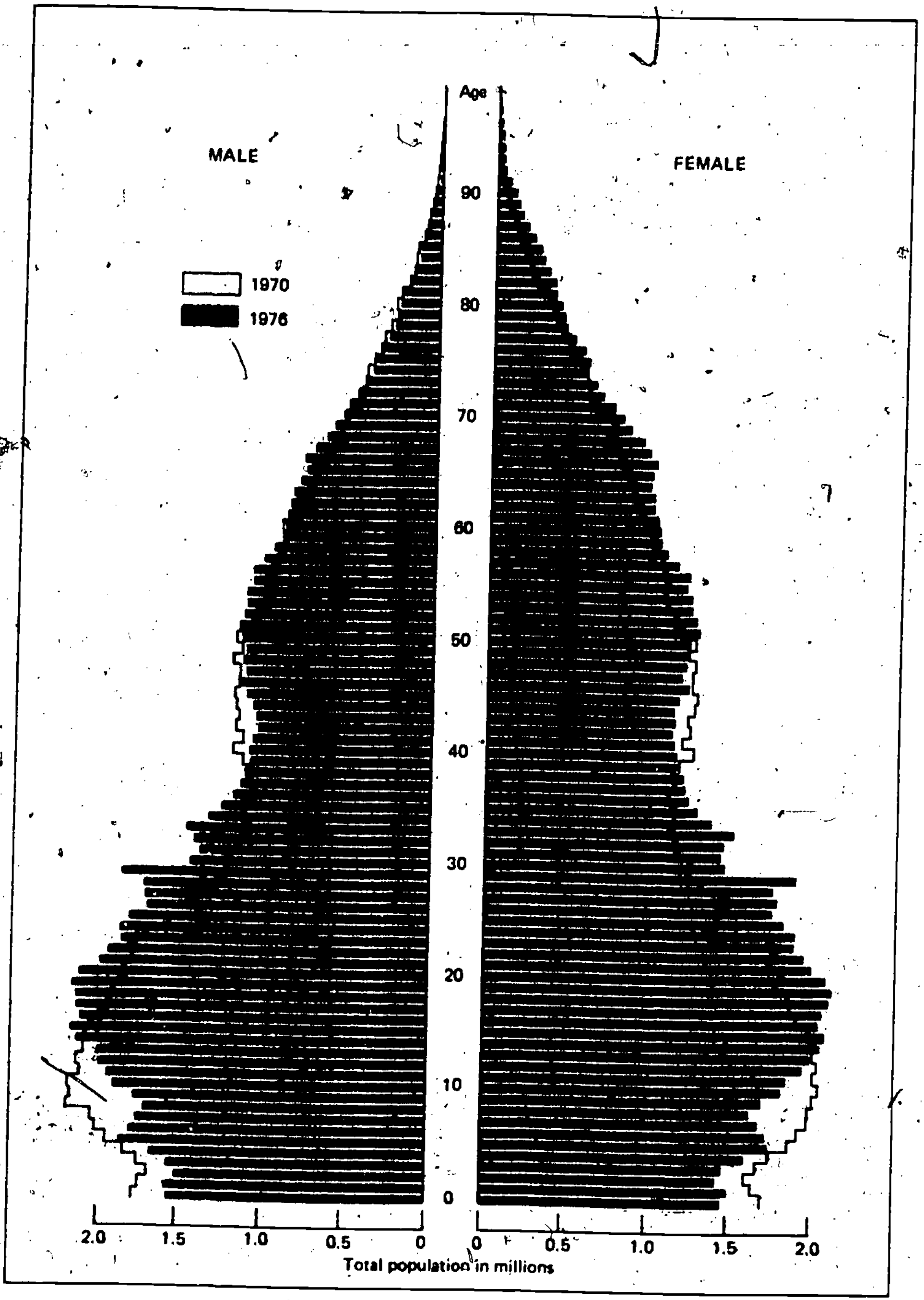

Figure 4.5. Distribution of the Total Population by Age and Sex: 1970 and 1976.

Source: U.S. Department of Commerce, Bureau of the Census, Current Population Reports: Population Estimates and Projections, Series P-25, No. 643, Washington, D.C., January 1977, Tables 1 and 5.

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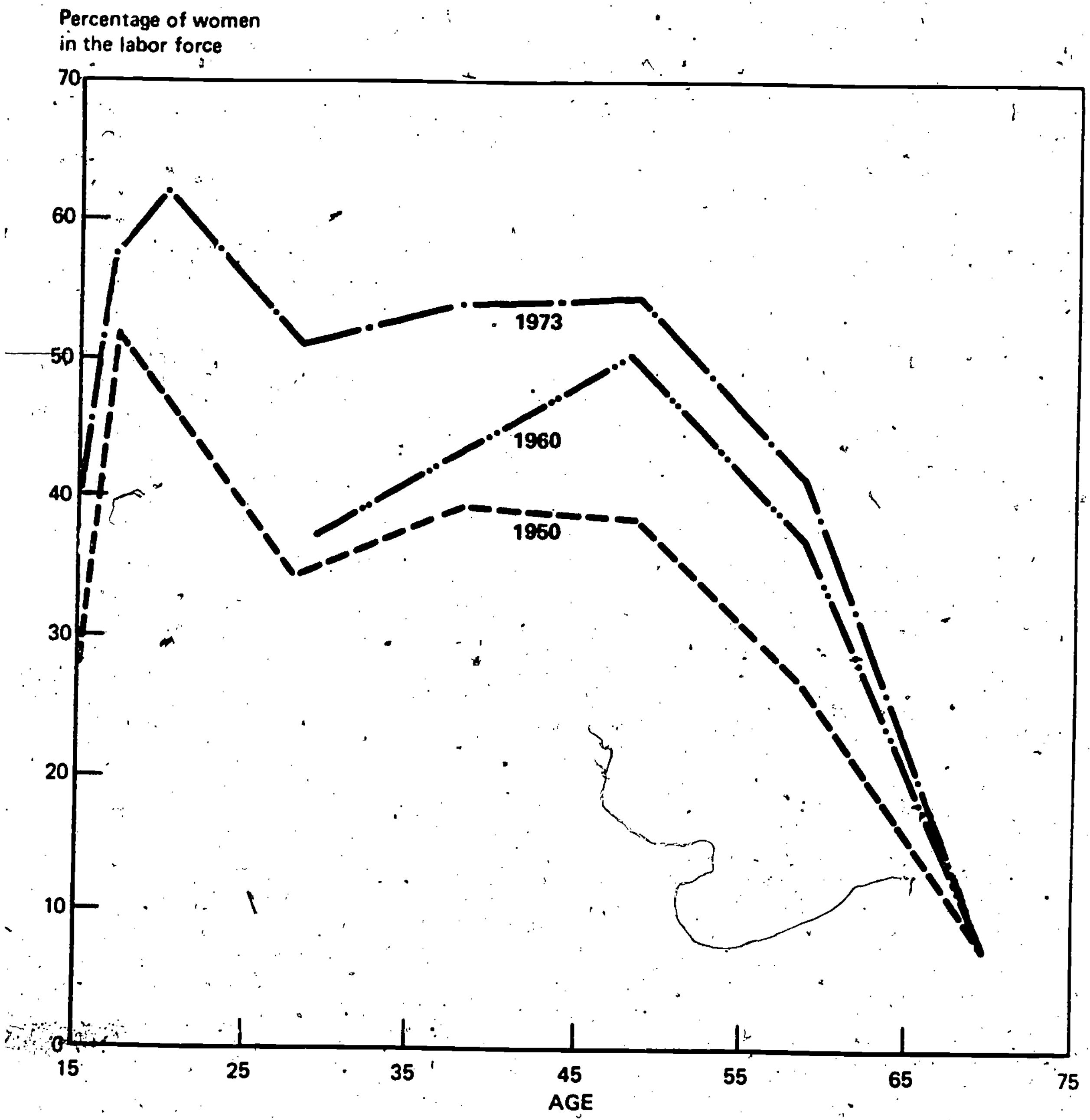

Figure 4.6. Women in the Labor Force by Age

Source: U.S. Department of Housing and Urban Development, Executive Office of the President, Committee on Community Development, 1976 Report on National Growth and Development, The Changing Issues for National Growth, the Domestic Council, Washington, D.C., February 1976, Figure II-2.

Table 4.5. Employment by Census Regions[a], 1970

	Northeast	North Central	South	West	Total
Total males, 16 years old and over	16,260,439	18,530,003	20,666,324	11,778,744	67,235,510
Labor force	12,509,058	14,394,838	15,483,150	9,115,068	51,502,114
Percent of total	76.9	77.7	74.9	77.4	76.6
Civilian labor force	12,318,878	14,189,247	14,524,446	8,516,668	49,549,239
Employed	11,890,009	13,657,860	14,051,822	8,024,063	47,623,754
Unemployed	428,869	531,387	472,624	492,605	1,925,485
Percent of civilian labor force	3.5	3.7	3.3	5.8	4.0
Not in labor force	3,751,381	4,135,165	5,183,174	2,663,676	15,733,396
Inmate of institution	247,048	282,866	310,176	177,644	1,017,734
Enrolled in school	1,149,480	1,260,916	1,494,660	821,004	4,726,060
Other: under 65 years	885,535	907,573	1,515,407	696,135	4,004,650
65 years and over	1,469,318	1,683,810	1,862,931	968,893	5,984,952
Total females, 16 years old and over	18,470,065	20,338,151	22,654,201	12,389,343	73,851,760
Labor force	7,729,023	8,418,575	9,228,028	5,171,041	30,546,667
Percent of total	41.8	41.4	40.7	41.7	41.4
Civilian labor force	7,724,698	8,413,374	9,204,281	5,159,454	30,501,807
Employed	7,380,834	7,991,642	8,745,655	4,811,714	28,929,845
Unemployed	343,864	421,732	458,626	347,740	1,571,962
Percent of civilian labor force	4.5	5.0	5.0	6.7	5.4
Not in labor force	10,741,042	11,919,576	13,426,173	7,218,302	43,305,093
Inmate of institution	258,114	294,046	241,094	145,834	939,088
Enrolled in school	1,148,980	1,310,813	1,591,443	889,156	4,940,392
Other: under 65 years	6,776,095	7,579,049	8,610,688	4,685,466	27,651,298
65 years and over	2,557,853	2,735,668	2,982,948	1,497,846	9,774,315

[a] "Census Regions" and Census Divisions" are described in Appendix C.

Source: U.S. Department of Commerce, Bureau of the Census, U.S. Census of Population 1970, United States Summary, General Social and Economic Characteristics, Washington, D.C., June 1972, Table 132.

Table 4.6. Residence of the United States Population, 1960 and 1970

Residence	1960 Population		1970 Population	
	Total (10^3)	Percentage of U.S.	Total (10^3)	Percentage of U.S.
Total population	179,323	100.0	203,212	100.0
Urban	125,269	69.9	149,325	73.5
In urban area	95,848	53.4	118,447	58.3
Other urban	29,420	16.4	30,878	15.2
Rural	54,054	30.1	53,887	26.5
Inside SMSAs[a,b]	112,885	63.0	139,419	68.6
Urban	99,563	55.5	123,007	60.5
Rural	13,323	7.4	16,412	8.1
Outside SMSAs	66,438	37.0	63,793	31.4
Urban	25,706	14.3	26,318	13.0
Rural	40,732	22.7	37,475	18.4

[a] Standard Metropolitan Statistical Area.

[b] See Appendix B.

Source: U.S. Department of Commerce, Bureau of the Census, Statistical Abstract of the United States: 1976, 97th Annual Edition, Washington, D.C., July 1976, Table No. 16.

Table 4.7. Selected Characteristics of Families[a], 1975
(% distribution)

Characteristics	Number (10³)	Income			
		Total	Under $5,000	$5,000 to $19,999	$20,000 and over
All families					
Number, thousands	56,245	56,245	6,766	35,029	14,449
Percent	(x)	100.0	12.0	62.3	25.7
Type of family					
Male head	48,763	100.0	8.3	63.0	28.1
Married, wife present	47,318	100.0	8.1	62.9	29.0
Other marital status	1,444	100.0	13.0	66.6	20.2
Female head	7,482	100.0	36.6	57.6	6.0
Age of head					
14 to 24 years	4,042	100.0	25.6	70.1	4.3
25 to 34 years	12,885	100.0	9.8	70.6	19.5
35 to 44 years	11,107	100.0	8.0	58.9	32.8
45 to 54 years	11,125	100.0	6.6	53.1	40.2
55 to 64 years	8,923	100.0	10.3	59.1	30.9
65 and over	8,163	100.0	23.6	65.7	10.9
Size of family					
2 persons	21,280	100.0	17.2	64.6	18.2
3 persons	12,252	100.0	11.4	63.1	25.6
4 persons or more	22,712	100.0	7.5	59.8	32.8
Tenure status					
Owner-occupied	40,360	100.0	8.1	60.6	31.3
Renter-occupied	14,606	100.0	21.3	67.1	11.6
Occupier paid no cash rent	1,090	100.0	23.5	65.3	11.2

[a] See Glossary - "Families."

Source: U. S. Department of Commerce, Bureau of the Census, Current Population Reports: Consumer Income, Series P-60, No. 105, Washington, D.C., June 1977, Table C.

Table 4.8. Selected Characteristics of Families, 1977[a] (10^3)

Item	Number	Percent
Total families	56,710	100.0
Type of residence		
Metropolitan areas	37,955	66.9
Nonmetropolitan	18,755	33.1
Nonfarm	54,526	96.1
Farm	2,184	3.9
Size of family		
2 persons	21,530	38.0
3 persons	12,472	22.0
4 persons	11,483	20.2
5 persons	6,209	10.9
6 persons	2,800	4.9
7 persons or more	2,216	3.9
Race or origin		
White	50,083	88.3
Black	5,804	10.2
Other	823	1.5
Spanish origin[b]	2,583	4.6
Presence of own children		
None under 18 years	26,565	46.8
1 or more under 18 years	30,145	53.2
Tenure		
Homeowners	40,815	72.0
Renters of private housing	14,844	26.2
Renters of public housing	1,050	1.9
Education of men and women maintaining families		
Did not complete high school	19,687	34.7
High school graduate, no college	19,614	34.6
1 to 3 years of college	7,924	14.0
4 or more years of college	9,486	16.7
Occupation of men and women maintaining families[c]		
White collar	19,000	33.5
Blue collar	17,523	30.9
Service	3,486	6.1
Farm-related	1,489	2.6
Armed Forces	808	1.4
Unemployed	2,188	3.9
Not in labor force	12,215	21.5
Age of family members		
Total number of members	190,844	100.0
Under 18 years	63,885	33.5
18 to 64 years	111,886	58.6
65 years and over	15,073	7.9

[a] Data current as of March 1977.

[b] Persons of Spanish origin may be of any race.

[c] The Census Bureau is in the process of dropping the term "head" from enumerations and publications, the phrase "maintaining families" denotes head.

Source: U.S. Department of Commerce, Bureau of the Census, Current Population Reports: Population Characteristics, Series P-20, No. 313, Washington, D.C., September 1977, Table 4.

Table 4.9. Households[a] by Size 1960–76
(percentage)

Size of household	1960	1964	1968	1970	1971	1972	1973	1974	1975	1976
All households, 10^3	52,799	56,149	60,813	63,401	64,778	66,676	68,251	69,859	71,120	72,867
Percent	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1 person	13.1	13.9	16.1	17.0	17.7	18.3	18.5	19.1	19.6	20.6
2 persons	27.8	27.8	28.6	28.8	29.2	29.2	30.2	30.8	30.6	30.6
3 persons	18.9	17.9	17.4	17.3	17.1	17.3	17.3	17.1	17.4	17.2
4 persons	17.6	17.0	15.8	15.8	15.5	16.0	15.7	15.6	15.6	15.7
5 persons	11.5	11.3	10.4	10.4	10.3	9.6	9.4	9.3	9.0	8.6
6 persons	5.7	6.0	6.0	5.6	5.3	5.1	4.8	4.4	4.3	4.1
7 or more persons	5.4	6.1	5.7	5.1	5.0	4.5	4.1	3.8	3.5	3.2

[a] See Glossary - "Households."

Source: U.S. Department of Commerce, Bureau of the Census, Current Population Reports: Population Characteristics, Series P-20, No. 311, Washington, D.C., 1977, Table A, p. 2.

Table 4.10. Median Income of Families 1947–1975
(constant 1975 dollars)

Year	Families	Unrelated individuals
1947	7,303	2,362
1950	7,422	2,336
1955	8,881	2,648
1960	10,214	3,126
1965	11,867	3,672
1970	13,676	4,348
1973	14,595	5,007
1974[a]	14,082	5,025
1975[a]	13,719	4,882

[a] Not strictly comparable with earlier years due to revised procedures.

Source: U.S. Department of Commerce, Bureau of the Census, Statistical Abstract of the United States: 1976, 97th Annual Edition, Washington, D.C., July 1976, Table No. 650.

Table 4.11. Income, Expenditures, and Wealth 1974

Characteristic	Total households (10^6)	Percent owning		Percent with				
		Black and white tv set	Color tv set	Air-conditioning		Refrigerator	Freezer	Washing machine
				Central	Room			
All households	70.8	96.6	61.3	18.7	31.8	98.9	33.7	71.9
Annual income								
Under $3,000	8.0	89.7	31.6	7.9	21.7	96.6	19.7	50.7
$3,000–$4,999	7.4	94.4	40.6	10.7	27.0	98.7	23.6	55.4
$5,000–$7,499	8.9	96.1	50.4	13.0	30.5	98.7	26.6	62.6
$7,500–$9,999	8.3	97.0	57.8	13.6	35.2	99.1	30.4	68.5
$10,000–$14,999	15.9	97.9	67.4	18.2	35.5	99.4	37.0	77.2
$15,000–$19,999	9.7	99.0	78.1	24.4	36.1	99.5	40.6	85.3
$20,000–$24,999	5.2	99.0	80.2	28.7	34.3	99.7	44.2	86.0
$25,000 and over	7.1	98.7	84.4	38.6	30.4	99.7	48.4	89.2
Age of head								
Under 25 years	6.1	93.0	41.5	17.4	28.9	98.5	8.9	44.1
25 to 29 years	7.5	95.9	59.3	19.9	34.9	99.3	20.3	62.7
30 to 34 years	6,9	97.8	69.8	22.9	33.2	99.3	32.1	75.9
35 to 44 years	12.3	97.9	71.0	21.6	30.2	99.2	45.9	83.5
45 to 54 years	12.6	97.3	68.4	21.0	33.2	98.8	44.0	81.7
55 to 64 years	11.6	97.2	63.8	16.2	33.6	98.9	39.5	77.1
65 years and over	13.7	95.7	49.8	13.9	29.5	98.7	27.6	63.8
Residence								
Central cities	22.3	95.6	56.1	17.3	33.1	98.4	20.3	60.0
Suburban rings	26.2	97.7	69.4	23.4	32.2	99.1	33.9	77.0
Outside metropolitan areas	22.3	96.3	57.0	14.5	30.1	99.2	47.0	77.9
Region								
Northeast	16.6	97.3	59.2	6.3	36.2	99.3	22.7	68.4
North Central	18.9	96.9	64.1	18.6	32.7	98.5	39.0	76.5
South	22.5	96.4	58.1	29.9	37.5	99.1	38.6	71.9
West	12.8	95.5	65.7	15.2	14.8	98.8	31.5	69.8

Source: U. S. Department of Commerce, Bureau of the Census, Statistical Abstract of the United States: 1976, 97th Annual Edition, Washington, D.C., July 1976, Table No. 689.

Table 4.12. Number of Occupied Housing Structures 1970 and 1975 (10^3)

Structure	1970			1975		
	Total	Owned	Rented	Total	Owned	Rented
All housing units	68,672[a]	NA	NA	79,087	NA	NA
Vacant, seasonal, migratory	5,227	NA	NA	6,563	NA	NA
Occupied housing units	63,445	39,886	23,560	72,523	46,867	25,656
1-family detached	42,133	34,397	7,736	48,869	39,787	7,082
1-family attached	1,907	1,113	794	2,884	1,534	1,350
2-4 units	8,379	2,161	6,218	8,910	2,138	6,772
5 or more units	8,955	464	8,491	10,517	585	9,932
Mobile home or trailer	2,073	1,752	321	3,341	2,822	519

[a] Numbers may not add due to rounding.

NA – Not available.

Source: U.S. Department of Commerce, Bureau of the Census, Annual Housing Survey, 1975, U.S. and Regions, Part A – General Housing Characteristics, Washington, D.C., 1977, Table A-1.

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Chapter 5

Buildings Structure and Climatological Data

M. A. Smith

K. Haygood

Chapter 5 focuses on energy use as determined by building structure. Certain characteristics of a physical structure effect energy use, for example, size, insulation, number of windows, and exterior doors. This chapter also discusses climatological conditions by geographic area.

Data on residential structures have been divided into three classifications: (1) mobile homes, (2) single-family homes, and (3) multifamily structures. Mobile home size characteristics are available only by estimate of factory shipments. Data depicting the structural characteristics of commercial buildings are not available. Even data concerning new construction of "nonresidential" buildings (Table 5.1) are limited to construction data by permit-issuing places.*

Inventories of existing structures are also unavailable with the exception of selected information from the Annual Housing Survey and the 1970 Census of Housing. However, data on new structures of both single-family and multifamily buildings are reviewed in several construction reports.

Undoubtedly, the most important determinants of individual building energy use are the number of windows and doors and the incorporation of insulation. Reliable sources of these data are not generally available.

Finally, climatological factors have an effect on space-conditioning equipment efficiency and usage. Climatological data are presented to indicate regional differences in temperature, wind speed, etc. that would affect materials used in building construction and in modifying

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*The Construction Review indicates that permit-issuing places describe approximately 85% of total residential construction activity from 1967-1976 (Table 5.1).

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existing structures. Heat pumps, for example (Chapter 2), are most effective in moderate climates. The climatological conditions of the building's location are generally investigated before construction. Climatological factors are also important in construction standards for mobile homes, as there are different Federal insulation requirements for mobile home construction depending on the region of sale.

A weakness of Chapter 5 is in the review of commercial buildings inventory and structural characteristics. Several case studies or estimates have been done on commercial buildings but have been omitted from this chapter because of their limited scope.

The Tishman Research Corporation, in conjunction with Syska & Hennessy, Inc., recently released a study on office buildings in New York City.* The study is concerned with energy use and how it is affected by building characteristics. A representative sample of 44 buildings was chosen from a subpopulation of 436 buildings, and data on fuel consumption by fuel, buildings, and month were collected. The study analyzes the effects on fuel use of changing various building parameters. (The Tishman study is reviewed in more detail in Chapter 8.)

The F. W. Dodge Construction Statistics constitutes a yearly survey (1965—1976) of the construction industry. Data include yearly additions of floor space to the commercial sector by activity (e.g., office and bank buildings, schools and college classroom buildings, and government administration buildings). These statistics cover new construction

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*Syska & Hennessy, Inc., Tishman Research Corporation, Energy Conservation in Existing Office Buildings, U.S. Energy Research and Development Administration, New York, June 1977.

activity, along with additions, alterations, and repairs. The Dodge Construction Statistics tapes are massive, expensive, and not readily available for examination. Future considerations focus on an in-depth analysis of these tapes. Some of the F. W. Dodge Construction Statistics (by dollar value of construction contracts) are available in the Construction Review.*

Business Building Statistics[†] is a survey conducted by the Treasury Department to evaluate depreciation rates of existing buildings for the purpose of tax reports. Statistics are reported in relative terms (e.g. percent of floor space of total number of observations). The study presents physical and economic characteristics of the stock of business buildings in 1969. These data include: building by type of Census Division, year of construction, height, primary structural materials, and maintenance and repair expenses. The percentage of buildings and percentage of floor space is presented in relative terms by building type (Table 5.2).

Other sources of commercial buildings inventory and floor space data were omitted from this chapter because of their heavy reliance on estimation. These procedures and results are presented in greater detail in Chapter 8.

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*A. Sabghir (ed.), U.S. Department of Commerce, Domestic and International Business Administration, Construction Review — Monthly Industry Report, Washington, D.C., Tables D-3 and D-4.

[†] Department of the Treasury, Office of Industrial Economics, Business Building Statistics, Washington, D.C., August 1975.

Table 5.1. Private, Nonresidential Construction by Permit-Issuing Places[a] (number of buildings[b])

	Office buildings	Service stations and repair garages	Stores and other mercantile buildings	Religious buildings	Educational buildings	Hospitals and other institutional buildings	Amusement buildings
3,014 Places							
1960	8,036	7,544	25,437	5,316	1,792	1,057	3,038
1961	8,362	7,881	23,599	5,056	1,959	1,135	2,665
1962	8,558	7,719	23,384	5,238	1,817	1,367	2,587
1963	8,917	7,813	22,673	4,929	1,859	1,541	2,506
1964	9,303	8,205	24,505	5,174	2,118	1,531	2,923
12,000 Places							
1964	11,125	11,214	30,578	6,675	2,566	1,973	3,714
1965	11,653	10,716	32,589	6,445	2,572	1,873	3,660
1966	10,119	10,569	30,057	6,354	2,916	1,712	3,143
1967	9,850	10,922	27,904	5,902	2,816	1,595	2,996
13,000 Places							
1967	10,256	11,586	28,617	6,222	2,959	1,675	3,539
1968	10,348	10,434	31,959	5,662	2,695	2,129	3,780
1969	10,976	10,021	33,648	4,991	2,356	2,225	3,759
1970	10,135	9,108	33,670	4,339	2,095	1,909	4,361
1971	12,642	9,312	33,593	4,628	2,268	1,908	5,024
1972	16,026	8,049	38,359	4,630	2,156	2,040	6,418
14,000 Places							
1972	16,264	8,280	38,984	4,799	2,204	2,071	6,498
1973	17,495	5,468	44,530	5,212	2,423	2,370	6,149
1974	15,537	3,755	33,968	5,300	2,372	2,150	5,370
1975	13,242	3,996	30,173	5,344	2,095	2,009	4,197
1976	14,882	5,277	39,679	5,094	2,062	2,119	4,720

[a] Statistics concerning private, nonresidential construction are not available for total construction activity, but rather for construction based on reports submitted by local building permit offices (called "permit-issuing places"). Over time, more permit-issuing places are identified (hence, the 3,014, 12,000, 13,000, and 14,000 permit-issuing places in Table 5.1). The summary below presents census estimates of the percentage of permit-issuing universes to total residential construction. Each permit-issuing universe coincides with an "identification year" — that year in which the number of permit-issuing places was defined. Several years are reported twice to indicate any error occurring from the identification of the larger universe. For example, the number of office buildings authorized in the 14,000 place universe was about 1% greater than the number reported for the 13,000 place universe in 1972. Finally, data on public construction are available only in dollar values.

Universe	Years reported	Identification year	Percent of total residential construction
3,014	1960–1964	1959	72.4
12,000	1964–1967	1962	81.0
13,000	1967–1972	1967	85.0
14,000	1972–1976	1972	85.0

[b] It is crucial to note that this is only a portion of total construction and does not represent all construction acitivity.

Source: A. Sabghir (ed.), U.S. Department of Commerce, Domestic and International Business Administration, Construction Review — Monthly Industry Report, Vol. 23, No. 3, Washington, D.C., April/May 1977, Table C-2 (also previous years).

Table 5.2. Nonfarm Business Buildings, 1969

Building type	Number of observations[a]	Percent of buildings	Percent of total floor space
Office	1852	18.44	17.00
Bank	235	2.95	5.65
Theater	31	0.23	0.10
Hotel	47	1.21	2.98
Motel	69	1.17	1.04
Shopping center	235	3.80	15.96
Retail	2003	30.30	10.12
Warehouse	683	8.92	11.62
Factory	605	11.10	25.46
Machine shop	94	2.23	1.50
Parking garage	17	0.29	0.42
Repair garage	281	5.44	2.69
Service station	255	4.12	0.31
Recreational	61	0.93	0.66
Medical	100	2.14	1.74
Terminal	80	0.87	0.65
Food service	179	3.07	0.52
Miscellaneous	205	2.81	1.57
Total	7032	100.00	100.00

[a] In 1968 and 1969, the Internal Revenue Service conducted a survey of approximately 70,000 major businesses for the purpose of measuring tax-return filing delinquency. From this sample, the Office of Industrial Economics drew a sample of nonfarm businesses for their report. The number of buildings of each type is indicated by the "number of observations."

Note: Totals may not add due to rounding.

Source: Department of the Treasury, Office of Industrial Economics, Business Building Statistics, Washington, D.C., August 1975, Table 1.

THE BUILDING OWNERS AND MANAGERS ASSOCIATION INTERNATIONAL (BOMA) PUBLISHES AN *OFFICE BUILDING EXPERIENCE EXCHANGE REPORT*. THE REPORT IS A VOLUNTARY SURVEY OF ASSOCIATION MEMBERS REPRESENTING 92 AMERICAN AND CANADIAN CITIES IN 1974. DATA CONCERNING OPERATING COSTS AND INCOME STATISTICS ARE PRESENTED FOR BOTH TOTAL BUILDING AREA AND RENTED OFFICE AREA. THE FOLLOWING TABLE IS AN EXAMPLE OF INFORMATION AVAILABLE FROM THE REPORT, ALTHOUGH IT IS CRUCIAL TO NOTE THAT THIS IS NOT AN ENUMERATION OF NATIONAL BUILDINGS OR NATIONAL AVERAGE COST FIGURES.

Table 5.3. Office Building Energy Costs, 1974

	Average energy costs[a] (¢/ft^2)	Number of buildings reported
All buildings reported	69.3	690
Age of building		
Under five years old	69.0	89
5-10 years old	64.8	105
10-15 years old	86.9	79
15-20 years old	71.2	64
20-25 years old	59.3	36
25-30 years old	60.3	15
30-35 years old	68.7	6
35-40 years old	59.3	1
40-45 years old	85.7	29
45-50 years old	71.0	75
50-55 years old	71.2	51
55 and older	51.3	140
Story height		
Under 10 stories	60.9	247
10-20 stories	61.4	258
20-30 stories	62.2	112
30-40 stories	77.4	44
40 or more	89.9	29
Building size		
Under 50,000 ft^2	47.4	79
50,000-100,000 ft^2	51.0	120
100,000-300,000 ft^2	60.5	286
300,000-600,000 ft^2	63.2	135
600,000 or more ft^2	87.2	68

[a] All energy costs are given on an annual basis. For example, energy costs of a building under 5 years old were 69 cents per square foot for the full year.

Source: Building Owners and Managers Association International, *1975 Office Building Experience Exchange Report for the Calendar Year 1974*, Chicago, 1975, pp. 9-21.

Table 5.4. Mobile Home Shipments 1960–1976

Year	Mobile homes
1960	103,700
1961	90,200
1962	118,000
1963	150,480
1964	191,320
1965	216,470
1966	217,300
1967	240,360
1968	317,950
1969	412,690
1970	401,190
1971	496,570
1972	575,940
1973	566,920
1974	329,300
1975	212,690
1976	246,120

Source: A. Sabghir (ed.), U.S. Department of Commerce, Domestic and International Business Administration, Construction Review — Monthly Industry Report, Vol. 23, No. 3, Washington, D.C., April/May 1977, Table B-7 (also previous years).

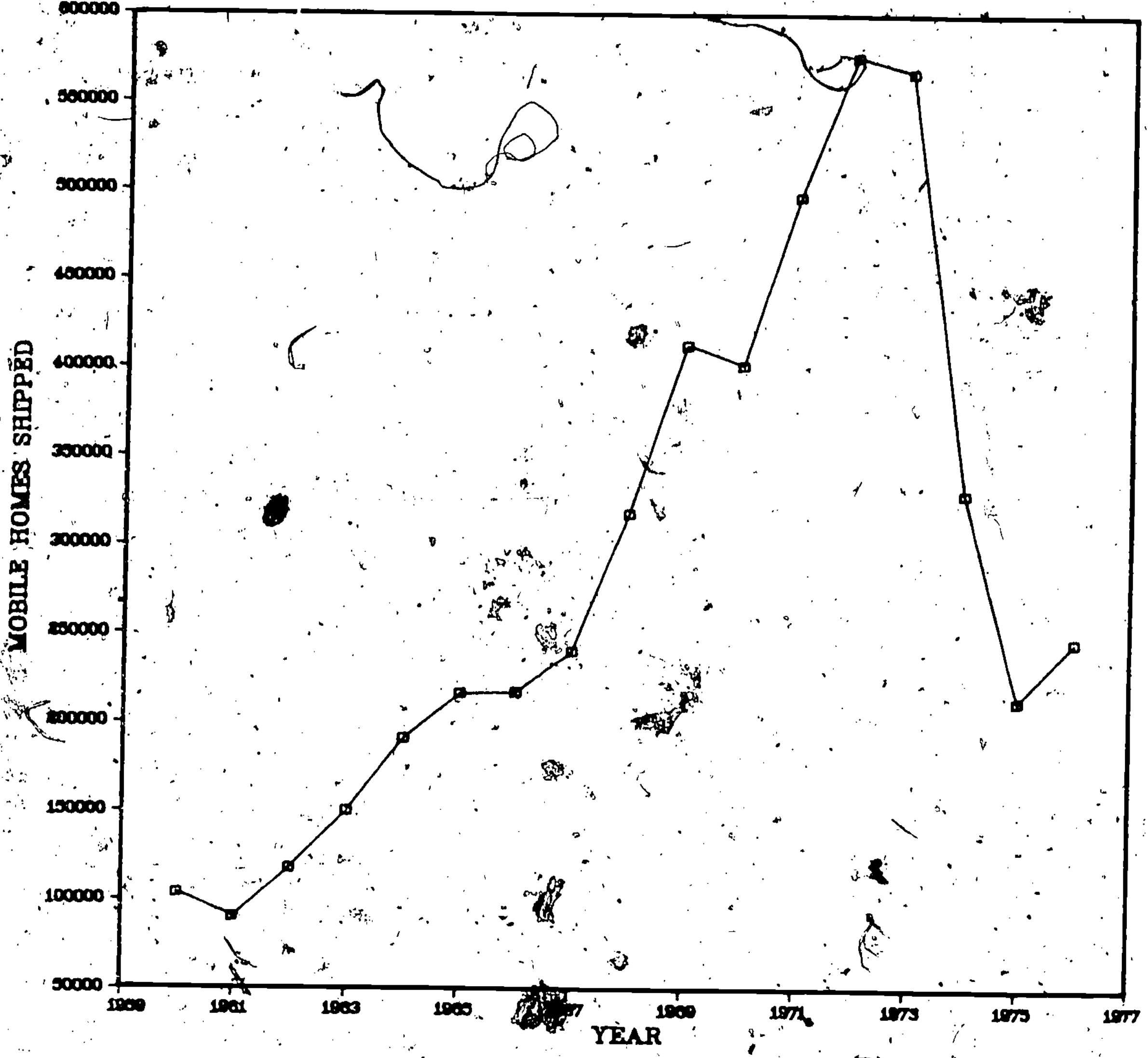


Figure 5.1. Trends in Mobile Home Shipments 1960—1976.

Source: A. Sadghir (ed.), U.S. Department of Commerce, Domestic and International Business Administration, Construction Review — Monthly Industry Report, Vol. 23, No. 3, Washington, D.C., April/May 1977, Table B-7 (also previous years).

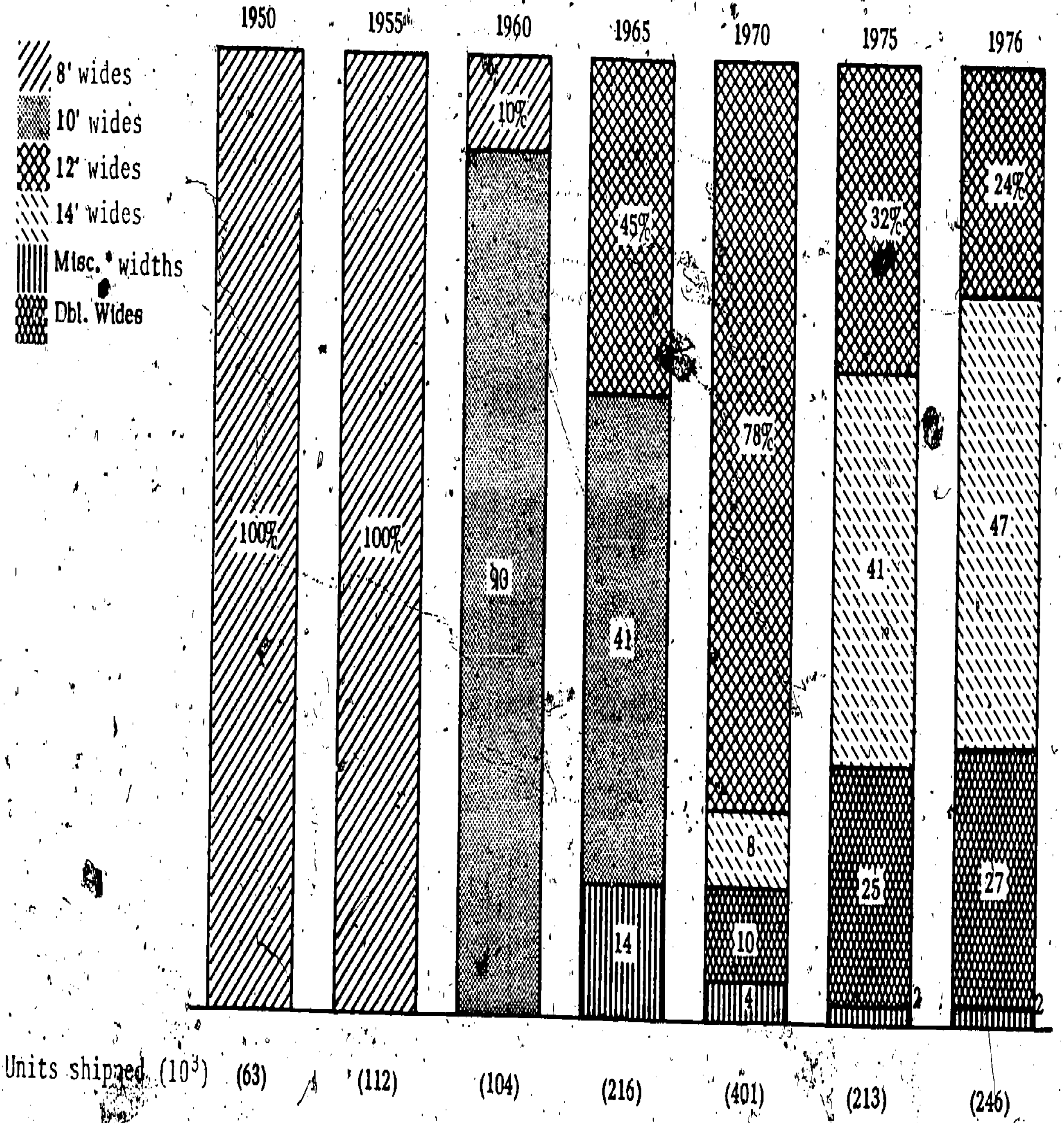
Table 5.5. 1976 Unit Shipments of Mobile Homes by Size

	Single-Wides									All Expandables	Double Wides					Other types	Total
	12' Wides				14' Wides						24' Wides				Other double wides		
	59' and under	60' to 64'	65' to 69'	70' and over	59' and under	60' to 64'	65' to 69'	70' to 74'	75' and over		49' and under	50' to 59'	60' to 69'	70' and over			
New England	95	454	127	153	159	321	586	1,635	23	38	55	43	31	0	17	15	3,752
Middle Atlantic	331	1,888	195	214	575	1,749	1,548	5,957	159	61	676	727	532	2	115	158	14,887
East North Central	486	1,821	151	93	1,537	3,417	2,710	11,957	9	195	1,072	1,999	2,471	7	321	74	28,320
West North Central	232	868	128	145	1,681	3,098	1,453	12,433	753	22	835	1,185	1,520	207	736	270	25,566
South Atlantic	3,419	14,489	7,104	5,334	202	887	622	1,881	47	4	5,528	6,167	8,327	340	9	303	54,663
East South Central	926	4,789	1,756	723	496	1,230	1,103	3,000	23	12	603	1,508	2,482	55	54	427	19,187
West South Central	1,024	1,708	435	146	2,167	6,855	1,745	10,191	8,351	38	294	1,383	1,801	106	407	681	37,332
Mountain	623	837	257	202	1,335	1,854	1,274	7,880	1,045	2	764	1,304	2,127	80	646	1,121	21,351
Pacific	784	4,540	1,523	1,011	680	2,595	379	7,688	101	55	1,939	5,210	10,929	355	1,956	1,323	41,068
Total U.S.	7,920	31,394	11,676	8,021	8,826	22,006	11,420	62,622	10,511	427	11,766	19,526	30,220	1,152	4,261	4,372	246,120
Percent of Total	3.2	12.8	4.7	3.3	3.6	8.9	4.6	25.4	4.3	0.2	4.8	7.9	12.3	0.5	1.7	1.8	100

Note: "Census Regions" and "Census Divisions" are described in Appendix C.

Source: Elrick and Lavidge, Inc., Manufactured Housing Institute, 1976 Data Book, Chicago, April 1977, pp. 12–13.

NOT ONLY ARE THE SIZES OF MOBILE HOMES INCREASING, BUT THE ABSOLUTE NUMBER HAS GROWN FROM 63,000 TO 246,000 SHIPMENTS IN 1950-1976.



*Includes 8', 10', 16', expandables and miscellaneous other sizes.

Figure 5.2. Mobile Home Size Trends in the United States.

Source: Elrick and Lavidge, Inc., Manufactured Housing Institute, 1976 Data Book, Chicago, April 1977, p. 6.

THE BUREAU OF THE CENSUS CONDUCTED THE SURVEY OF NEW MOBILE HOME PLACEMENTS TO DETERMINE MOBILE HOMES PLACED SPECIFICALLY FOR RESIDENTIAL PURPOSES. TOTAL MOBILE HOME SHIPMENTS INCLUDE NONRESIDENTIAL USES SUCH AS SCHOOL ROOMS, TEMPORARY BANK FACILITIES, AND OFFICES AT CONSTRUCTION SITES. THIS SURVEY DIFFERS FROM MOBILE HOME SHIPMENT DATA IN THAT IT SURVEYS BUSINESS ESTABLISHMENTS DEALING IN MOBILE HOMES RATHER THAN MANUFACTURERS. "MOBILE HOMES PLACED" ALSO EXCLUDES INVENTORY ON THE DEALER LOTS AT THE END OF THE REPORTING PERIOD. THE BUREAU OF CENSUS DATA DIFFERS SLIGHTLY FROM THE MANUFACTURED HOUSING INSTITUTE (MHI) DATA IN THAT MHI REQUIRES A MINIMUM DIMENSION REQUIREMENT OF 8 FEET WIDE OR 32 FEET LONG.

Table 5.6. New Mobile Homes Placed for Residential Use

Period	Units in thousands					Percent distribution				
	United States	Region				United States	Region			
		Northeast	North Central	South	West		Northeast	North Central	South	West
1974										
Total	345.8	26.4	85.6	166.7	67.1	100	8	25	48	19
1st quarter	92.9	5.6	17.2	50.7	19.4	100	6	19	55	21
2nd quarter	102.8	7.8	26.7	49.4	18.9	100	8	26	48	18
3rd quarter	93.5	8.8	26.2	42.1	16.4	100	9	28	45	18
4th quarter	56.6	4.2	15.4	24.4	12.5	100	7	27	43	22
1975										
Total	229.2	16.5	61.9	98.5	52.3	100	7	27	43	23
1st quarter	46.2	2.4	8.4	24.2	11.3	100	5	18	52	24
2nd quarter	62.1	4.2	18.0	25.3	14.6	100	7	29	41	24
3rd quarter	67.8	5.7	21.7	27.2	13.3	100	8	32	40	20
4th quarter	53.2	4.3	13.9	21.8	13.2	100	8	26	41	25
1976										
Total	245.8	18.5	68.1	96.2	63.1	100	8	28	39	26
1st quarter	47.2	2.3	11.1	22.6	11.2	100	5	23	[illegible]	24
2nd quarter	67.5	5.9	20.5	26.2	15.0	100	9	30	39	22
3rd quarter	73.5	6.1	22.2	26.5	18.7	100	8	30	35	25
4th quarter	57.6	4.2	14.3	20.9	18.2	100	7	25	36	32
1977										
1st quarter	48.7	2.0	9.5	20.7	16.5	100	4	20	43	34

Note: Totals may not add due to rounding.

Source: U.S. Department of Commerce, Bureau of the Census, Construction Reports - Housing Starts, Series C20-77-8, Washington, D.C. August 1977, Table S-1.

Table 5.7. Floor Area of New, Privately Owned Single-family Housing Units[a] (ft^2)

Location and square feet of floor area	Number of houses (10^3)						Percent distribution					
	1971	1972	1973	1974	1975	1976	1971	1972	1973	1974	1975	1976
All new houses												
United States, total	1,014	1,143	1,174	932	866	1,026	100	100	100	100	100	100
Northeast[b], total	134	149	155	131	113	120	100	100	100	100	100	100
Under 1,000	23	21	20	16	13	14	17	13	13	13	12	12
1,000 to 1,199	24	36	28	26	24	21	18	24	18	20	21	17
1,200 to 1,599	33	36	43	34	31	31	24	24	28	26	28	26
1,600 to 2,399	36	40	45	41	53	41	27	27	29	[illegible]	30	34
2,400 and over	18	16	19	14	11	13	14	11	12	11	10	11
North Central[b], total	208	231	255	217	215	270	100	100	100	100	100	100
Under 1,000	31	27	24	15	20	22	15	12	10	7	9	8
1,000 to 1,199	43	46	52	44	44	53	21	20	20	21	20	20
1,200 to 1,599	58	70	78	63	64	76	28	30	31	29	30	28
1,600 to 2,399	56	66	72	67	70	85	27	28	28	30	32	31
2,400 and over	20	22	29	28	17	34	10	9	11	13	8	13
South[b], total	467	524	514	394	358	405	100	100	100	100	100	100
Under 1,000	55	50	32	23	27	22	12	10	6	6	7	5
1,000 to 1,199	130	130	78	56	51	50	28	25	15	14	14	12
1,200 to 1,599	138	157	163	109	100	111	30	30	32	28	28	27
1,600 to 2,399	110	143	187	149	135	169	23	27	36	38	38	42
2,400 and over	34	44	54	57	45	53	7	8	11	14	13	13
West[b], total	204	239	251	190	181	231	100	100	100	100	100	100
Under 1,000	20	19	13	9	14	12	10	8	5	5	8	5
1,000 to 1,199	36	40	38	31	27	31	18	17	15	16	15	13
1,200 to 1,599	66	76	79	65	61	79	32	32	32	34	33	34
1,600 to 2,399	62	79	86	63	60	83	30	33	34	33	33	36
2,400 and over	20	[illegible]	35	22	19	26	10	11	14	11	11	11

[a] Includes houses built for rent.

[b] "Census Regions" and "Census Divisions" are described in Appendix C.

Source: U.S. Department of Commerce, Bureau of the Census, Characteristics of New Housing: 1976, Construction Reports, Series C25-76-13, Washington, D.C., July, 1977, Table 14 (also previous years).

Table 5.8. Principal Type of Exterior Wall Material of New Privately Owned Single-family Housing Units (10^3)

	1969	1970	1971	1972	1973	1974	1975	1976
United States, total[a]	710	716	1,012	1,143	1,174	932	866	1,026
Brick	276	278	370	414	413	322	276	323
Wood or wood products	200	216	291	336	355	294	313	393
Stucco	71	86	125	132	144	97	85	119
Aluminum siding	47	[illegible]	80	88	119	112	94	114
Other[b]	117	78	146	172	144	105	97	76
Northeast[c], total	101	90	129	149	155	131	113	120
Brick	13	11	12	13	13	9	10	10
Wood or wood products	51	51	71	87	79	60	50	54
Stucco	1	1	1	NA	NA	NA	NA	NA
Aluminum siding	13	13	20	21	30	27	22	29
Other[b]	24	14	25	27	32	33	30	26
North Central[c], total	156	150	208	231	255	217	215	270
Brick	47	46	57	58	58	43	34	41
Wood or wood products	62	63	87	96	111	100	117	155
Stucco	1	1	1	NA	NA	NA	NA	NA
Aluminum siding	26	37	47	53	64	59	46	60
Other[b]	19	3	16	23	20	14	16	14
South[c], total	313	326	468	524	514	394	358	405
Brick	204	211	453	331	328	256	218	258
Wood or wood products	49	62	287	86	80	60	72	85
Stucco	7	9	72	16	25	18	10	14
Aluminum siding	7	8	14	14	24	24	22	22
Other[b]	46	36	13	77	57	36	35	26
West[c], total	141	151	222	239	251	190	181	231
Brick	12	10	14	12	15	14	15	14
Wood or wood products	38	40	62	68	86	75	75	99
Stucco	61	75	110	113	114	76	73	103
Aluminum siding	2	d	d	NA	NA	3	3	4
Other[b]	28	26	36	45	35	22	16	11

[a] Includes only those houses reporting type of exterior wall material.

[b] Includes asbestos shingle, cinder block, cement block, stone, and other types.

[c] "Census Regions" and "Census Divisions" are described in Appendix C.

[d] Fewer than 500 houses.

NA - Not available.

Note: Totals may not add due to rounding.

Source: U.S. Department of Commerce, Bureau of the Census, Characteristics of New Housing: 1976, Construction Reports, Series C25-76-13, Washington, D.C., July 1977, Table 6 (also previous years).

Table 5.9. Number of Stories of New, Privately Owned, Single-family Housing Units by Census Regions (10³)

	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976
United States, total[a]	776	789	820	733	764	1,022	1,143	1,174	932	866	1,026
1 story	557	561	571	509	561	739	824	787	604	566	650
2 stories or more[b]	141	147	167	142	129	182	210	269	233	197	254
Split-level	79	82	82	82	73	101	108	118	95	103	122
Northeast[c], total	125	115	121	106	100	130	149	155	131	113	120
1 story	56	48	48	40	45	60	71	68	59	54	46
2 stories or more	51	48	57	46	38	50	59	68	59	48	62
Split-level	19	19	16	21	16	20	19	19	13	11	12
North Central[c], total	186	184	203	160	163	211	231	255	217	215	270
1 story	113	111	120	94	101	129	141	147	129	122	147
2 stories or more	35	39	47	36	33	41	46	59	51	47	65
Split-level	37	34	36	31	30	41	44	49	37	46	58
South[c], total	331	338	338	322	348	458	524	514	394	358	405
1 story	286	289	286	267	297	382	435	399	296	277	311
2 stories or more	30	32	34	38	37	54	64	85	74	59	71
Split-level	14	17	18	17	14	22	25	30	24	21	23
West[c], total	135	152	157	245	153	223	239	251	190	181	231
1 story	101	113	117	110	119	168	177	173	120	113	147
2 stories or more	24	27	28	22	21	37	41	57	49	44	56
Split-level	9	12	11	13	13	18	21	20	21	25	28

[a] Total may not add due to rounding.

[b] Includes a small number of houses with 1 1/2, 2 1/2, or 3 stories.

[c] "Census Regions" and "Census Divisions" are described in Appendix C.

Source: U.S. Department of Commerce, Bureau of the Census, Characteristics of New Housing, Construction Reports, Series C-25, Washington, D.C., July 1977, Table 13 (also previous years).

Table 5.10. Average Square Feet of Units in Multifamily Buildings[a]

Average square feet per unit per building[b]	Units (10³)						Percent distribution					
	1971	1972	1973	1974	1975	1976	1971	1972	1973	1974	1975	1976
United States, total	692	828	840	760	430	336	100	100	100	[illegible]	100	100
Less than 600	88	102	106	85	43	35	13	12	13	11	10	10
600 to 799	155	186	196	159	90	90	22	22	23	21	21	27
800 to 999	221	264	247	220	115	94	32	32	29	29	27	28
1,000 to 1,199	132	162	163	141	79	59	19	20	19	19	18	18
1,200	95	115	128	156	103	58	14	14	15	20	24	17
Northeast[c], total	91	132	131	95	69	45	100	100	100	100	100	100
Less than 600	8	17	17	11	9	5	9	13	13	11	13	9
600 to 799	13	23	21	16	8	6	14	18	16	17	11	12
800 to 999	20	39	39	29	20	13	22	29	30	31	28	28
1,000 to 1,199	31	30	31	21	17	12	33	22	24	22	24	26
1,200	20	24	22	18	17	13	22	18	17	19	24	26
North Central[c], Total	140	174	175	152	93	83	100	100	100	100	100	100
Less than 600	26	28	18	23	8	7	18	16	10	15	8	8
600 to 799	32	33	37	31	23	25	23	19	21	20	25	30
800 to 999	46	55	53	48	31	26	33	31	30	32	33	31
1,000 to 1,199	23	36	34	27	15	15	17	21	20	18	16	19
1,200	13	22	31	23	16	9	9	12	18	15	17	11
South[c], total	260	304	333	344	164	101	100	100	100	100	100	100
Less than 600	31	33	44	35	14	10	12	11	13	10	8	10
600 to 799	52	67	72	70	34	28	20	22	22	20	21	28
800 to 999	87	93	94	95	38	27	33	30	28	28	23	26
1,000 to 1,199	47	61	69	66	32	17	18	20	21	19	20	17
1,200	43	51	55	78	46	19	16	17	16	23	28	19
West[c], total	201	218	202	170	103	103	100	100	100	100	100	100
Less than 600	23	24	27	16	12	13	12	11	13	9	12	13
600 to 799	59	62	66	42	25	31	29	29	33	25	24	80
800 to 999	68	77	61	48	26	28	34	36	30	28	25	27
1,000 to 1,199	31	35	29	28	16	14	15	16	14	16	15	14
1,200	19	19	19	36	25	17	10	9	10	22	24	17

[a] Consists of privately owned multifamily completions.

[b] All units in building are included in one size category based on average number of square feet per housing unit. The average was calculated using total square feet of all floors based on exterior dimensions divided by number of housing units in the building. Hallways, lobbies, elevator shafts were included in the total floor area; unfinished basements, common laundry rooms, etc. were excluded.

[c] "Census Regions" and "Census Divisions" are described in Appendix C.

Source: U.S. Department of Commerce, Bureau of the Census, Characteristics of New Housing, Construction Reports, Series C-25, Washington, D.C., 1977, Table 17 (also previous years).

Table 5.11: Number of Floors and Units in New Multifamily Buildings[a]

	Number of units (10^3)						Percent distribution					
	1971	1972	1973	1974	1975	1976	1971	1972	1973	1974	1975	1976
Number of floors per building												
United States, total	692	828	840	760	430	336	100	100	100	100	100	100
1 to 3 floors	581	702	705	635	331	288	84	85	84	84	77	86
4 floors or more	111	126	135	125	100	48	16	15	16	16	23	14
Northeast,[b] total	91	132	131	95	69	49	100	100	100	100	100	100
1 to 3 floors	61	90	89	63	39	33	66	68	68	66	56	68
4 floors or more	31	[illegible]	42	32	31	15	34	32	32	34	44	32
North Central,[b] total	140	174	175	152	93	83	100	100	100	100	100	100
1 to 3 floors	117	149	142	130	84	78	84	86	81	86	90	94
4 floors or more	23	25	33	21	9	5	16	14	19	14	10	6
South,[b] total	260	304	333	344	164	101	100	100	100	100	100	100
1 to 3 floors	218	263	293	287	122	84	84	87	88	83	74	83
4 floors or more	42	41	39	57	42	17	16	13	12	17	26	17
West,[b] total	201	218	202	170	103	103	100	100	100	100	100	100
1 to 3 floors	185	200	181	155	86	93	92	92	90	91	83	90
4 floors or more	16	17	21	15	18	10	8	8	10	9	17	10
Number of units per building												
United States, total	692	828	840	760	430	336	100	100	100	100	100	100
2 to 4 units	106	118	121	93	59	76	15	14	14	12	14	23
5 to 9 units	118	143	167	151	85	65	17	17	20	20	20	19
10 to 19 units	159	213	210	174	92	73	23	26	25	23	21	22
20 to 29 units	85	107	100	91	45	37	12	13	12	12	10	11
30 to 49 units	66	78	80	89	41	31	9	9	9	12	9	9
50 units or more	159	169	163	163	109	54	23	20	19	21	25	16
Northeast,[b] total	91	132	131	95	69	49	100	100	100	100	100	100
2 to 4 units	14	17	17	13	8	9	16	13	13	14	12	18
5 to 9 units	5	12	16	13	8	7	6	9	12	13	11	14
10 to 19 units	16	38	33	15	10	11	18	29	25	15	14	23
20 to 29 units	12	13	13	7	5	4	14	10	10	7	7	8
30 to 49 units	9	6	10	11	6	3	10	5	8	11	9	6
50 units or more	34	45	42	37	32	15	37	34	32	39	47	32
North Central,[b] total	140	174	175	152	93	83	100	100	[illegible]	100	100	100
2 to 4 units	19	22	23	19	15	21	14	13		[illegible]	16	25
5 to 9 units	21	23	25	25	18	14	15	13			20	17
10 to 19 units	30	40	40	34	20	18	22	23	23	23	21	22
20 to 29 units	21	29	27	21	14	13	15	17	15	14	14	15
30 to 49 units	14	26	21	17	10	10	10	15	12	11	11	13
50 units or more	35	34	39	35	17	7	25	19	22	23	18	8
South,[b] total	260	304	333	344	164	101	100	100	100	100	100	100
2 to 4 units	35	37	39	28	15	18	14	12	12	8	9	18
5 to 9 units	61	73	88	84	37	25	24	24	27	24	23	25
10 to 19 units	69	86	96	91	40	23	27	28	29	27	24	23
20 to 29 units	30	39	38	40	17	11	11	13	11	12	10	10
30 to 49 units	20	21	31	41	16	8	8	7	9	12	10	8
50 units or more	44	47	40	59	39	17	17	16	12	17	24	17
West,[b] total	201	218	202	170	103	103	100	100	100	100	100	100
2 to 4 units	37	42	42	32	21	29	18	19	21	19	20	28
5 to 9 units	31	34	38	30	21	19	15	16	19	17	21	18
10 to 19 units	43	49	41	33	22	21	21	22	20	20	22	20
20 to 29 units	22	26	22	23	9	10	11	12	11	13	9	9
30 to 49 units	22	24	17	20	9	9	11	11	9	12	8	9
50 units or more	46	43	42	32	21	15	23	20	21	19	20	15

[a] Includes privately owned multifamily housing completions.

[b] "Census Regions" and "Census Divisions" are described in Appendix C.

Note: Totals may not add due to rounding.

Source: U.S. Department of Commerce, Bureau of the Census, Characteristics of New Housing: 1976, Construction Reports, Series C-25, Washington, D.C., 1977, Table 17 (also previous years).

Table 5-12. Home Insulation[a] by House Heating Fuel, 1975 (10^3)

	Utility gas	Bottled, tank, or LP gas	Fuel oil	Electricity	All other or none	Total
Total	27483.0	3155.8	9949.2	4775.5	1505.7	46869.2
Storm window or other protective window covering						
All windows covered	12053.7	1124.5	6332.5	1950.7	275.6	21737.0
Some windows covered	2393.7	306.9	1473.7	422.8	196.0	4793.1
No windows covered	12945.8	1716.5	2106.1	2383.4	1028.3	20180.1
Not reported	89.8	7.9	36.9	18.7	5.8	159.1
Storm doors						
All doors covered	13094.0	1186.2	6668.9	1853.1	311.1	23113.2
Some doors covered	2996.7	344.0	1338.9	565.1	151.0	5395.7
No doors covered	11295.7	1615.7	1894.5	2337.2	1039.2	18182.2
Not reported	96.5	9.9	46.9	20.2	4.4	178.0
Attic or roof insulation						
Yes	20640.1	1894.3	7877.3	4228.0	499.4	35139.1
No	4368.5	1024.6	1492.0	309.8	816.8	8011.8
Don't know or not reported	2474.5	236.8	579.9	237.7	189.5	3718.3
Homes with one or more of these types of insulation	23244.6	2270.5	9308.8	4432.1	760.5	40016.5
Homes with one or more of these types of insulation as a percentage of total	84.58	71.95	93.56	92.81	50.51	85.38

Note: Totals may not add due to rounding.

[a] Limited to occupied one - family detached housing units.

Source: U.S. Department of Commerce, Bureau of the Census, Annual Housing Survey: 1975, FEA Special tabulation, Washington, D.C., February 1977.

Table 5.13. Retrofit Home Insulation[a] by House Heating Fuel, 1975 (10^3)

	Utility gas	Bottled, tank, or LP gas	Fuel oil	Electricity	All other or none	Total
Total[a]	27,483.0	3,195.8	9,949.2	4,775.5	1,505.2	46,869.2
Storm doors added[b]	16,090.8	1,530.1	8,007.8	2,418.2	462.1	28,508.9
Yes	1,377.6	141.8	640.1	270.7	47.6	2,477.7
No	14,139.0	1,316.2	7,116.0	2,044.0	395.0	25,010.3
Not reported	574.2	72.1	251.6	103.5	19.5	1,020.9
Storm windows added[b]	14,447.4	1,431.4	7,806.2	2,373.5	471.5	26,530.0
Yes	1,302.7	195.6	797.0	276.8	85.4	2,657.4
No	12,653.4	1,167.9	6,774.5	1,976.0	363.1	22,934.8
Not reported	491.3	68.0	234.7	120.7	23.1	937.9
Attic insulation added[b]	1,146.8	118.0	638.8	287.8	48.4	2,239.7
Less than 3 inches	90.8	6.4	50.7	24.8	6.4	179.1
3 inches to 6 inches	615.8	60.5	343.1	126.3	26.2	1,171.9
6 inches or more	304.2	34.6	195.5	105.9	12.3	652.4
Don't know or not reported	136.0	16.5	49.5	30.9	3.5	236.4
Wall insulation added[b]	1,596.1	177.2	883.2	365.8	71.3	3,093.6
Yes	737.8	111.6	448.1	206.1	46.1	1,549.8
No	820.1	57.0	429.1	146.9	23.7	1,476.8
Not reported	38.2	8.6	6.0	12.8	1.5	67.0
Storm doors, storm windows, attic insulation, wall insulation, caulking, or weather stripping added	5,897.8	604.0	2,637.6	1,021.4	233.4	10,394.2
Storm doors, storm windows, attic insulation, wall insulation, caulking or weather stripping added as a percentage of total	21.46	19.14	26.51	21.39	15.50	22.[illegible]8
Storm windows, storm doors, or attic insulation added	3420.5	397.0	1,75[illegible].6	684.9	167.5	6,423.5
Storm windows, storm doors, or attic insulation added as a percentage of total	12.45	12.58	17.63	14.34	11.1	13.71

[a] Includes occupied one-family detached housing units.

[b] Total includes those units reporting retrofit projects.

Source: U.S. Department of Commerce, Bureau of the Census, Annual Housing Survey: 1975, FEA Special Tabulation, Washington, D.C., February 1977.

Table 5.14. Thermal Resistance (R) Values of Insulation by Percent of Single-family Detached Units in 1974

	N.E.[a]	M.A.	E.N.C.	W.N.C.	S.A.	E.S.C.	W.S.C.	M.	P.	Total United States
Total number of units	3,600	12,000	18,000	8,400	24,000	7,200	18,000	10,800	18,000	120,000
Exterior walls										
None	6.0	1.1	1.2	1.9	29.5	2.2	4.1	0.8	6.0	8.3
R-3	0	0	0	0	2.6	0.8	0.3	40.8	9.6	5.9
R-7	0	6.3	6.6	0	8.5	9.7	5.9	2.9	15.1	7.3
R-11	91.1	92.6	91.9	90.5	59.2	86.4	89.7	55.5	69.2	77.8
R-19	0	0	0	5.7	0	0	0	0	0	0.4
Other	2.9	0	0.3	1.9	0.2	0.9	0	0	0.1	0.3
Ceiling roof										
None	0	1.6	3.3	2.3	1.3	4.2	5.4	0.8	4.8	2.9
R-9	2.8	0.7	7.5	8.9	8.5	4.7	3.3	1.2	4.5	5.2
R-11	0	11.4	0	0	0.7	2.0	1.6	11.6	16.3	5.1
R-13	20.7	9.3	35.9	32.7	54.3	45.6	45.6	7.1	28.2	34.7
R-18	6.9	3.6	23.7	24.5	5.6	15.1	5.2	9.4	4.4	10.2
R-19	32.7	46.0	12.5	1.1	22.2	13.9	26.9	47.8	41.6	27.3
R-22	29.1	27.2	13.2	9.1	1.9	11.5	11.3	20.8	0.1	10.7
R-26	4.8	0.2	3.6	19.6	5.1	2.1	0.7	1.6	0	3.5
Other	3.0	0	0.3	1.8	0.4	0.9	0	0	0.1	0.4
Floor joists										
None	62.2	53.4	79.9	69.8	50.8	52.4	39.6	83.4	83.6	63.4
R-7	0	7.7	1.4	0	0	0	0	1.0	0	1.0
R-11	28.6	38.9	10.7	0	49.1	47.1	60.4	15.6	16.4	32.1
R-19	8.1	0	7.9	29.6	0	0	0	0	0	3.4
Other	1.1	0	0.1	0.6	0.1	0.5	0	0	0	0.1

[a] N.E. = New England, M.A. = Middle Atlantic, E.N.C. = East North Central, W.N.C. = West North Central, S.A. - South Atlantic, E.S.C. = East South Central, W.S.C. = West South Central, M. = Mountain, P. = Pacific. "Census Regions" and "Census Divisions" are described in Appendix C.

Note: Identical information is available from this source for the years 1961 and 1973.

Source: National Association of Home Builders Research Foundation, Office of Technology Assessment, Congress of the United States, Thermal Characteristics of Homes Built in 1974, 1973, and 1961, Rockville, Md., July 1977, p. 7.

Table 5.15. Average Annual Climatological Data for Selected Cities

Division, city, and state	Maximum Temperature[a] (F°)	Minimum Temperature[a] (F°)	Precipitation[a] (in.)	Wind speed[b] (mph)	Heating degree-days[a] (65° base)
New England[c]					
Hartford, Conn.	59.6	38.6	43.37	9.0	6,350
Portland, Maine	55.3	34.7	40.80	8.8	7,498
Boston, Mass.	58.7	43.8	42.52	12.7	5,621
Concord, N. H.	57.5	33.7	36.17	6.7	7,360
Providence, R. I.	59.0	40.9	42.75	10.8	5,972
Burlington, Vt.	54.2	34.5	32.54	8.8	7,876
Middle Atlantic[c]					
Atlantic City, N. J.	63.6	43.8	45.46	10.8	4,946
Albany, N. Y.	58.1	37.1	33.36	8.8	6,888
Philadelphia, Pa.	64.2	44.9	39.93	9.6	4,865
South Atlantic[c]					
Wilmington, Del.	63.7	44.3	40.25	9.1	4,940
Washington, D. C.	66.7	47.8	38.89	9.3	4,211
Jacksonville, Fla.	78.1	58.7	54.47	8.6	1,327
Atlanta, Ga.	70.3	51.3	48.34	9.1	3,095
Baltimore, Md.	65.1	44.8	40.46	9.5	4,729
Charlotte, N. C.	71.2	49.7	42.72	7.6	3,218
Columbia, S. C.	75.4	51.5	46.36	7.0	2,598
Norfolk, Va.	68.0	50.6	44.68	10.6	3,488
Charleston, W. Va.	66.0	44.4	40.75	6.5	4,590
East North Central[c]					
Chicago, Ill.	59.4	41.8	34.44	10.3	6,127
Detroit, Mich.	58.3	41.4	30.96	10.2	6,228
Cincinnati, Ohio	64.4	43.5	39.04	9.1	5,070
Indianapolis, Ind.	62.2	42.4	38.74	9.7	5,577
Milwaukee, Wis.	55.1	36.3	29.07	11.8	7,444
East South Central[c]					
Mobile, Ala.	77.3	57.4	66.98	9.3	1,684
Louisville, Ky.	65.9	45.3	43.11	8.4	4,645
Jackson, Miss.	77.1	52.8	49.19	7.7	2,300
Memphis, Tenn.	71.7	51.5	49.10	9.2	3,227
West North Central[c]					
Des Moines, Iowa	58.3	39.7	30.85	11.1	6,710
Wichita, Kans.	67.6	45.6	30.58	12.6	4,687
Duluth, Minn.	48.1	29.1	30.18	11.5	9,756
Kansas City, Mo.	63.7	45.3	37.00	10.1	5,161
Omaha, Nebr.	62.8	40.2	30.18	10.9	6,049
Bismarck, N. Dak.	53.5	29.3	16.16	10.6	9,044
Sioux Falls, S. Dak.	56.5	34.2	24.72	11.2	7,838
West South Central[c]					
Little Rock, Ark.	72.6	49.3	48.52	8.2	3,354
New Orleans, La.	77.7	58.9	56.77	8.4	1,465
Oklahoma City, Okla.	71.1	48.7	31.37	12.9	3,695
Dallas, Tex.	76.5	54.4	32.30	11.2	2,382
Mountain[c]					
Phoenix, Ariz.	85.1	55.4	7.05	6.0	1,552
Denver, Colo.	64.0	32.2	15.51	9.0	6,016
Boise, Idaho	62.6	39.1	11.50	9.0	5,833
Great Falls, Mont.	55.9	33.8	14.99	13.1	7,652
Reno, Nev.	67.0	31.7	7.20	6.3	6,022
Albuquerque, N. Mex.	70.0	43.5	7.77	8.9	4,292
Salt Lake City, Utah	63.8	38.2	15.17	8.7	5,983
Cheyenne, Wyo.	58.8	33.0	14.65	13.3	7,255
Pacific[c]					
Juneau, Alaska	47.0	33.5	54.67	8.5	9,007
Los Angeles, Calif.	69.2	54.1	11.59	7.4	1,819
Honolulu, Hawaii	83.3	69.8	22.90	11.8	
Portland, Oreg.	61.6	43.6	37.61	7.7	4,792
Seattle, Wash.	57.2	43.3	38.79	9.3	5,185

[a] Based on a standard 30-year period, 1941–1970.

[b] U.S. National Oceanic and Atmospheric Administration period of record through 1974.

[c] "Census Regions" and "Census Divisions" are described in Appendix C.

Source: U.S. Department of Commerce, Bureau of the Census, Statistical Abstract of the United States, 97th Edition, Washington, D.C., 1976, Table 325, Table 326, Table 329, Table 333, and Table 334.

THE CITIES SELECTED FOR THIS TABLE REPRESENT EACH OF THE NINE CENSUS DIVISIONS. THEY WERE RANDOMLY SELECTED TO PRESENT AN INDICATION OF THE VARIATION, BY CENSUS DIVISION, OF PRECIPITATION, WIND SPEED, AND HEATING DEGREE-DAYS OVER A 30-YEAR PERIOD.

Table 5.16. Average Monthly Climatological Data by Selected Cities[a]

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Precipitation, in.												
Los Angeles, Calif.	2.52	2.32	1.71	1.10	0.08	0.03	0.01	0.02	0.07	0.22	1.76	2.39
Great Falls, Mont.	0.88	0.75	0.97	1.18	2.37	3.11	1.27	1.09	1.17	0.68	0.81	0.71
Denver, Colo.	0.61	0.67	1.21	1.93	2.64	1.93	1.78	1.29	1.[illegible]	1.13	0.76	0.43
Dallas, Tex.	1.80	2.36	2.54	4.30	4.47	3.05	1.84	2.26	3.15	2.68	2.03	1.8[illegible]
Des Moines, Iowa	1.14	1.05	2.31	2.94	4.21	4.90	3.28	3.30	3.07	2.14	1.42	1.09
Cincinnati, Ohio	3.34	3.04	4.09	3.64	3.74	3.81	4.12	2.62	2.55	2.15	3.08	2.86
Charlotte, N. C.	3.51	3.83	4.52	3.40	2.90	3.70	4.57	3.96	3.46	2.69	2.74	3.44
Jacksonville, Fla.	2.78	3.58	3.56	3.07	3.22	6.27	7.35	7.89	7.83	4.54	1.79	2.59
Albany, N. Y.	2.20	2.11	2.58	2.70	3.26	3.00	3.12	2.87	3.12	2.63	2.84	2.93
Wind speed, mph												
Los Angeles, Calif.	6.7	7.3	8.0	8.4	8.2	7.9	7.6	7.5	7.1	6.8	6.6	6.6
Great Falls, Mont.	15.8	14.9	13.5	13.2	11.5	11.4	10.3	10.5	11.7	13.7	15.0	16.0
Denver, Colo.	9.2	9.3	9.9	10.4	9.4	9.0	8.5	8.2	8.2	8.2	8.7	9.0
Dallas, Tex.	11.5	12.3	13.4	13.2	11.6	11.1	9.8	9.3	9.8	9.9	10.9	11.3
Des Moines, Iowa	11.7	11.8	13.1	13.4	11.7	10.5	9.0	8.8	9.7	10.6	11.7	11.5
Cincinnati, Ohio	10.7	10.7	11.2	10.9	8.9	7.9	7.1	6.7	7.4	8.0	9.6	10.1
Charlotte, N. C.	8.0	8.5	8.9	9.0	7.7	6.9	6.7	6.6	6.9	7.1	7.4	7.5
Jacksonville, Fla.	8.5	9.7	9.6	9.3	8.9	8.6	7.7	7.4	8.5	8.8	8.4	8.[illegible]
Albany, N. Y.	9.8	10.3	10.5	10.4	9.1	8.1	7.3	6.9	7.3	7.9	8.9	9.1
Heating degree-days, 65° F Base												
Los Angeles, Calif.	331	270	267	195	114	71	19	15	23	77	158	267
Great Falls, Mont.	1380	1075	1070	648	367	162	18	42	260	524	912	1194
Denver, Colo.	1088	902	868	525	253	80	0	0	120	408	768	1004
Dallas, Tex.	626	456	335	88	0	0	0	0	0	60	28[illegible]	530
Des Moines, Iowa	1414	1142	964	465	186	26	0	13	94	350	8[illegible]6	1240
Cincinnati, Ohio	1051	888	722	341	138	9	0	0	44	271	636	970
Charlotte, N. C.	710	588	461	145	34	0	0	0	10	152	[illegible]20	698
Jacksonville, Fla.	348	282	176	24	0	0	0	0	0	19	161	317
Albany, N. Y.	1349	1162	980	543	253	39	9	22	135	422	762	1212

[a] Based on standard 30-year period, 1941-1970.

Source: U.S. Department of Commerce, Bureau of the Census, Statistical Abstract of the United States, 97th Edition, Washington, D.C., 1976, Table 329, Table 333, and Table 334.

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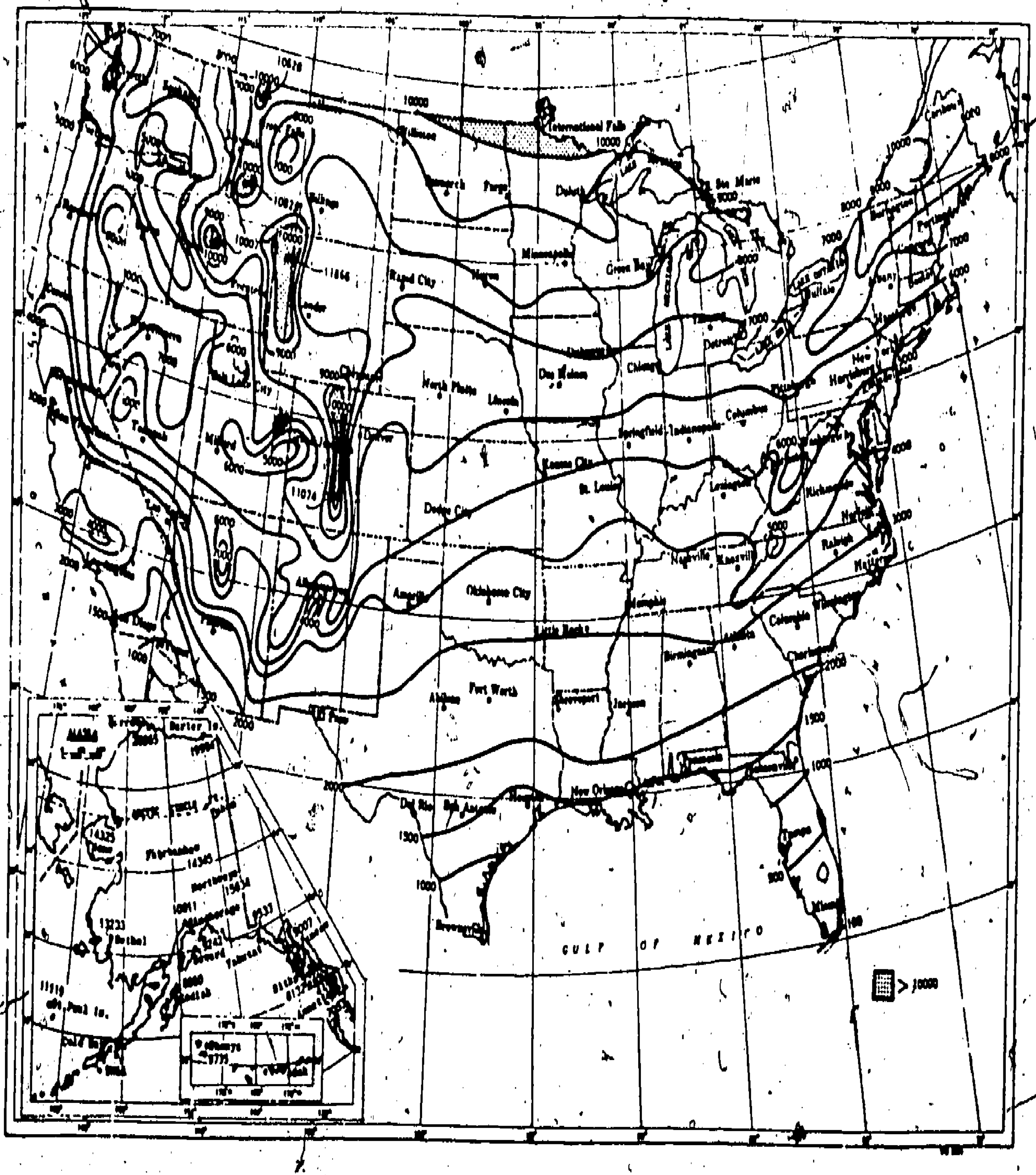

Figure 5.3. Normal Seasonal Heating Degree-Days (Base 65°F) 1941-1970.

Source: James A. Ruffner and Frank E. Bair (Editors), The Weather Almanac, 2nd Edition, Gale Research Company, Detroit, Mich., 1977, p. 306.

Table 5.17. Cooling Degree-Days by Selected Cities

Division and city and state	1974	1975	1976	Normals[a]-Jan. to Dec.
New England[b]				
Hartford, Conn.	764	870	819	584
Portland, Maine	296	351	308	252
Boston, Mass.	646	862	895	661
Concord, N.H.	302	553	419	349
Providence, R.I.	666	694	631	532
Burlington, Vt.	442	699	483	396
Middle Atlantic[b]				
Atlantic City, N.J.	906	883	765	864
Albany, N.Y.	386	597	476	574
Philadelphia, Pa.	1,165	1,243	1,211	1,104
South Atlantic[b]				
Wilmington, Del.	1,109	1,101	1,003	992
Washington, D.C.	872	1,001	779	940
Jacksonville, Fla.	2,460	2,784	2,179	2,596
Atlanta, Ga.	1,506	1,600	1,254	1,589
Baltimore, Md.	1,038	1,245	1,149	1,108
Charlotte, N.C.	1,337	1,601	1,255	1,596
Columbia, S.C.	2,195	2,230	1,975	2,087
Norfolk, Va.	1,531	1,744	1,558	1,441
Charleston, W. Va.	910	1,074	801	1,055
East North Central[b]				
Chicago, Ill.	610	1,040	766	664
Detroit, Mich.	854	1,025	967	743
Cincinnati, Ohio	1,024	1,364	908	1,118
Indianapolis, Ind.	850	1,046	770	974
Milwaukee, Wis.	386	598	667	450
East South Central[b]				
Mobile, Ala.	2,548	2,732	2,405	2,577
Louisville, Ky.	1,055	1,506	1,130	1,268
Jackson, Miss.	2,036	2,300	1,943	2,321
Memphis, Tenn.	1,840	2,184	1,800	2,029
West North Central[b]				
Des Moines, Iowa	974	1,237	1,050	928
Wichita, Kans.	1,466	1,512	1,417	1,673
Duluth, Minn.	149	229	271	176
Kansas City, Mo.	1,159	1,534	1,296	1,420
Omaha, Nebr.	1,021	1,389	1,249	1,173
Bismarck, N. Dak.	409	433	663	487
Sioux Falls, S. Dak.	751	910	1,040	719
West South Central[b]				
Little Rock, Ark.				
New Orleans, La.	2,655	2,637	2,390	2,706
Oklahoma City, Okla.	1,651	1,615	1,702	1,876
Dallas, Tex.	2,578	2,609	2,251	2,587
Mountain				
Phoenix, Ariz.	4,285	3,785	3,965	3,508
Denver, Colo.	715	554	667	625
Boise, Idaho	851	789	535	714
Great Falls, Mont.	473	315	389	339
Reno, Nev.	258	348	236	329
Albuquerque, N. Mex.	1,353	1,100	1,141	1,316
Salt Lake City, Utah	1,191	900	943	927
Cheyenne, Wyo.				
Pacific[b]				
Juneau, Alaska	0	7	6	0
Los Angeles, Calif.	627	505	864	615
Honolulu, Hawaii	4,643	4,166	4,395	4,221
Portland, Oreg.	409	342	216	300
Seattle, Wash.	184	120	73	183

[a] 30-year average.

[b] "Census Regions" and "Census Divisions" are described in Appendix C.

Source: U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Climatological Data, National Summary, Vol. 27, No. 12, Asheville, N.C., December 1976, pp. 13-16. (Also previous years.)

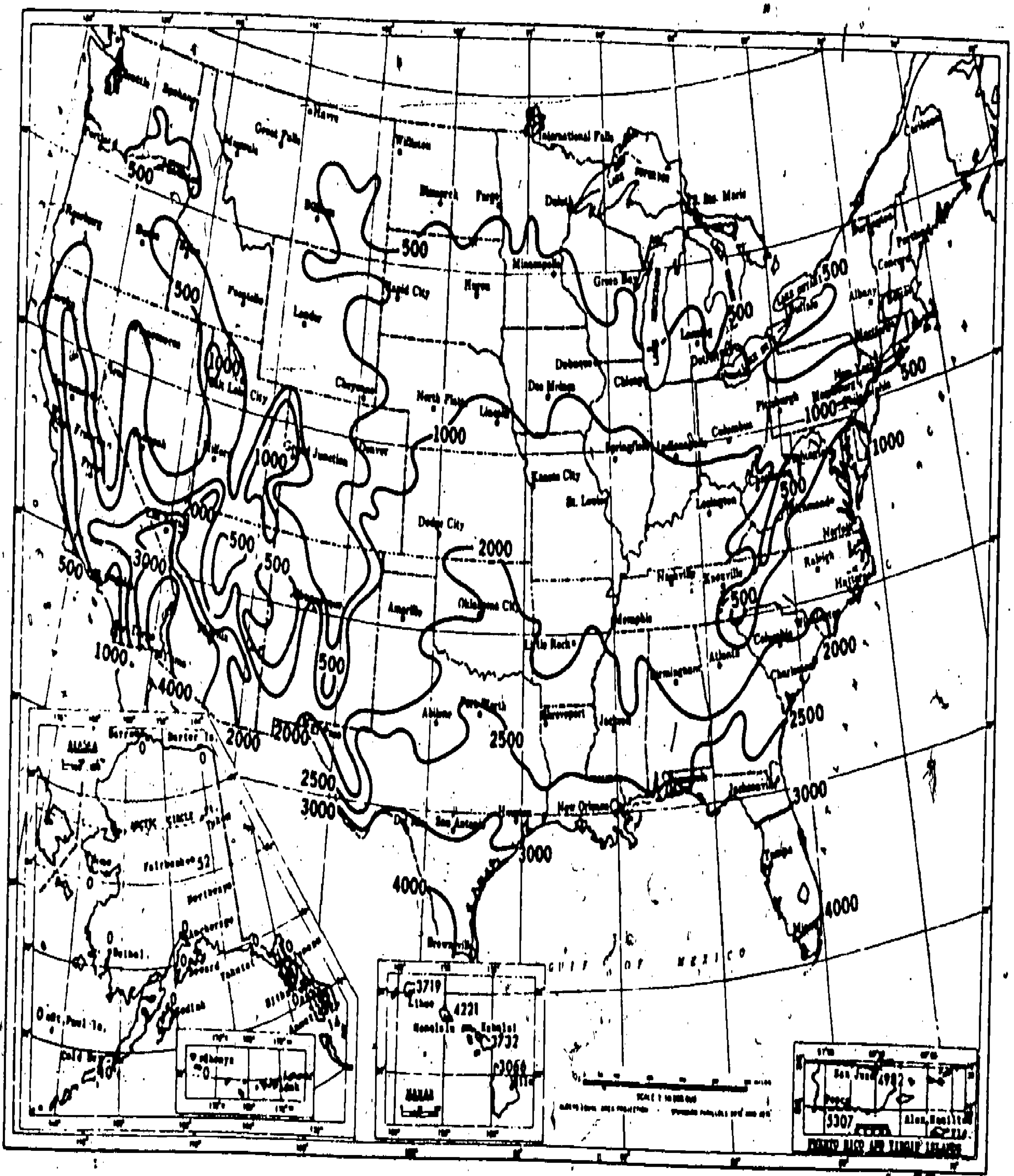

Figure 5.4. Normal Seasonal Cooling Degree-Days (Base 65°F) 1941–1970.

Source: James A. Ruffner and Frank E. Bair (Editors), The Weather Almanac, 2nd Edition, Gale Research Company, Detroit, Mich., 1977, p. 307.

Table 5.18. Average Annual Humidity by Selected Cities[a]

	1974				1975				1976			
	1:00 AM[b]	7:00 AM	1:00 PM	7:00 PM	1:00 AM	7:00 AM	1:00 PM	7:00 PM	1:00 AM	7:00 AM	1:00 PM	7:00 PM
New England[c]												
Hartford, Conn.	76	78	53	63	75	76	53	63	74	75	51	61
Portland, Maine	80	78	60	72	84	80	62	75	78	56	58	70
Boston, Mass.	73	73	57	65	70	70	57	63	69	68	53	61
Concord, N. H.	84	84	56	68	85	85	56	60	84	83	55	68
Providence, R. I.	77	75	55	66	77	76	57	67	77	76	54	67
Burlington, Vt.	76	77	61	65	77	79	61	65	75	78	63	66
Middle Atlantic[c]												
Atlantic City, N. J.	81	80	58	73	87	87	63	78	78	77	52	67
Albany, N. Y.	82	82	58	69	79	78	56	68	81	81	59	68
Philadelphia, Pa.	72	73	52	60	75	76	56	64	71	72	51	59
South Atlantic[c]												
Wilmington, Del.	76	77	55	64	75	76	55	64	74	75	52	61
Washington, D. C.	83	85	57	67	83	84	58	70	79	81	51	62
Jacksonville, Fla.	90	92	58	77	89	90	60	77	88	90	59	76
Atlanta, Ga.	79	85	57	63	81	85	61	67	74	80	53	58
Baltimore, Md.	77	80	58	64	77	79	58	65	74	77	53	59
Charlotte, N. C.	77	83	57	63	78	83	57	65	74	82	53	57
Columbia, S. C.	86	90	54	66	86	89	56	69	80	84	47	60
Norfolk, Va.	77	78	57	68	79	79	59	70	73	73	50	61
Charleston, W. Va.	80	85	60	63	80	84	59	64	74	80	54	57
East North Central[c]												
Chicago, Ill.	76	80	62	65	77	80	61	64	71	75	55	56
Indianapolis, Ind.	83	87	66	71	86	89	67	72	83	88	60	65
Detroit, Mich.	71	73	57	60	71	74	58	61	67	70	54	56
Cincinnati, Ohio	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Milwaukee, Wis.	77	79	64	68	81	83	66	71	75	78	60	63
East South Central[c]												
Mobile, Ala.	83	87	59	68	84	87	61	70	80	84	53	64
Louisville, Ky.	75	80	60	61	77	82	60	63	76	82	57	59
Jackson, Miss.	86	90	59	66	90	93	64	73	88	93	59	67
Memphis, Tenn.	82	87	64	66	74	79	59	61	68	74	51	53
West North Central[c]												
Des Moines, Iowa	74	78	59	60	73	78	59	60	66	71	50	51
Wichita, Kans.	75	80	57	58	75	82	58	59	67	75	48	46
Duluth, Minn.	81	84	68	67	78	82	67	66	71	74	56	54
Kansas City, Mo.	72	78	58	59	75	82	60	61	70	78	55	54
Omaha, Nebr.	77	82	60	57	77	81	61	60	73	79	53	53
Bismarck, N. Dak.	80	85	59	57	75	79	59	57	72	79	53	53
Sioux Falls, S. Dak.	75	82	57	57	77	81	62	63	66	74	49	49
West South Central[c]												
Little Rock, Ark.	82	86	60	63	81	85	81	64	75	79	53	66
New Orleans, La.	84	87	64	71	90	92	71	78	84	89	63	69
Oklahoma City, Okla.	75	81	55	53	75	81	56	55	67	75	47	45
Dallas, Tex.	75	84	59	54	70	79	55	51	70	79	54	50
Mountain[c]												
Phoenix, Ariz.	30	21	38	49	29	20	37	50	28	20	34	46
Denver, Colo.	38	39	60	65	38	38	58	64	36	35	56	62
Boise, Idaho	47	38	56	62	50	43	58	66	50	40	63	71
Great Falls, Mont.	48	43	58	65	57	52	68	73	47	42	58	64
Reno, Nev.	42	30	52	71	47	33	57	74	43	28	53	72
Albuquerque, N. Mex.	35	27	47	59	36	28	49	61	36	26	47	61
Salt Lake City, Utah	44	40	58	63	49	45	62	68	45	41	63	67
Cheyenne, Wyo.	36	36	54	57	38	39	57	60	37	39	55	59
Pacific[c]												
Juneau, Alaska	81	73	83	87	77	70	79	83	83	75	84	88
Los Angeles, Calif.	63	67	80	84	63	66	80	81	63	64	79	81
Honolulu, Hawaii	73	58	71	78	72	56	70	77	64	52	63	67
Portland, Oreg.	70	55	73	82	71	58	74	82	73	58	75	84
Seattle, Wash.	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

[a] Data from airport unless otherwise indicated.

[b] Local time at reporting stations for each reading.

[c] "Census Regions" and "Census Divisions" are described in Appendix C.

NA — Not available.

Source: U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Climatological Data, Annual Summary, Asheville, N.C., December 1976, pp. 38-47 (also previous years).

Table 5.19. Sunshine for Selected Cities: Total Hours by Month and Year, 1976

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual total	4-year annual average[a]
New England[b]														
Hartford, Conn.	162	204	212	239	235	252	284	284	226	161	168	154	2584	2559
Portland, Maine	158	170	221	259	266	289	298	283	252	222	185	172	2775	2506
Boston, Mass.	153	185	247	267	339	342	320	303	254	187	175	156	2928	2720
Concord, N. H.	139	145	196	267	292	293	294	299	237	189	177	151	2681	2532
Providence, R. I.	142	198	209	215	258	260	278	257	208	169	189	170	2553	2460
Burlington, Vt.	129	114	162	253	196	289	297	256	162	139	82	113	2192	1867
Middle Atlantic[b]														
Atlantic City, N. J.	148	206	226	266	262	267	272	308	230	166	165	159	2675	2461
Albany, N. Y.	152	160	228	281	199	279	259	246	213	110	97	138	2362	2251
Philadelphia, Pa.	172	204	219	293	242	250	280	306	225	184	199	168	2742	2587
South Atlantic[b]														
Wilmington, Del.[c]	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Washington, D. C.	150	197	186	335	311	304	310	314	219	167	160	189	2843	2589
Jacksonville, Fla.	212	222	263	298	271	276	316	286	221	237	184	136	2923	2830
Atlanta, Ga.	192	244	190	307	233	231	286	248	196	224	191	178	2720	NA
Baltimore, Md.	164	200	213	318	263	258	280	286	227	184	201	158	2751	2492
Charlotte, N. C.	223	257	253	354	339	238	301	290	218	206	190	184	3053	2909
Columbia, S. C.	207	236	185	306	203	151	273	275	175	214	179	162	2565	2647
Norfolk, Va.	215	228	241	310	223	229	NA	NA	NA	188	219	NA	NA	NA
Parkersburg, W. Va.	119	180	245	314	306	245	276	283	210	148	159	124	2607	2378
East North Central[b]														
Chicago, Ill.	146	169	215	292	305	317	331	310	257	176	176	167	2857	2575
Detroit, Mich.	107	146	183	266	242	333	318	308	254	157	149	140	2604	2409
Cincinnati, Ohio	100	141	182	222	184	142	229	248	202	151	177	146	2124	2132
Indianapolis, Ind.	132	184	216	287	271	276	317	309	240	189	200	174	2793	NA
Milwaukee, Wis.	155	173	176	253	293	327	338	309	249	152	188	164	2778	2401
East South Central[b]														
Birmingham, Ala.	203	184	190	250	246	253	214	303	224	200	177	169	2612	2543
Lousville, Ky.	173	179	174	283	248	236	348	344	266	202	217	205	2873	2471
Jackson, Miss.	179	177	163	290	244	276	275	250	215	212	185	171	2636	2502
Memphis, Tenn.	220	198	215	314	289	325	400	375	273	236	201	212	3259	2867
West North Central[b]														
Des Moines, Iowa	184	197	216	255	294	355	346	308	264	203	209	179	3007	2663
Wichita, Kans.	239	272	273	238	317	376	373	353	273	210	245	259	3428	3021
Duluth, Minn.	109	157	147	249	336	326	359	337	256	126	121	110	2642	2340
Kansas City, Mo.	186	207	245	319	375	367	389	241	319	233	211	236	3427	2985
Omaha, Nebr.	210	190	207	231	307	338	271	300	265	207	195	173	2894	2765
Bismarck, N. Dak.	154	166	183	261	368	348	375	354	312	194	162	88	2963	2770
Rapid City, S. Dak.	182	213	224	213	283	322	353	332	278	240	188	157	2984	2984
West South Central[b]														
Little Rock, Ark.	NA	238	283	334	362	354	386	372	313	261	231	226	NA	NA
New Orleans, La.	201	221	191	318	262	343	286	320	268	236	190	165	3001	NA
Okalhoma City, Okla.	261	247	266	200	245	NA	385	NA	231	202	203	239	NA	NA
Houston, Tex.	198	190	124	161	256	296	198	291	252	199	158	156	2478	2421
Mountain[b]														
Phoenix, Ariz.	285	244	311	332	374	411	356	389	296	311	296	277	3911	3918
Denver, Colo.	218	249	292	265	291	346	341	309	242	269	210	254	3284	3172
Boise, Idaho	148	169	278	297	392	360	377	314	288	267	201	182	3273	NA
Great Falls, Mont.	114	140	267	208	313	209	366	356	318	215	146	95	2747	2685
Reno, Nev.	204	164	315	335	421	424	409	377	322	308	259	250	3788	3821
Albuquerque, N. Mex.	276	244	270	310	330	368	330	320	262	243	270	264	3487	3342
Salt Lake City, Utah	161	186	251	282	346	374	388	382	305	293	231	247	3447	3237
Cheyenne, Wyo.	161	173	246	182	212	250	253	239	219	233	140	[illegible]	2484	2759
Pacific[b]														
Juneau, Alaska	42	119	96	212	166	138	207	206	135	53	12	21	1407	1384
Los Angeles, Calif.	282	182	324	308	NA	380	356	390	250	290	254	246	NA	NA
Honolulu, Hawaii	208	162	194	197	262	226	270	282	242	246	178	210	2678	2732
Portland, Oreg.	87	139	252	258	285	292	341	231	233	185	134	63	2499	2285
Seattle, Wash.	71	151	199	260	325	318	337	145	207	132	102	44	2291	2322

[a] Average of 1973 through 1976.

[b] "Census Regions" and "Census Divisions" are described in Appendix C.

[c] No information is available from this source for any cities in Delaware.

NA - Not available.

Source: U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Climatological Data, Annual Summary, Asheville, N. C., December 1976, pp. 35–37 (also previous years).

CHAPTER 5 — REFERENCES

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Chapter 6

National Economic Determinants

M. A. Smith

Chapter 6 is a brief introduction to economic indicators and their relation to energy use; it is generally accepted that economic indicators are correlated to energy use. It is interesting to note that the gross national product (GNP) declined in real terms from 1973 to 1975 - the oil embargo years (Table 6.1). This is in contrast to a consistent increase in the GNP prior to 1973. The GNP is presented by industry and sector, although several independent sources estimate GNP expenditures for education and health.

Personal consumption expenditures indicate allocations of disposable income toward specific expenses. Expenditures are presented here in both current and constant (1972) dollars for comparison. Several of the categories of consumption in Table 6.6 show expenditures for certain "commercial" services, such as retail and wholesale trade of food and clothing. Table 6.7 highlights personal consumption expenditures for energy in real terms. This table indicates that the percentage of income spent on energy has remained relatively constant in real terms.

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Table 6.1. General Income Indicators
($\$10^9$)

Item	1960	1965	1970	1971	1972	1973	1974	1975	1976[a]
Current dollars									
Gross national product	506.0	688.1	982.4	1063.4	1171.1	1306.6	1413.2	1516.3	1692.4
Net national product	458.3	630.6	891.6	964.7	1065.8	1188.9	1275.5	1355.0	1512.7
National income	412.0	566.0	798.4	858.1	951.9	1064.6	1135.7	1207.6	1349.4
Personal income	399.7	537.0	801.3	859.1	942.5	1052.4	1153.3	1249.7	1375.4
Disposable personal income	349.4	472.2	685.9	742.8	801.3	901.7	982.9	1080.9	1181.8
Constant (1972) dollars[b]									
Gross national product	736.8	925.9	1075.3	1107.5	1171.1	1235.0	1214.0	1191.7	1265.0
Net national product	667.4	848.5	975.9	1004.7	1065.8	1123.7	1095.7	1064.8	1130.7
National income	600.0	761.6	864.1	893.7	951.9	1006.2	975.6	949.0	1008.6
Personal income	582.1	722.6	877.1	894.7	942.5	994.7	990.7	982.1	1028.0
Disposable personal income	508.8	635.4	750.8	773.6	801.3	852.3	844.3	849.4	883.3

[a] Preliminary.

[b] All economic indicators are deflated using an implicit GNP price deflator available from the source, Table B-3.

Source: President of the United States, Economic Report of the President, Transmitted to the Congress together with the Annual Report of the Council of Economic Advisers, Washington, D.C., January 1977, Tables B-1, B-3, B-17, B-18, and B-22.

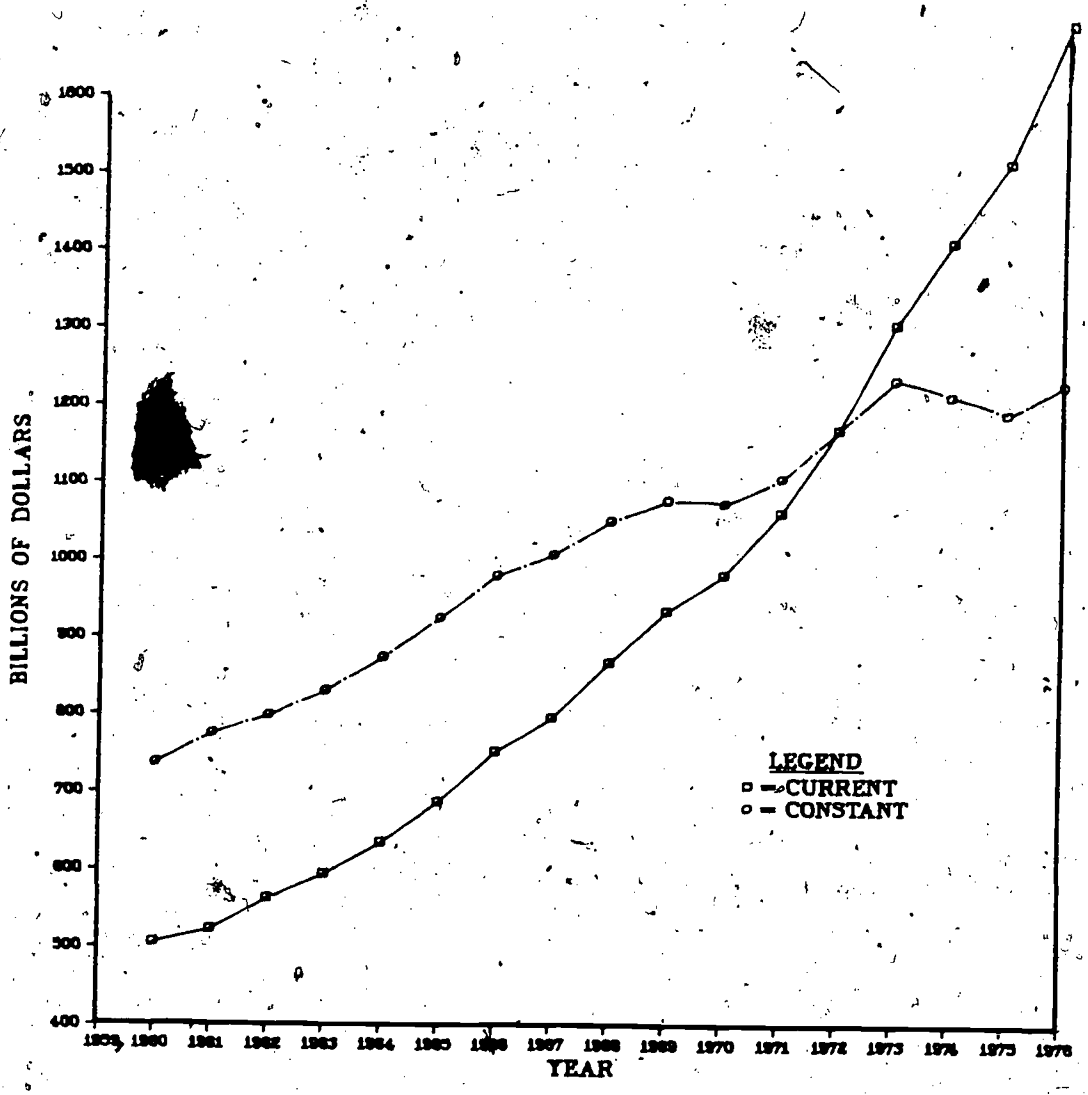

Figure 6.1. Gross National Product in Current and Constant (1972) Dollars.

Source: President of the United States, Economic Report of the President, Transmitted to the Congress together with the Annual Report of the Council of Economic Advisers, Washington, D.C., January 1977, Tables B-1 and B-2.

Table 6.2. Gross National Product by Industry
(1972 $$10^9$)

Industry	1960	1965	1970	1971	1972	1973	1974	1975	1976[b]
Agriculture, forestry, and fisheries	32.2	33.0	34.3	36.1	35.4	35.9	35.6	37.7	36.8
Contract construction	45.6	56.3	56.2	56.1	56.6	57.2	51.6	49.0	55.3
Manufacturing	172.0	235.1	260.6	264.1	288.8	313.0	296.8	270.0	304.9
Transportation, communications, and utilities	58.0	74.3	95.1	97.3	103.6	112.6	112.4	111.5	116.9
Wholesale and retail trade	117.9	148.6	178.4	186.8	201.2	212.0	207.2	211.1	219.5
Finance, insurance, and real estate	102.3	127.8	153.7	161.7	168.6	172.3	173.9	180.2	193.9
Services	82.2	101.2	124.7	126.6	134.5	143.1	143.1	144.4	152.3
Government and government enterprises	107.2	127.4	152.0	153.1	154.9	157.3	159.8	162.3	164.0
Other[a]	19.4	22.1	20.4	25.7	27.7	31.6	33.6	25.4	31.1
Total GNP	736.8	925.9	1075.3	1107.5	1171.1	1235.0	1214.0	1191.7	1274.7

[a] Includes mining, rest of the world, and residual.

[b] 1976 data from the Survey of Current Business.

Source: President of the United States, Economic Report of the President, Transmitted to the Congress together with the Annual Report of the Council of Economic Advisers, Washington, D.C., January 1977, Table B-5; U.S. Department of Commerce, Bureau of Economic Analysis, Survey of Current Business, Vol. 57, No. 7, Washington, D.C., July 1977, Table 6.2.

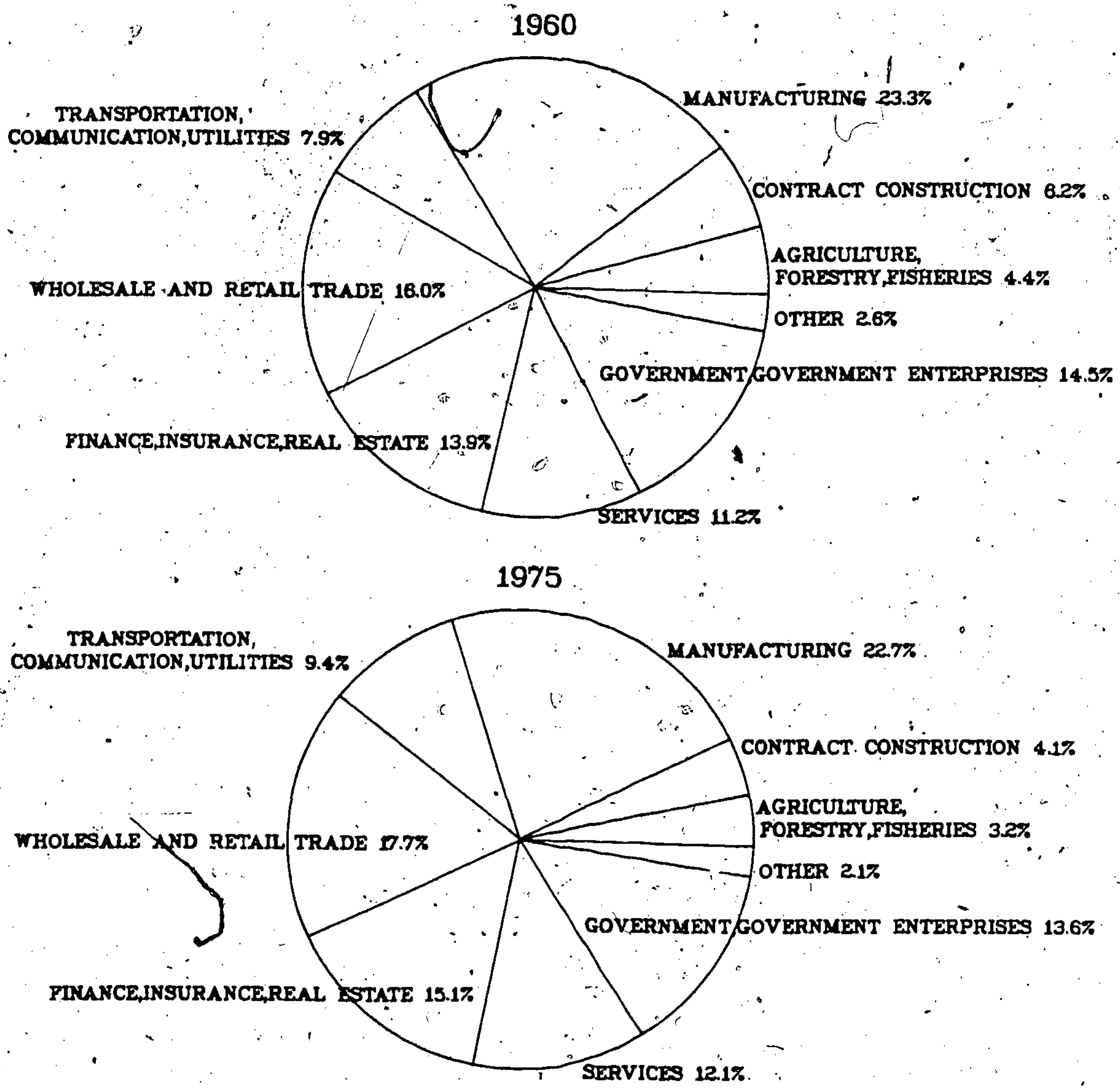

Figure 6.2. Components of GNP, 1960 and 1975.
(percentage based on constant 1972 dollars)

Source: President of the United States, Economic Report of the President, Transmitted to the Congress together with the Annual Report of the Council of Economic Advisers, Washington, D.C., January 1977, Tables B-5 and B-10.

Table 6.3. Gross National Product by Sector
($ 10^9)

Sector	1960	1965	1970	1971	1972	1973	1974	1975	1976[a]
Current dollars									
Business	442.5	596.6	831.5	896.9	989.5	1,108.0	1,192.4	1,277.5	1,428.4
Households and institutions	13.8	19.2	31.6	34.7	37.2	40.5	44.7	49.7	55.9
Government	47.1	67.6	114.7	125.2	137.4	149.1	161.6	178.5	194.8
Rest of the world	2.5	4.7	4.6	6.6	7.0	9.1	14.5	10.6	13.3
Total GNP	506.0	688.1	982.4	1,063.4	1,171.1	1,306.6	1,413.2	1,516.3	1,692.4
Constant (1972) dollars									
Business	611.8	776.4	898.3	927.6	989.5	1,050.4	1,027.3	1,004.1	1,072.0
Households and institutions	26.8	31.1	36.3	36.6	37.2	38.1	38.2	38.5	40.7
Government	94.9	112.4	135.2	136.0	137.4	138.9	141.5	144.2	146.3
Rest of the World	3.2	6.1	5.5	7.2	7.0	7.6	7.0	4.8	5.9
Total GNP	736.8	925.9	1,075.3	1,107.5	1,171.1	1,235.0	1,214.0	1,191.7	1,265.0

[a] Preliminary

Source: President of the United States, Economic Report of the President, Transmitted to the Congress together with the Annual Report of the Council of Economic Advisers, Washington, D.C., January 1977, Tables B-9 and B-10.

Table 6.4. Gross National Product Expenditures for Education

Calendar year	GNP ($$10^6$)	School year	Education[a] expenditures ($$10^6$)	Percentage of GNP
1969	935,541	1969-70	70,401	7.5
1971	1,063,436	1971-72	83,221	7.8
1973	1,306,554	1973-74	98,513	7.5
1975	1,516,338	1975-76	120,100	7.9

[a] Includes expenditures for public and nonpublic institutions at elementary, secondary, and higher levels.

Source: W. V. Grant and C. George Lind, U. S. Department of Health, Education, and Welfare, National Center for Education Statistics, <u>Digest of Education Statistics</u>, 1976 Edition, Washington, D. C., 1977, p. 25.

Table 6.5. Components of GNP Allocated to National Health Expenditures ($\$10^6$)

	1972	1973	1974
Private expenditures			
Health and medical services	50,647	55,846	59,972
Medical research	203	208	219
Percent of GNP	4.3	4.3	4.3
Public expenditures			
Health and medical services	29,901	33,094	37,243
Medical research	1,855	2,090	2,170
Percent of GNP	2.7	2.7	2.8
Total expenditures	82,606	91,238	99,604
Total percent of GNP	7.1	7.0	7.0

Note: Health statistics end June 30, GNP represents fiscal year.

Source: U. S. Department of Commerce, Bureau of the Census, Statistical Abstract of the United States: 1976, 97th Edition, Washington, D. C., 1976, Table 104.

Table 6.6. Personal Consumption Expenditure by Product (current[a] $$10^9$)

Product	1960	1965	1970	1971	1972	1973	1974	1975	1976
Personal consumption expenditures	328.2	432.8	617.6	667.1	729.0	809.9	889.6	980.4	1,094.0
Food and tobacco	86.8	107.2	141.2	147.7	156.4	181.2	203.6	224.2	241.6
Clothing, accessories, and jewelry	34.0	43.3	62.8	67.2	73.6	71.8	76.3	82.0	89.3
Personal care	5.4	7.6	10.4	10.6	11.4	12.6	13.5	14.3	15.3
Housing	41.9	63.5	90.9	99.1	107.9	120.2	136.5	150.8	167.9
Household operation[b]	33.3	43.9	63.0	67.5	75.7	85.4	92.5	98.7	109.4
Electricity	4.8	6.6	9.8	10.9	12.3	13.9	16.5	19.8	22.2
Gas	3.1	4.1	5.2	5.7	6.2	6.7	7.6	9.3	11.1
Fuel oil and coal	3.6	5.4	2.5	2.7	3.0	4.0	4.5	5.0	12.0
Water and other sanitary services	1.2	1.7	6.8	6.9	7.8	7.7	9.6	10.1	5.4
Medical care expenses	21.1	28.1	47.4	51.8	57.2	68.3	76.9	90.3	106.4
Personal business	20.2	21.9	35.3	38.1	41.4	40.6	45.5	51.8	58.6
Transportation	41.1	58.2	77.8	90.5	99.9	110.9	115.1	125.1	150.1
Recreation	19.5	26.3	40.7	43.0	48.1	55.2	[illegible]	66.2	72.6
Private education and research	4.4	5.9	10.4	10.9	11.9	12.6	[illegible]	15.4	16.9
Religious and welfare activities	4.7	6.0	8.6	9.2	10.1	10.6	[illegible]	12.5	13.8
Foreign travel and other, net	3.0	3.2	4.8	5.2	5.8	5.2	5.3	5.0	4.2

[a] Current dollars are shown here, although Table 6.8 gives the implicit price deflators which can be used to deflate any of the items in this table. Constant (1972) figures for fuel consumption are shown in Table 6.7.

[b] Includes items not shown separately.

Note: Totals may not add due to rounding.

Source: U.S. Department of Commerce, Bureau of Economic Analysis, Survey of Current Business, Vol. 57, No. 7, Washington, D.C., July 1977, Table 2.6 (also previous years).

Table 6.7. Personal Consumption Expenditures for Energy (1972 \$$10^9$)[a]

	1960	1965	1970	1971	1972	1973	1974	1975	1976[b]
Total personal consumption expenditure	453.1	558.0	669.0	691.7	733.0	767.7	759.2	770.5	854.9
Gasoline and oil	16.5	19.0	23.5	24.2	24.9	25.8	29.3	29.1	31.0
Fuel oil and coal	5.2	5.7	5.8	5.7	6.3	7.1	7.7	7.6	8.8
Electricity[c]	7.5	8.9	10.9	11.5	12.3	13.3	14.5	23.6	26.5
Gas[c]	4.9	5.8	6.2	6.3	6.5	6.4	6.6		
Total personal consumption expenditure, %	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Gasoline and oil	3.6	3.4	3.5	3.5	3.4	3.4	3.9	3.8	3.6
Fuel oil and coal	1.1	1.0	0.9	0.8	0.9	0.9	1.0	1.0	1.0
Electricity	1.7	1.6	1.6	1.7	1.7	1.7	1.9	3.1	3.1
Gas	1.1	1.0	0.9	0.9	0.9	0.8	0.9		

[a] Expenditures were deflated using the personal consumption expenditure implicit price deflators available from the Economic Report of the President, Table B-3.

[b] 1976 data available from the Survey of Current Business, February 1977, Table 11.

[c] Data from the Statistical Abstract, Table 635.

Sources: President of the United States, Economic Report of the President, Transmitted to the Congress together with the Annual Report of the Council of Economic Advisers, Washington, D.C., January 1977, Tables B-3, B-13; U.S. Department of Commerce, Bureau of Economic Analysis, Survey of Current Business, Vol. 57, No. 2, Washington, D.C., February 1977, Table 11, p. 8; U.S. Department of Commerce, Bureau of the Census, Statistical Abstract of the United States: 1976, 97th Annual Edition, Washington, D.C., 1976, Table 635.

Table 6.7. Personal Consumption Expenditures for Energy (1972 $$10^9$)[a]

	1960	1965	1970	1971	1972	1973	1974	1975	1976[b]
Total personal consumption expenditure	453.1	558.0	669.0	691.7	733.0	767.7	759.2	770.5	854.9
Gasoline and oil	16.5	19.0	23.5	24.2	24.9	25.8	29.3	29.1	31.0
Fuel oil and coal	5.2	5.7	5.8	5.7	6.3	7.1	7.7	7.6	8.8
Electricity[c]	7.5	8.9	10.9	11.5	12.3	13.3	14.5	23.6	26.5
Gas[c]	4.9	5.8	6.2	6.3	6.5	6.4	6.6		
Total personal consumption expenditure, %	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Gasoline and oil	3.6	3.4	3.5	3.5	3.4	3.4	3.9	3.8	3.6
Fuel oil and coal	1.1	1.0	0.9	0.8	0.9	0.9	1.0	1.0	1.0
Electricity	1.7	1.6	1.6	1.7	1.7	1.7	1.9	3.1	3.1
Gas	1.1	1.0	0.9	0.9	0.9	0.8	0.9		

[a] Expenditures were deflated using the personal consumption expenditure implicit price deflators available from the Economic Report of the President, Table B-3.

[b] 1976 data available from the Survey of Current Business, February 1977, Table 11.

[c] Data from the Statistical Abstract, Table 635.

Sources: President of the United States, Economic Report of the President, Transmitted to the Congress together with the Annual Report of the Council of Economic Advisers, Washington, D.C., January 1977, Tables B-3, B-13; U.S. Department of Commerce, Bureau of Economic Analysis, Survey of Current Business, Vol. 57, No. 2, Washington, D.C., February 1977, Table 11, p. 8; U.S. Department of Commerce, Bureau of the Census, Statistical Abstract of the United States: 1976, 97th Annual Edition, Washington, D.C., 1976, Table 635.

Table 6.8. Implicit Price Deflators
(1972 = 100)

Year	Gross national product	Personal consumption expenditures			
		Total	Durable goods	Non-durable goods	Services
1960	68.67	71.7	82.1	72.6	68.0
1961	69.28	72.5	82.7	73.3	69.1
1962	70.55	73.6	83.9	73.9	70.4
1963	71.59	74.7	84.8	74.9	71.7
1964	72.71	75.7	85.7	75.8	72.8
1965	74.32	77.1	85.6	77.3	74.3
1966	76.76	79.3	85.7	80.1	76.5
1967	79.02	81.3	87.4	81.9	78.8
1968	82.57	84.6	90.7	85.3	82.0
1969	86.72	88.5	93.1	89.4	86.1
1970	91.36	92.5	95.5	93.6	90.5
1971	96.02	96.6	99.0	96.6	95.8
1972	100.00	100.0	100.0	100.0	100.0
1973	105.80	105.5	101.6	107.9	104.7
1974	116.41	116.9	108.3	124.0	113.5
1975	127.25	126.3	117.7	133.7	122.7
1976[a]	133.79	132.7	124.4	138.0	130.9

[a] Preliminary.

Source: President of the United States, Economic Report of the President, transmitted to the Congress together with the Annual Report of the Council of Economic Advisors, Washington, D.C., January 1977, Table B-3.

Table 6.9. Consumer Price Index:
1947 to 1975
(1967 = 100)

Year	CPI	Year	CPI
1947	66.9	1962	90.6
1948	72.1	1963	91.7
1949	71.4	1964	92.9
1950	72.1	1965	94.5
1951	77.8	1966	97.2
1952	79.5	1967	100.0
1953	80.1	1968	104.2
1954	80.5	1969	109.8
1955	80.2	1970	116.3
1956	81.4	1971	121.3
1957	84.3	1972	125.3
1958	86.6	1973	133.1
1959	87.3	1974	147.7
1960	88.7	1975	161.2
1961	89.6		

Source: U.S. Department of Commerce, Bureau of the Census, Current Population Reports: Consumer Income, Series P-60, No. 105, Washington, D.C., June 1977, p. 270.

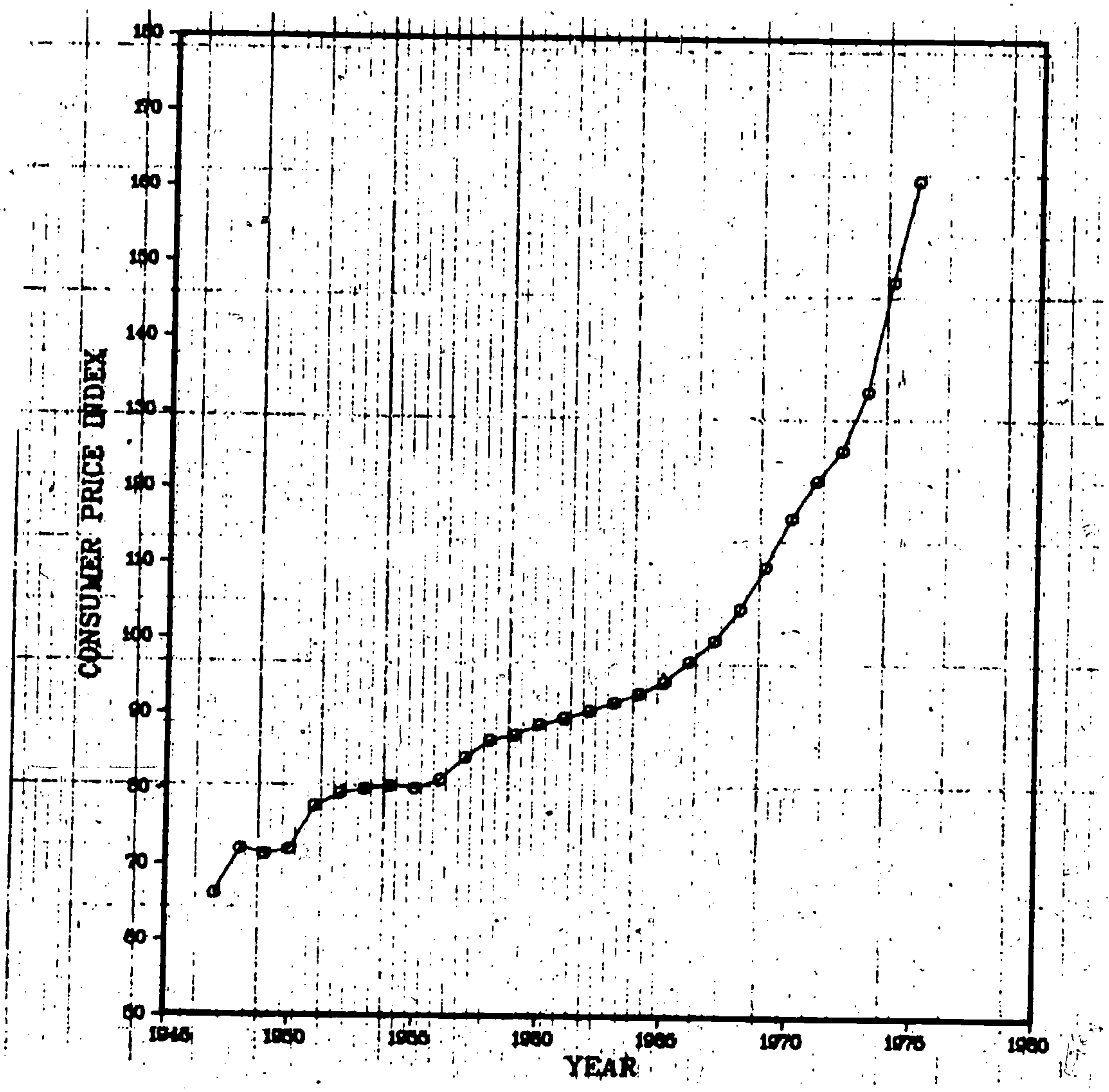

Figure 6.3. Consumer Price Index: 1947–1975.
(1967 = 100)

Source: U.S. Department of Commerce, Bureau of the Census, <u>Current Population Reports: Consumer Income</u>, Series P-60, No. 105, Washington, D.C., June 1977, p. 270.

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Chapter 7

Fuel Consumption and Prices

G. E. Liepins

Chapter 7 deals with fuel consumption disaggregated by fuel and sector. One encounters four major difficulties in monitoring energy use by sector and fuel: (1) nonuniform accounting methods, (2) nonuniform sectoral definitions, (3) inadequate data, and (4) inaccurate data. Each of the difficulties is discussed in greater detail below.

Nonuniform accounting methods

Electricity, more than any other energy form, is subject to nonuniform accounting methods. Six methods seem prevalent. The methods differ in whether or not they account for transmission-distribution losses and also in the way they account for generation efficiencies.

Method 1: energy used in Btu = (kWhr of electricity used) x 3412.

Method 2: energy used in Btu = (kWhr of non-hydro-generated electricity) x 3412 x e[†] + (kWhr of hydro-generated electricity) x 3412.

Method 3: energy used in Btu = (kWhr of electricity used) x 3412 x e.[†]

The first three methods do not account for distribution-transmission losses (l), whereas the last three do.

Methods 4, 5, and 6: energy used in Btu = $(\frac{1}{1-l})$ x (result of methods 1, 2, and 3, respectively).

[†] "e" is the reciprocal of the efficiency factor, that is, if 65% of the energy used in thermal generation of electricity is lost in the form of heat, then thermal generation is 35% efficient and $e = \frac{1}{0.35} = 2.86$.

An alternative approach uses heat rate in place of 3412 x e. (For further discussion of efficiencies, heat rates, and transmission losses, see the User's Guide, Note 6.)

As an example, each of the six methods of energy accounting is used to calculate the energy used in generating 1000 kWhr of electricity, 150 kWhr of which is hydro-generated, and 850 kWhr of which is thermally generated at 35% efficiency and is subject to 3% transmission losses.*

Method 1: $1000 \times 3412 = 3.412 \times 10^6$ Btu

Method 2: $850 \times 3412 \times \frac{1}{0.35} + 150 \times 3412 \doteq 8.806 \times 10^6$ Btu

Method 3: $1000 \times 3412 \times \frac{1}{0.35} = 9.758 \times 10^6$ Btu

Method 4: (result of method 1) $\times \frac{1}{0.97} = 3.518 \times 10^6$ Btu

Method 5: (result of method 2) $\times \frac{1}{0.97} = 9.07 \times 10^6$ Btu

Method 6: (result of method 3) $\times \frac{1}{0.97} = 10.05 \times 10^6$ Btu

Methods 1 and 6 yield the opposite poles of energy content. Were one to use method 6 in conjunction with the factors 33% generation efficiency and 9% transmission losses (these are probably more reasonable factors, see User's Guide, Note 6), the energy content of the 1000 kWhr would be 12.486 x 10^6 Btu. Clearly one can see that the differences in the method of reporting strongly affect the Btu-use figures.

Nonuniform sectoral definitions

Another obstacle to the compilation of reliable, easily comparable data is the nonuniformity of sectoral definitions. This is especially the case for the commercial sector, which is not consistently defined

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*Thirty-five percent generation efficiency and 3% transmission loss are the factors published by the FEA in the Monthly Energy Review. Hydro-generation of 15% of electricity is consistent with historical data (see Table 7.13).

from source to source. The problem is further aggravated because a reporting agency may change its method of classification over time, a policy that leads to historical inconsistencies. The best example of this occurs in data published by the Edison Electric Institute (EEI). The Institute depends on individual utilities to report their sales by sector. The commercial and industrial sectors are basically contained in the categories "small light and power" and "large light and power". It is popular to assume that the former category can be equated to the commercial sector, but the assumption is invalid.* Current estimates also indicate that residential electric use is approximately 104% of that reported by the EEI.+ Moreover, different utilities have different standards as to what constitutes each of the categories, and these standards vary over time (see User's Guide, Note 1).

The American Gas Association (AGA) reports strictly in terms of residential, commercial, industrial and "other" sectors, and is also dependent on its member utilities for its raw data. In AGA's publication, Gas Facts, commercial service is defined in terms of the "nature of the customer's primary business" (see Glossary: "Commercial Service" for further details). Nevertheless, gang-metered residential gas consumption is ascribed to the commercial sector. Jack Faucett Associates, Inc. have estimated that gang-metered residential consumption accounts for 22% of gas usage reported for commercial sector.

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*Steve Cohn of ORNL, in a conversation with the author, indicated that in the Tennessee Valley Authority region approximately one-third of the electricity used by companies designated "large light power" should be ascribed to the commercial sector.

+Gang-metered residential use is often ascribed to the category "Small Light and Power."

An even more accurate accounting of gas consumption by the commercial sector would result from the application of the following equation: comm = AGA (comm) + AGA (other) — AFF — gas sales, elect. — (gang-metered). The component terms are defined as follows: "comm" represents gas consumption by the commercial sector, "AGA (comm)" represents commercial consumption as reported by the AGA, "AGA (other)" represents consumption ascribed to "other" by the AGA, "AFF" represents agricultural, forestry and fishing industry consumption, "gas sales, elect." represents consumption of gas by electric utilities reported in the "other" category, and "gang-metered" represents gang-metered residential consumption. At present, the magnitudes of some of the components can only be estimated.

Inadequate data

Data availability is extremely uneven. Certain facts are extensively documented while other documentation appears to be totally nonexistent. Published retail prices for coal consumed by either the commercial or residential sectors seem to be unavailable, and the actual amount of coal consumed by the residential sector appears to be unavailable. Much the same appears to be the case for petroleum products, though the prices are better documented.

Inaccurate data

Lack of accurate data is another difficulty encountered in this chapter. Even the most reliable of the data are prone to errors. These errors occur not only because of ambiguities in classification, but also because for even the best available data, there is some need to estimate. Numerous such examples are available. Both the EEI and the AGA depend on individual utilities to report their sales, and not all utilities report. The missing data are estimated from historical trends. Much the same is the case for the Bureau of Mines (BOM). The BOM periodically publishes revisions of previous data (as additional information is submitted). Perhaps the best example of data inaccuracy has to do with Census data. The Energy and Environmental Analysis, Inc. portion of the Energy Consumption Data Base study, p. 35 states,

> The procedure employed by Census in gathering fuel expenditure information resulted in overreporting of 15 to 50 percent. The census information form asked the respondent to list average monthly fuel bill for electricity, gas and other fuels. In a recent study done by Census, it was found that respondents tended to report their maximum fuel bill for the year.
>
> The results of the Census study show that natural gas was overreported by 25 to 50 percent, while electricity was overreported 15 to 30 percent.

In short, energy use and related expenditure data are unevenly available, and what are available are subject to inconsistencies of definition and inaccuracies, the magnitude of which are difficult to estimate.

Given the previous discussion about errors and inaccuracies, what can one say about the patterns of energy use? The following facts seem certain and can be distilled from the chapter. They apply both to the residential and to the commercial sector through 1975.

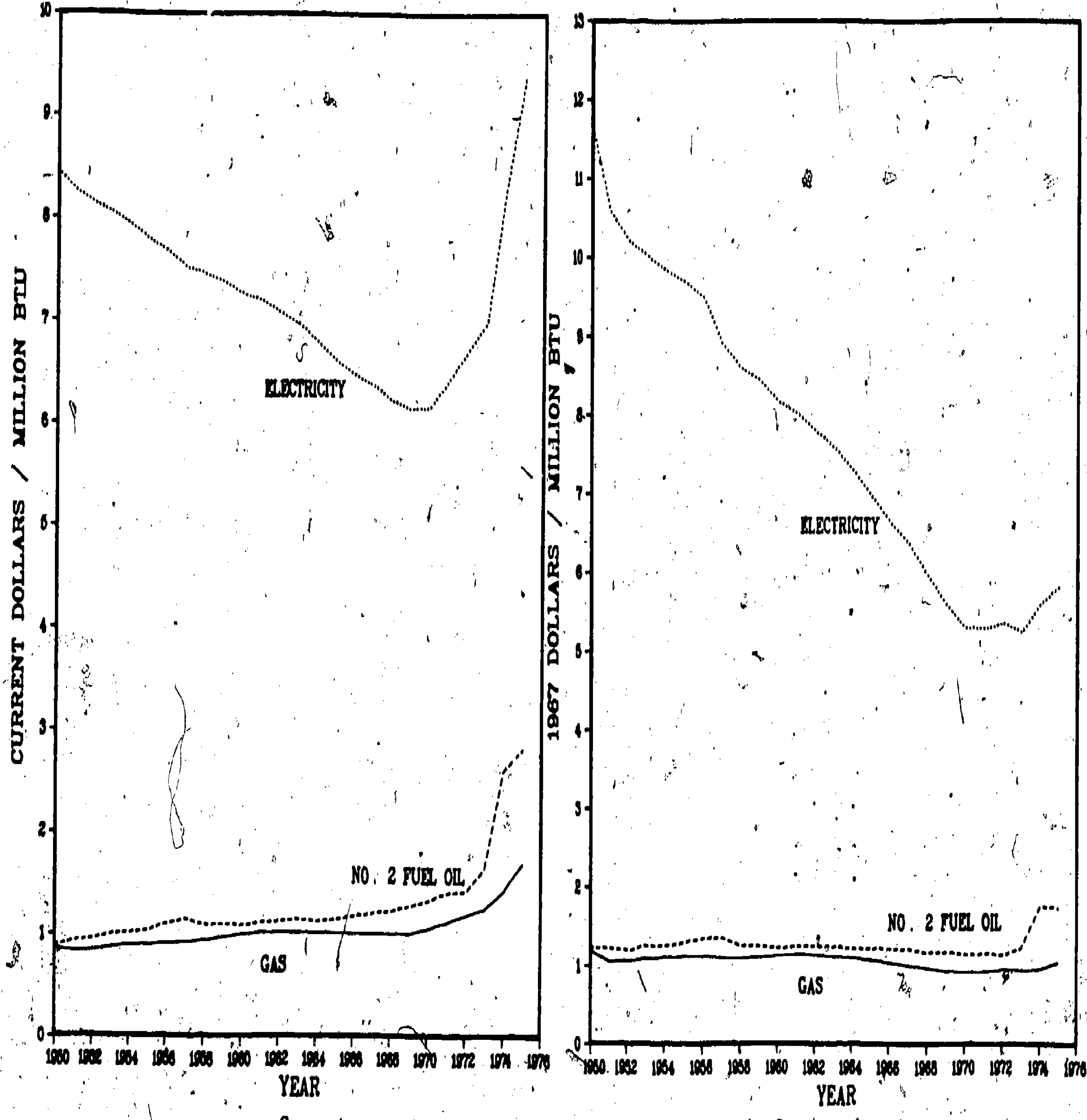
1. Electricity prices generally decreased from 1950 to 1970 and increased monotonically thereafter (in both constant 1967 and current dollars).

2. Gas prices have generally increased since 1950 (except for a stable period from 1960 to 1966) in both constant 1967 and current dollars.

3. Electricity use has exhibited a continuing upward trend except for a short downward swing in 1973-1974 due to the energy crisis.

4. Gas consumption has exhibited an upward trend from 1950 to 1970, and has exhibited a downward trend since.

5. Over the last 20 years, coal has decreased in importance to the residential-commercial sector, both by percentage of energy supplied and by actual Btu content supplied.



Current

Constant(1967)

Fig. 7.1. Residential Fuel Prices in Current and Constant Dollars.

Source: American Gas Association, Historical Statistics of the Gas Utility Industry, 1966-1975, Arlington, Va., 1977, p. 131.

ONE OF THE REASONS THAT ELECTRICITY IS SUCH AN EXPENSIVE ENERGY SOURCE IS THE INEFFICIENCY IN THERMAL GENERATION AND THE SECONDARY LOSSES DUE TO TRANSMISSION AND DISTRIBUTION.*

Table 7.1. Average Annual Residential Retail Prices of Specified Fuels and Electricity 1950 through 1975[a]
($/10⁶ Btu)[b]

Year	Utility gas		Electricity		Number 2 fuel oil	
	Current $	1967 $[c]	Current $	1967 $[c]	Current $	1967 $[c]
1950	0.85	1.18	8.44	11.71	0.88	1.22
1951	0.82	1.05	8.24	10.59	0.93	1.22
1952	0.84	1.06	8.12	10.21	0.95	1.19
1953	0.87	1.09	8.03	10.02	1.00	1.25
1954	0.89	1.11	7.91	9.83	1.01	1.25
1955	0.90	1.12	7.77	9.69	1.04	1.30
1956	0.91	1.12	7.65	9.40	1.10	1.35
1957	0.92	1.09	7.50	8.90	1.15	1.36
1958	0.94	1.09	7.44	8.59	1.08	1.25
1959	0.97	1.11	7.36	8.43	1.10	1.26
1960	1.00	1.13	7.24	8.16	1.08	1.22
1961	1.02	1.14	7.18	8.01	1.12	1.25
1962	1.02	1.13	7.06	7.79	1.13	1.25
1963	1.02	1.11	6.95	7.58	1.15	1.25
1964	1.01	1.09	6.77	7.29	1.12	1.21
1965	1.01	1.07	6.59	6.97	1.15	1.22
1966	1.00	1.03	6.45	6.64	1.18	1.21
1967	1.00	1.00	6.36	6.36	1.21	1.21
1968	1.00	0.96	6.21	5.96	1.25	1.16
1969	1.01	0.92	6.13	5.58	1.28	1.17
1970	1.06	0.91	6.15	5.29	1.33	1.14
1971	1.12	0.92	6.42	5.29	1.41	1.16
1972	1.19	0.95	6.71	5.36	1.42	1.13
1973	1.25	0.94	6.98	5.24	1.64	1.23
1974	1.42	0.96	8.29	5.61	2.60	1.76
1975	1.69	1.05	9.40	5.83	2.81	1.74

[a] Prices given are for total usage.

[b] Electric energy calculated at 3412 Btu/kWhr.

[c] Prices in 1967 dollars calculated by G. E. Liepins using consumer price index.

Source: American Gas Association, Historical Statistics of the Gas Utility Industry, 1966–1975, Arlington, Va., 1977, Table 76, p. 132.

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*The Monthly Energy Review (April 1977, p. 45) estimates that these losses average 68%.

Table 7.2. Price Indexes for Various Energy Sources in 1967 Dollars, 1954 — 1976

	Electricity	Gas, all types	Gas and electricity	Fuel oil and coal	Fuel oil no. 2
1954	94.0	77.9	85.3	81.2	82.9
1955	95.2	81.0	87.5	82.3	85.8
1956	95.5	82.3	88.4	85.9	91.1
1957	95.9	83.7	89.3	90.3	94.4
1958	97.1	88.6	92.4	88.7	89.2
1959	98.5	91.6	94.7	89.8	90.8
1960	99.8	97.7	98.6	89.2	89.6
1961	100.1	99.0	99.4	91.0	92.3
1962	100.1	98.9	99.4	91.5	93.3
1963	100.1	99.0	99.4	93.2	93.9
1964	99.6	99.3	99.4	92.7	92.9
1965	99.1	99.6	99.4	94.6	95.4
1966	99.1	100.2	99.6	97.0	97.2
1967	100.0	100.0	100.0	100.0	100.0
1968	100.9	101.0	100.9	103.1	100.0
1969	102.8	102.8	102.8	105.6	106.5
1970	106.2	108.5	107.3	110.1	109.3
1971	113.2	116.2	114.7	117.5	116.1
1972	118.9	122.3	120.5	118.5	116.6
1973	124.9	127.9	126.4	136.0	134.5
1974	147.5	143.9	145.8	214.6	213.0
1975	167.0	172.5	169.6	235.3	230.6
1976	177.6	200.9	188.8	250.8	247.2
1977	189.3	239.3			280.2

Source: U.S. Department of Labor, Bureau of Labor Statistics, Retail Prices and Indexes of Fuels and Utilities, Washington, D.C., September 1977, Table 1.

FIG. 7.2 AND TABLE 7.3 ARE BASED ON DATA PRESENTED IN ENERGY PERSPECTIVES. IT IS IMPERATIVE THAT THE READER UNDERSTAND THAT THE SECTOR DEFINITIONS ARE NOT ENTIRELY CONSISTENT ACROSS FUELS. PETROLEUM PRODUCT CONSUMPTION DATA PRESENTED IN ENERGY PERSPECTIVES ARE DERIVED FROM BUREAU OF MINES STATISTICS, AND THAT PORTION OF THESE FUELS CONSUMED FOR HEATING PURPOSES HAS BEEN ALLOCATED TO THE RESIDENTIAL-COMMERCIAL SECTOR. RESIDENTIAL-COMMERCIAL CONSUMPTION OF COAL HAS BEEN DEFINED BY ENERGY PERSPECTIVES TO BE THE AMOUNT OF COAL INCLUDED UNDER THE WEEKLY COAL REPORT HEADING "RETAIL DELIVERIES." THE EDISON ELECTRIC INSTITUTE CATEGORIES "SMALL LIGHT AND POWER" AND "OTHER PUBLIC AUTHORITIES" HAVE BEEN SUMMED AND THEN EQUATED WITH THE COMMERCIAL SECTOR FOR PURPOSES OF REPORTING ELECTRIC ENERGY USED (ELECTRIC ENERGY IS GIVEN IN TERM OF POINT OF USE, THAT IS, CONVERTED AT 3412 BTU/KWHR.) THE AMERICAN GAS ASSOCIATION'S CATEGORY "COMMERCIAL CUSTOMER" HAS BEEN USED TO DETERMINE CO-MERCIAL GAS SALES.

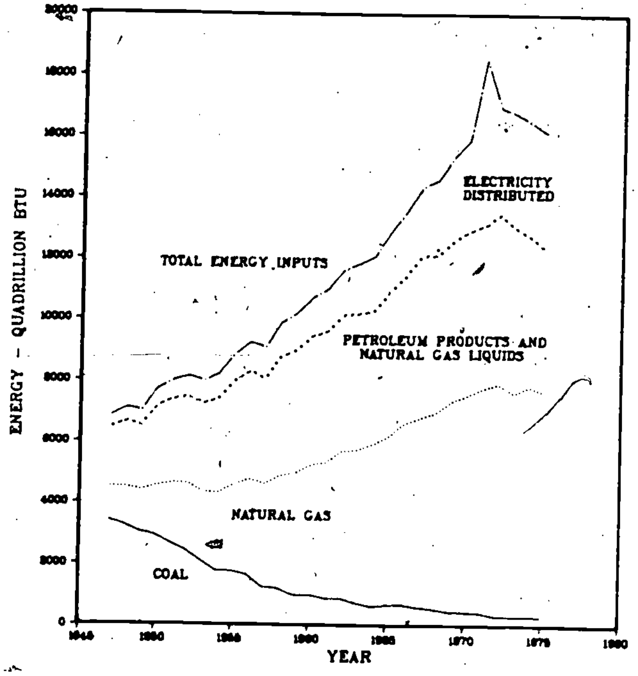

Figure 7.2. Energy Use by the Household and Commercial Sector (in Terms of Point of Use), 1947 – 1975

Source: W. G. Dupree et al., U.S. Department of the Interior; Energy Perspectives 2, Washington, D.C., June 1976, p. 64.

Table 7.3. Energy Use by the Household and Commercial Sector, 1947-75 (in terms of point of use) (10^{12} Btu)

	Petroleum products and natural gas liquids (asphalt omitted)									
Year	Kerosine	Distillate fuel oil	Residual fuel oil	Liquefied gases	Total[a]	Coal[b]	Natural gas	Total fossil fuels	Electricity distributed[c]	Total energy consumption
1947	354	1,106	355	110	1,925	3,399	1,125	6,449	391	6,840
1948	401	1,244	368	141	2,154	3,238	1,262	6,654	442	7,096
1949	375	1,183	380	156	2,093	3,025	1,387	6,505	488	6,993
1950	555	1,373	457	218	2,603	2,913	1,642	7,158	546	7,704
1951	491	1,547	478	207	2,722	2,648	2,007	7,377	615	7,992
1952	493	1,626	497	217	2,833	2,416	2,213	7,462	666	8,128
1953	469	1,649	514	237	2,869	2,072	2,294	7,235	733	7,968
1954	483	1,865	495	251	3,094	1,752	2,566	7,412	797	8,209
1955	478	2,077	543	288	3,386	1,745	2,849	7,980	854	8,834
1956	488	2,198	551	287	3,523	1,629	3,151	8,303	935	9,238
1957	431	2,196	512	293	3,432	1,225	3,391	8,048	1,019	9,067
1958	506	2,404	664	314	3,889	1,187	3,712	8,788	1,095	9,883
1959	491	2,428	704	375	3,997	969	4,024	8,990	1,203	10,193
1960	448	2,551	786	404	4,189	983	4,268	9,440	1,262	10,702
1961	445	2,657	761	412	4,275	868	4,477	9,620	1,385	11,005
1962	467	2,719	787	450	4,423	872	4,849	10,144	1,490	11,634
1963	453	2,711	787	483	4,434	731	5,027	10,192	1,645	11,837
1964	404	2,658	793	495	4,350	609	5,343	10,302	1,792	12,094
1965	449	2,802	983	511	4,744	678	5,517	10,939	1,948	12,887
1966	433	2,723	1,132	543	4,830	677	5,945	11,452	2,101	13,553
1967	388	3,099	1,208	594	5,289	585	6,223	12,097	2,257	14,354
1968	433	2,975	1,096	642	5,145	529	6,451	12,125	2,467	14,592
1969	428	2,981	1,120	731	5,260	447	6,890	12,597	2,752	15,349
1970	415	3,060	1,173	723	5,371	427	7,108	12,906	3,000	15,906
1971	401	3,050	1,148	732	5,332	406	7,366	13,104	3,209	18,529
1972	375	3,191	1,176	788	5,530	308	7,613	13,451	3,478	16,929
1973	348	3,122	1,206	749	5,425	296	7,318	13,039	3,709	16,748
1974	283	2,870	1,053	691	4,896	314	7,518	12,728	3,723	16,451
1975[d]	244	2,796	962	686	4,688	282	7,373	12,343	3,783	16,126

[a] Data may not add to totals shown due to rounding.

[b] Includes anthracite, bituminous coal and lignite.

[c] Utility electricity, generated and imported, distributed on basis of sales reported in the Edison Electric Institute Statistical Yearbook. Conversion of electricity to energy equivalent was made at the value of contained energy corresponding to 100% efficiency using a theoretical rate of 3412 Btu/kWhr.

[d] Preliminary.

Source: W. G. Dupree et al., U.S. Department of the Interior, Energy Perspectives 2, Washington, D.C., June 1976, p. 65.

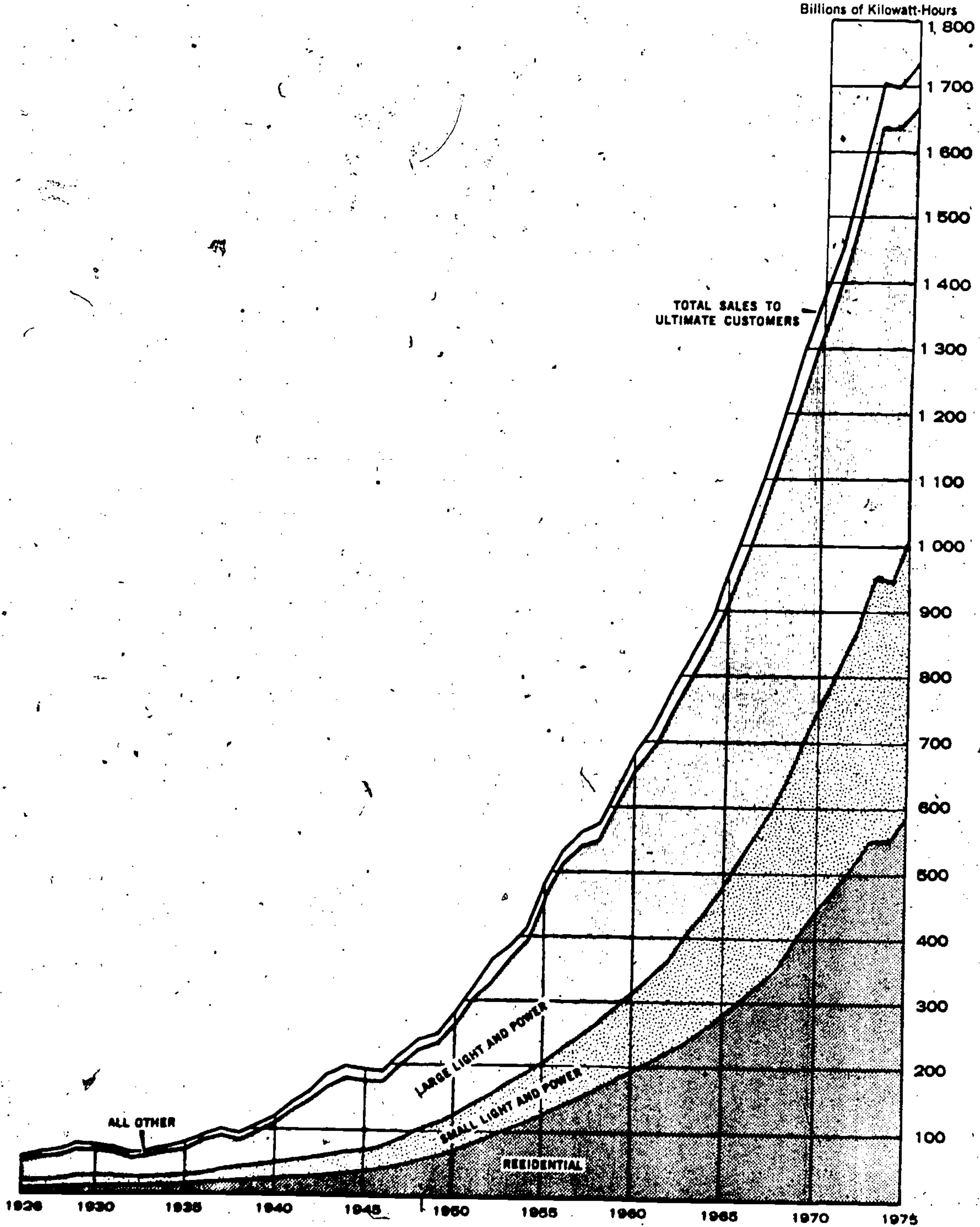

Figure 7.3. Electricity Sales by Major Classes, 1926–1975 – Total Electricity Utility Industry[a].

[a] Alaska and Hawaii included since 1960.

Source: Edison Electric Institute, Statistical Yearbook of the Electric Utility Industry, 1975, New York, October 1976, p. 30.

Table 7.4. Electricity Sales-Total Electric Utility Industry[a]
(by years and classes of service)
(10^6 kWhr)

Year	Total sales	Exports to Canada and Mexico	Total sales to ultimate customers	Residential	Commercial and industrial		Street and highway lighting	Other public authorities	Railroads and railways	Interdepartmental
					Small light and power[b]	Large light and power[b]				
1959	627,529	786	626,743	180,186	109,079	312,618	5,870	14,211	4132	647
1960	683,987	788	683,199	196,400	114,806	344,799	6,121	15,642	4770	661
1961	721,645	917	720,728	209,021	134,864	347,427	6,762	16,438	4685	1531
1962	777,749	1661	776,088	226,414	144,095	373,916	7,350	18,349	4717	1247
1963	832,796	1985	830,811	241,692	166,516	388,399	7,748	20,194	4667	1595
1964	894,609	4253	890,356	262,010	183,539	409,356	8,290	20,651	4721	1789
1965	957,113	3699	953,414	280,970	202,112	433,365	8,782	21,675	4652	1858
1966	1,042,158	3176	1,038,982	306,572	225,878	465,077	9,240	25,922	4514	1779
1967	1,111,373	4350	1,107,023	331,525	242,492	486,043	9,863	29,426	4572	3102
1968	1,206,606	4285	1,202,321	367,692	265,151	518,834	10,302	32,162	4540	3640
1969	1,311,008	3830	1,307,178	407,922	286,686	557,220	10,772	35,861	4531	4186
1970	1,395,568	4209	1,391,359	447,795	312,750	572,522	11,183	37,816	4633	4660
1971	1,469,955	3514	1,466,441	479,080	333,752	592,700	11,673	39,819	4537	4880
1972	1,580,466	2752	1,577,714	511,423	361,859	639,467	12,193	43,190	4440	5142
1973	[illegible]705,773	2570	1,703,203	554,171	396,903	687,235	12,836	42,340	4186	5532
1974	1,703,495R	2726R	1,700,769	554,960	392,716	689,435	13,313	40,721	4258	5366
1975	1,738,107	5083	1,733,024	586,149	418,069	661,558	13,907	43,625	4273	5443

[a] Alaska and Hawaii included since 1960.

[b] Small Light and Power and Large Light and Power are not wholly comparable on a year-to-year basis due to changes from one classification to another. The changes in classification can be inferred from data presented by Chern, Wen S.; Holcomb, Brady D.; Caudill, Steven B., in Historical Trends of Electricity Sales by Sector, Region and State, 1951–1974, unpublished report, Oak Ridge National Laboratory, Oak Ridge, Tenn., September 1976. For further information see the User's Guide, Note 2.

R – Revised.

Source: Edison Electric Institute, Statistical Yearbook of the Electric Utility Industry 1975, New York, October 1976, Table 19s, p. 31.

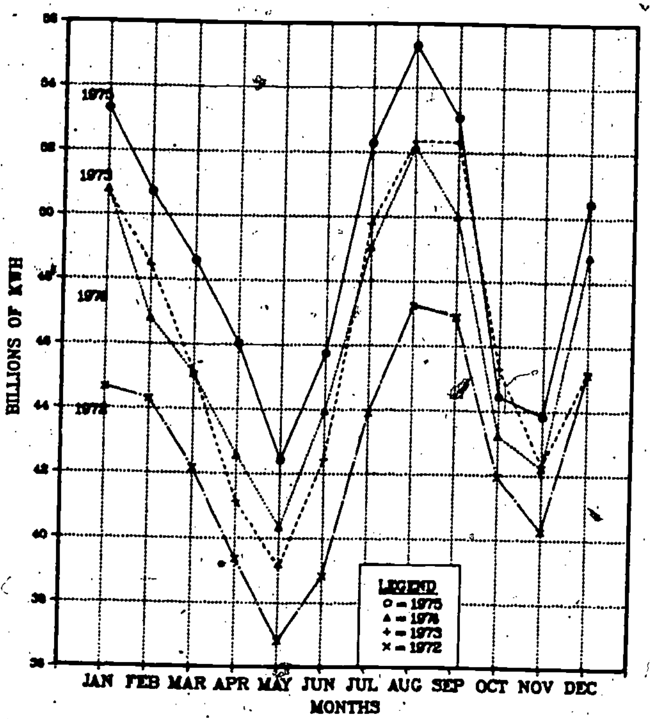

Figure 7.4. Monthly/1972 through 1975 Residential Electricity Sales.

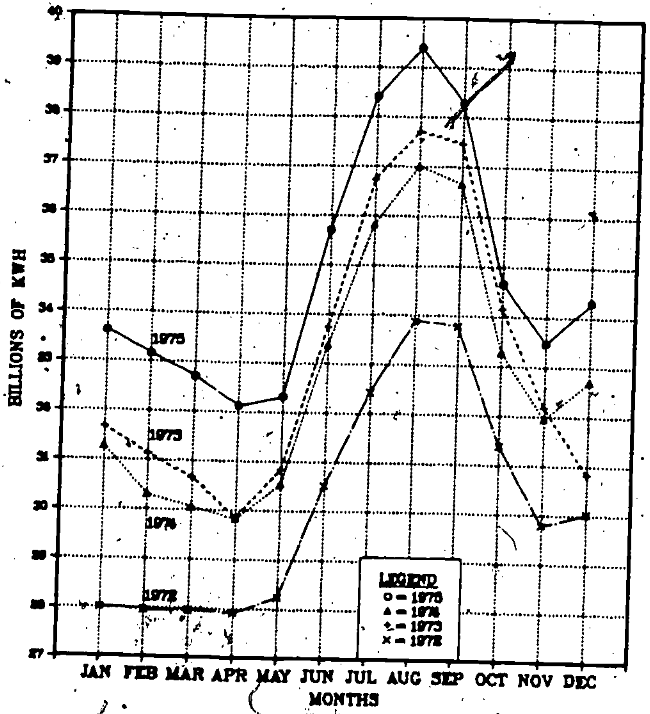

Figure 7.5. Monthly/1972 through 1975 Small Light and Power Electricity Sales.

Source: Edison Electric Institute, Statistical Yearbook of the Electric Utility Industry 1975, New York. October 1976.

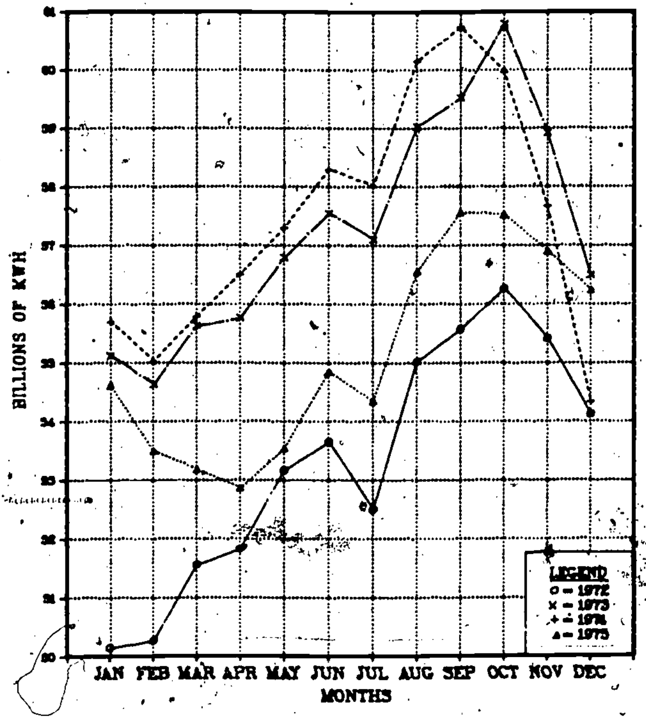

Figure 7.6. Monthly/1972 through 1975 Large Light and Power Electricity Sales.

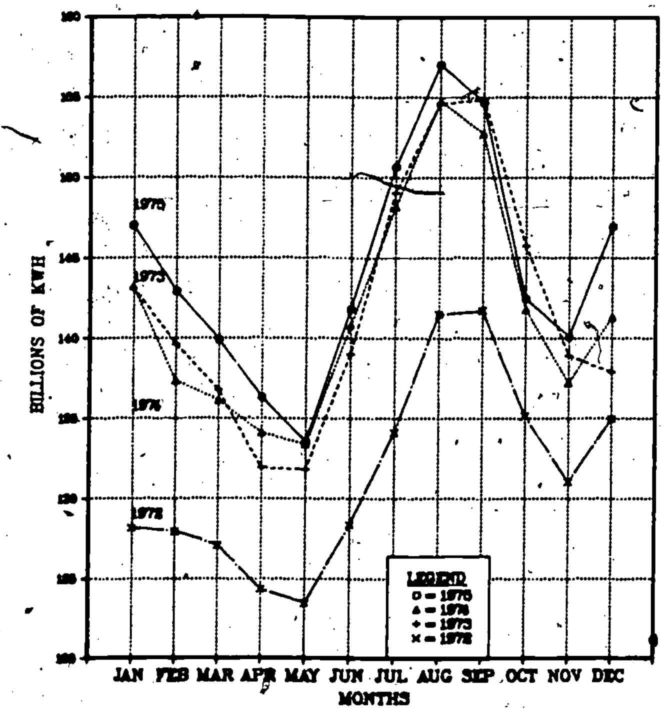

Figure 7.7. Monthly/1972 through 1975 Total Electricity Sales.

Source: Edison Electric Institute, Statistical Yearbook of the Electric Utility Industry 1975, New York, October 1976, Table 24s, p. 35.

Table 7.5. Monthly Electricity Sales[a] to Residential Customers, 1972-1975 (10^9 kWhr)

	Residential			
	1972	1973	1974	1975
January	44.644	50.700	50.795	53.299
February	44.295	48.428	46.797	50.716
March	42.162	45.126	45.080	48.595
April	39.351	41.142	42.568	46.036
May	36.813	39.102	40.353	42.424
June	38.827	42.451	43.958	45.741
July	43.899	49.781	49.042	52.275
August	47.232	52.342	52.161	55.310
September	46.882	52.308	50.002	53.057
October	41.929	45.285	43.212	44.430
November	40.253	42.308	42.209	43.824
December	45.136	45.198	48.803	50.442

Table 7.6. Monthly Electricity Sales[a] to Small Light and Power[b] Customers, 1972-1975 (10^9 kWhr)

	1972	1973	1974	1975
January	28.008	31.665	31.270	33.613
February	27.954	31.124	30.294	33.146
March	27.952	30.646	30.049	32.704
April	27.915	29.848	29.819	32.115
May	28.248	30.838	30.534	32.313
June	30.514	33.745	33.373	35.703
July	32.423	36.733	35.819	38.400
August	33.875	37.704	36.998	39.394
September	33.784	37.452	36.644	38.275
October	31.384	34.146	33.271	34.655
November	29.781	32.180	31.947	33.463
December	30.021	30.822	32.698	34.288

[a] Sales by the total electric industry in the U.S.

[b] Large Light and Power and Small Light and Power data are not comparable on a yearly basis due to differences in classification. See User's Guide, Note 2 for further details.

Source: Edison Electric Institute, Statistical Yearbook of the Electric Utility Industry 1975, New York, October 1976, Table 24s, p. 35.

Table 7.7. Monthly Electricity Sales[a] to Large Light and Power Customers[b], 1972–1975 (10⁹ kWhr)

	1972	1973	1974	1975
January	50.145	55.111	55.695	54.608
February	50.268	54.619	55.022	53.480
March	51.555	55.627	55.786	53.170
April	51.825	55.753	56.502	53.851
May	53.161	56.784	57.297	53.530
June	53.651	57.542	58.292	54.843
July	52.492	57.091	58.004	53.335
August	55.020	59.023	60.151	56.552
September	55.576	59.514	60.731	57.555
October	56.259	60.779	59.958	57.512
November	55.404	58.910	57.665	56.892
December	54.111	56.482	54.332	56.230

[a] Sales by the total electric industry in the U.S.

[b] Large Light and Power and Small Light and Power data are not comparable on a yearly basis due to differences in classification. See User's Guide, Note 2 for further details.

Table 7.7a. Monthly Electricity Sales[a] to all Domestic Customers[b], 1972–1975 (10⁹ kWhr)

	1972	1973	1974	1975
January	128.150	143.116	143.201	147.021
February	127.924	139.596	137.340	142.881
March	127.079	136.747	136.116	139.872
April	124.325	131.896	134.088	136.294
May	123.457	131.813	133.384	133.505
June	128.367	139.014	140.785	141.801
July	134.108	149.064	148.165	150.637
August	141.473	154.594	154.740	157.013
September	141.720	154.878	152.701	154.635
October	135.133	145.715	141.745	142.409
November	131.021	138.889	137.202	140.043
December	134.975	137.881	141.302	146.913

[a] Sales by the total electric industry in the U.S.

[b] Includes Residential, Commercial and Industrial, Street and Highway Lighting, Other Public Authorities, Railroads and Railways, Interdepartmental Usage.

Source: Edison Electric Institute, Statistical Yearbook of the Electric Utility Industry 1975, New York, October 1976, Table 24s, p. 35.

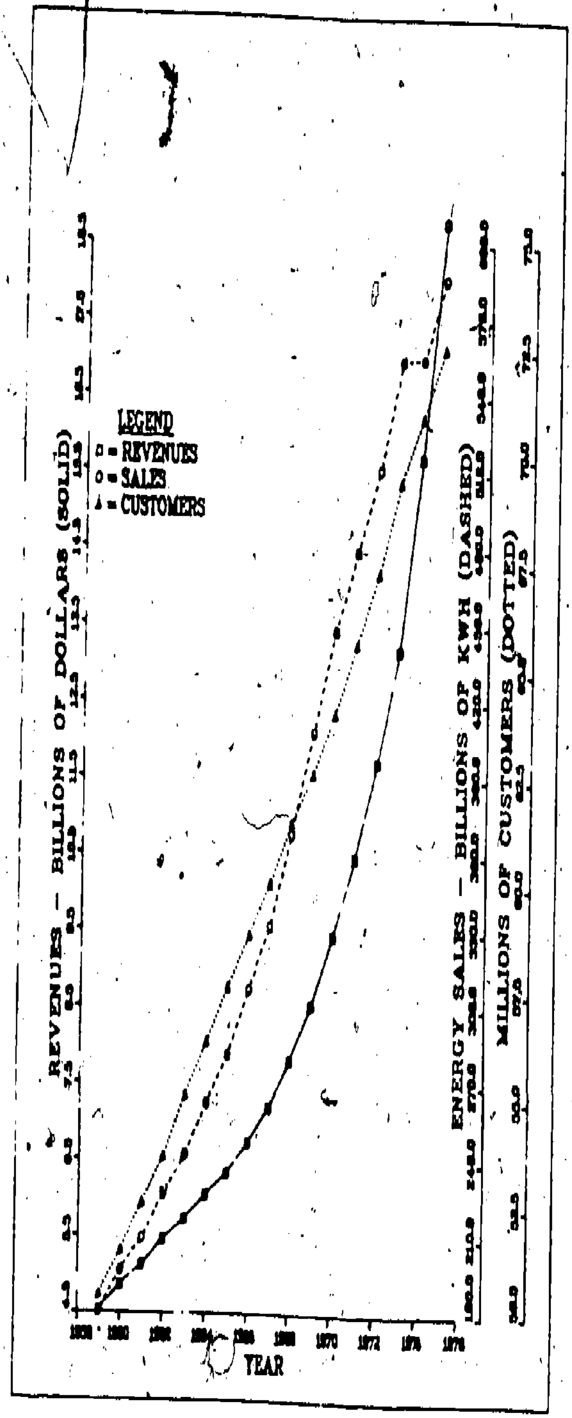

Figure 7.8. Electric Industry Sales to Residential Customers.

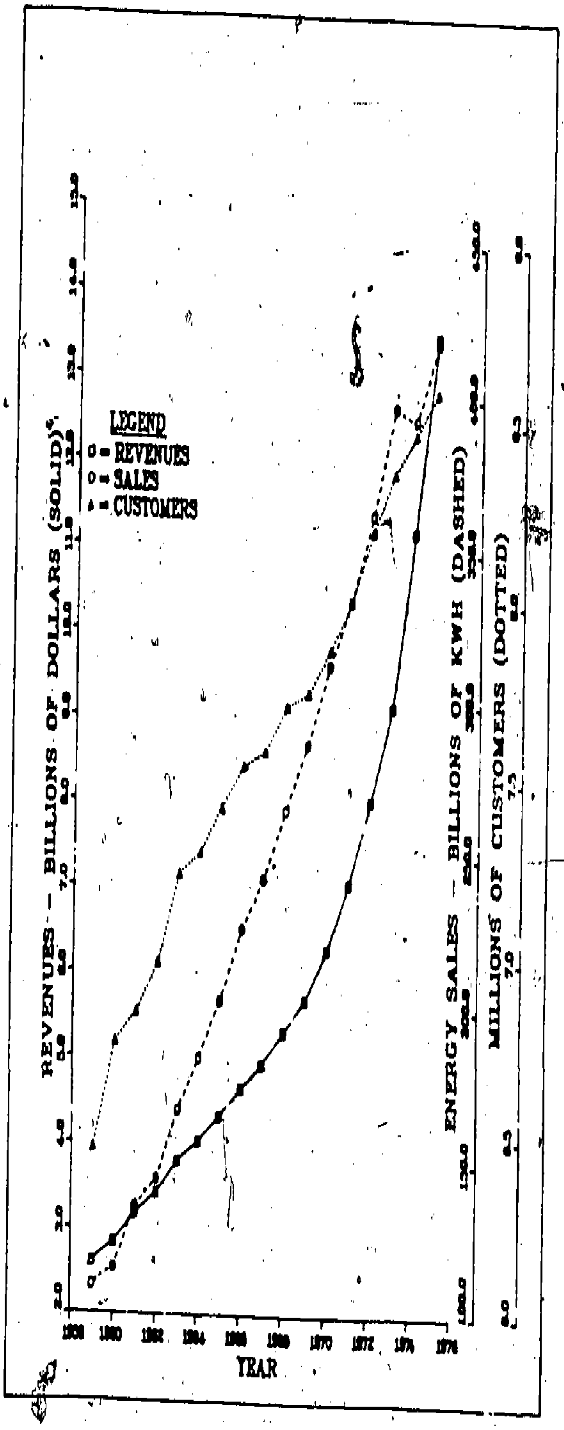

Figure 7.9. Electric Industry Sales to Small Light and Power Customers.

Note: All monies are in terms of current dollars.

Source: Edison Electric Institute, Statistical Yearbook of the Electric Utility Industry 1975, New York, October 1976, Table 19s, p. 31; Table 27s, p. 37; Table 33s, p. 43; Table 44s, p. 52; Table 45s, p. 53.

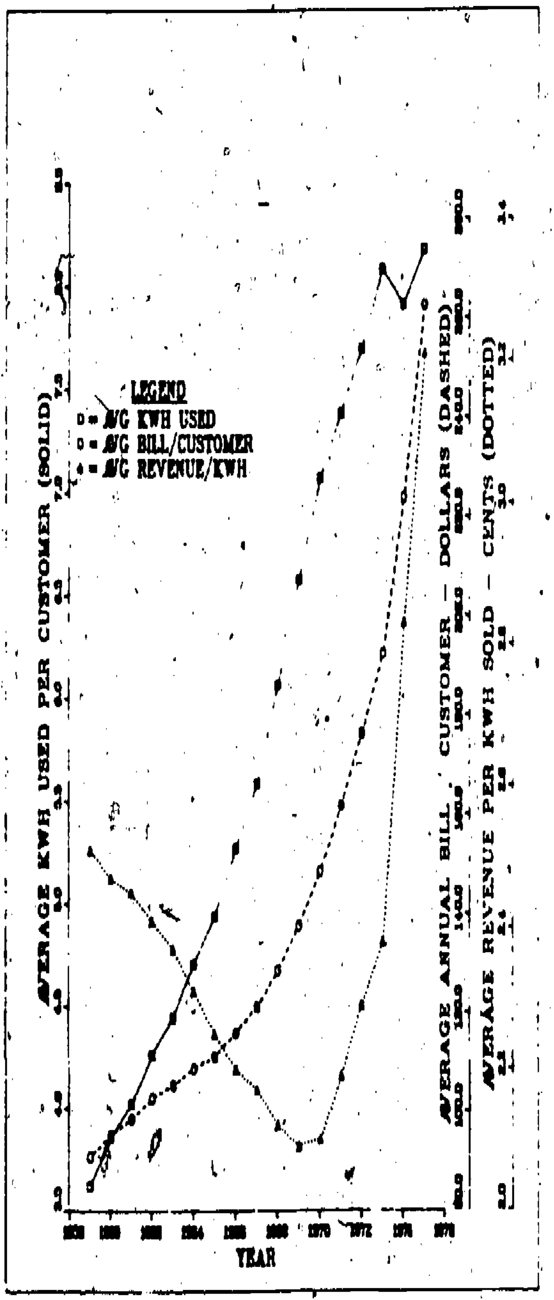

Figure 7.10. Average Electric Industry Sales to Residential Customers.

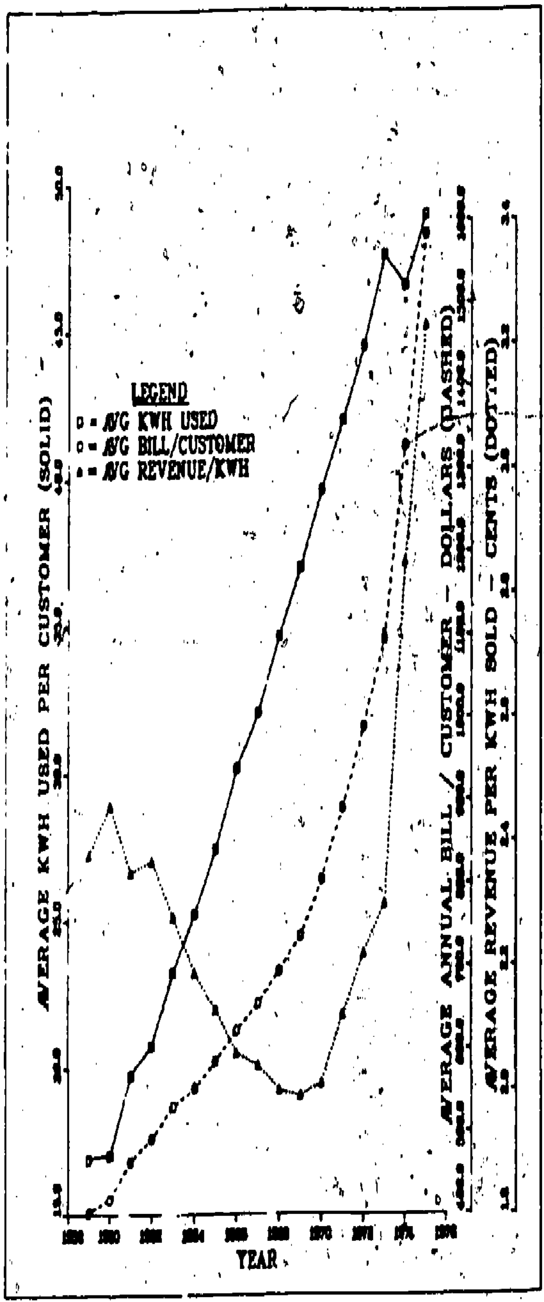

Figure 7.11. Average Electric Industry Sales to Small Light and Power Customers.

Note: All monies are in terms of current dollars.

Source: Edison Electric Institute, Statistical Yearbook of the Electric Utility Industry 1975, New York, October 1976, Table 19s, p. 31; Table 27s, p. 37; Table 33s, p. 43; Table 44s, p. 52; Table 45s, p. 53.

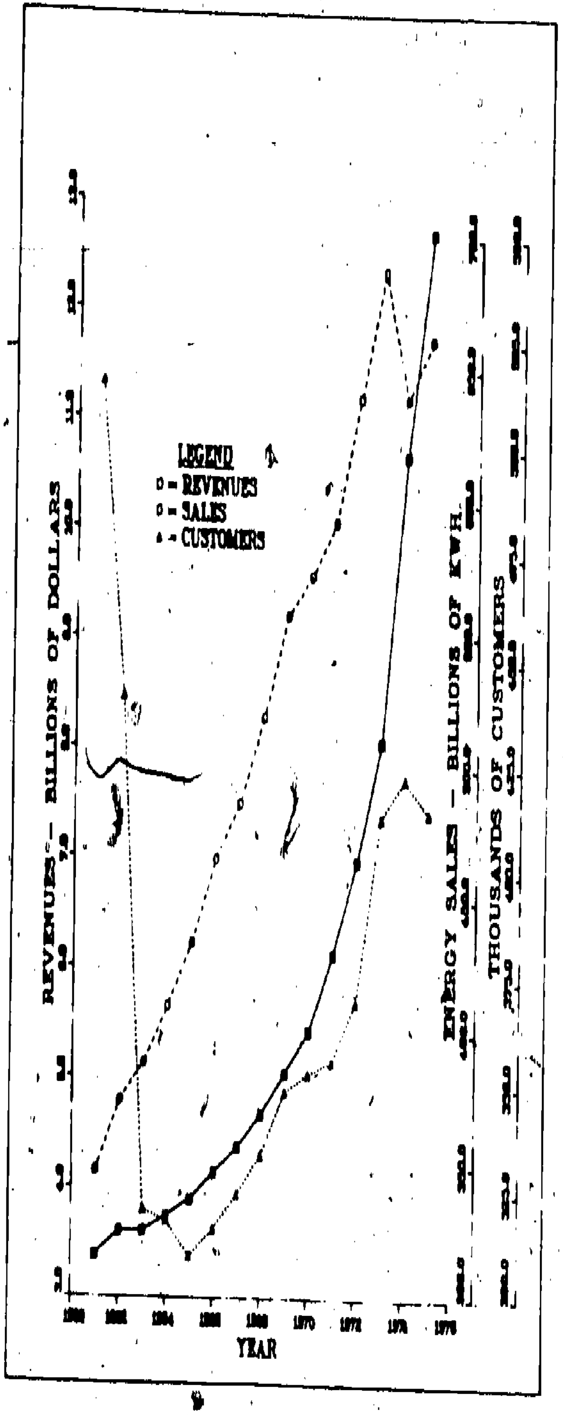

Figure 7.12. Electric Industry Sales to Large Light and Power Customers.

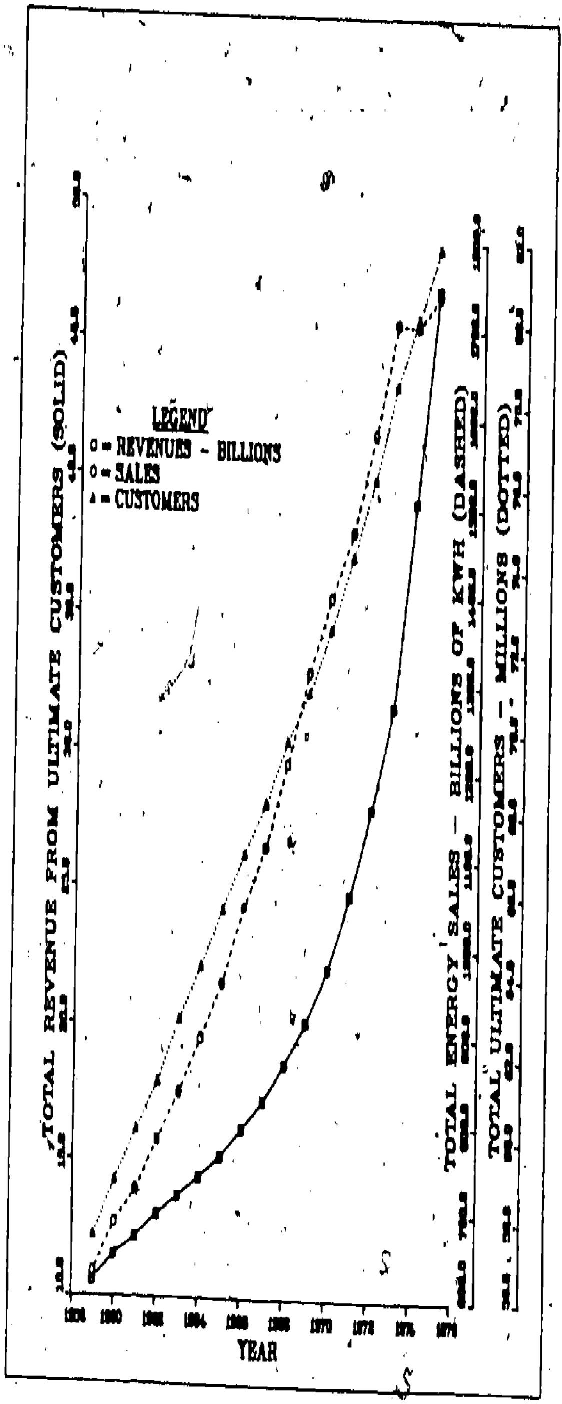

Figure 7.13. Total Electric Industry Sales.

Note: All monies are in terms of current dollars.

Source: Edison Electric Institute, Statistical Yearbook of the Electric Utility Industry 1975, New York, October 1976, Table 19s, p. 31; Table 27s, p. 37; Table 33s, p. 43; Table 44s, p. 52; Table 45s, p. 53.

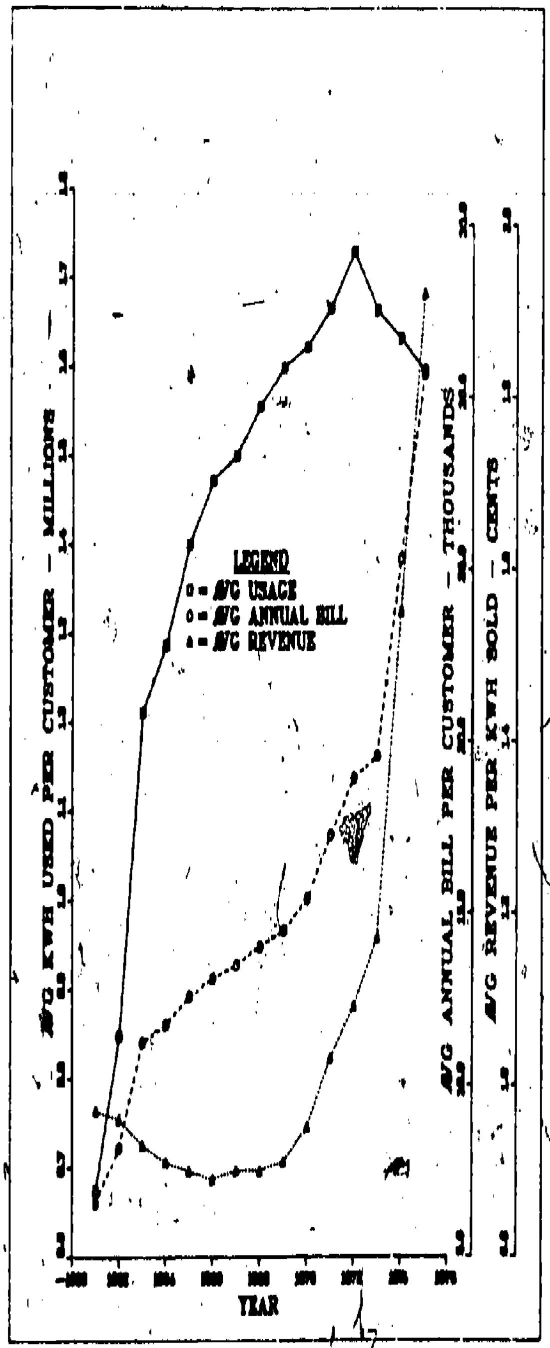

Figure 7.14. Average Electric Industry Sales to Large Light and Power Customers.

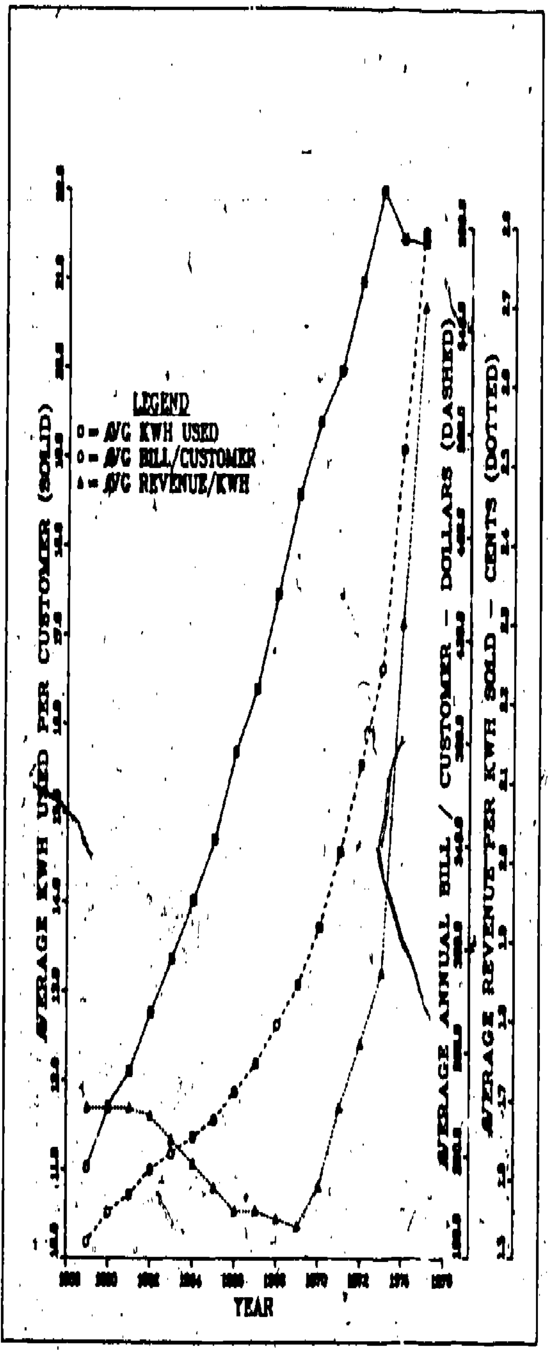

Figure 7.15. Total Electric Industry Sales Averages.

Note: All monies are in terms of current dollars.

Source: Edison Electric Institute, Statistical Yearbook of the Electric Utility Industry 1975, New York, October 1976, Table 19s, p. 31; Table 27s, p. 37; Table 33s, p. 43; Table 44s, p. 52; Table 45s, p. 53.

Table 7.8. Residential Electricity Use, 1959-1975
(includes revenues, sales, and customers)

Year	Revenues ($\$10^3$)	Energy sales (10^6 kWhr)	Number of customers	Average kWhr used by customer	Average annual bill per customer ($)	Average revenue per kWhr sold (¢)
1959	4,514,707	180,186	50,403,378	3618	90.81	2.51
1960	4,855,799	196,400	51,446,472	3854	95.19	2.47
1961	5,115,799	209,021	52,569,050	4019	98.47	2.45
1962	5,457,614	226,414	53,649,362	4259	102.64	2.41
1963	5,722,544	241,692	55,073,055	4442	105.28	2.37
1964	6,040,681	262,010	56,307,195	4703	108.64	2.31
1965	6,328,756	280,970	57,596,016	4933	110.99	2.25
1966	6,733,714	306,572	58,826,283	5265	115.83	2.20
1967	7,183,908	331,525	60,033,404	5577	121.02	2.17
1968	7,802,033	367,692	61,439,030	6057	128.41	2.12
1969	8,532,729	407,922	62,598,910	6571	137.33	2.09
1970	9,415,707	447,795	64,017,662	7066	148.39	2.10
1971	10,483,526	479,080	65,650,046	7380	161.62	2.19
1972	11,729,833	511,423	67,314,000	7691	176.12	2.29
1973	13,194,773	554,171	69,438,429	8079	192.28	2.38
1974	15,702,853	554,960	70,949,607	7907	223.77	2.83
1975	18,803,156	586,149	72,570,187	8176	262.45	3.21

Note: All monies are in terms of current dollars.

Source: Edison Electric Institute, Statistical Yearbook of the Electric Utility Industry 1975, New York, October 1976, Tables 19s, p. 31; Table 27s, p. 37; Table 33s, p. 43; Table 44s, p. 52; Table 45s, p. 53.

Table 7.9. Commercial and Industrial Electric Energy Use, 1959-1975 Small Light and Power[a]
(includes revenues, sales, and customers)

Year	Revenues ($ 10³)	Energy sales (10⁶ kWhr)	Number of customers	Average kWhr used by customer	Average annual bill per customer ($)	Average revenue per kWhr sold (¢)
1959	2,598,452	109,079	6,462,452	16,875	402	2.38
1960[b]	2,828,186	114,806	6,759,902	17,006	418	2.46
1961	3,168,055	134,864	6,843,592	19,709	463	2.35
1962	3,420,013	144,095	6,980,960	20,733	491	2.37
1963	3,788,316	166,516	7,232,065	23,224	530	2.28
1964	4,028,198	183,539	7,293,997	25,213	552	2.19
1965	4,312,859	202,112	7,419,956	27,399	584	2.13
1966	4,649,084	225,678	7,536,066	30,133	621	2.06
1967	4,935,911	212,492	7,579,626	32,041	654	2.04
1968	5,315,100	265,151	7,706,779	34,637	693	2.00
1969	5,704,764	286,686	7,744,851	36,950	735	1.99
1970	6,290,225	312,750	7,865,073	39,952	805	2.01
1971	7,071,971	333,752	8,002,572	41,943	869	2.12
1972	8,041,052	361,859	8,200,033	44,496	988	2.22
1973	9,147,188	396,903	8,361,847	47,580	1094	2.30
1974	11,196,960	392,716	8,472,817	46,557	1327	2.85
1975	13,486,624	418,069	8,591,108	48,964	1582	3.23

[a] "Small light and power: and "Large light and power" data are not comparable on a yearly basis due to differences in classification. See User's Guide, Note 2.

[b] Alaska and Hawaii included since 1960.

Note: All monies are in terms of current dollars.

Source: Edison Electric Institute, Statistical Yearbook of the Electric Utility Industry 1975, New York, October 1976, Table 19s, p. 31; Table 27s, p. 37; Table 33s, p. 43; Table 44s, p. 52; Table 45s, p. 53.

Table 7.10. Commercial and Industrial Electric Energy Use, 1961-1975 Large Light and Power[a]
(includes revenues, sales, and customers)

Year	Revenues ($10³)	Energy sales (10⁶ kWhr)	Number of customers	Average kWhr[b] used by customer	Average annual[b] bill per customer	Average revenue per kWhr sold (¢)
1961	3,369,749	347,427	515,389	674,106	6,538	0.97
1962	3,591,097	373,916	441,394	824,125	8,136	0.96
1963	3,596,121	388,399	320,732	1,210,977	11,212	0.93
1964	3,733,369	409,356	318,168	1,286,603	11,734	0.91
1965	3,884,748	433,365	309,615	1,399,690	12,547	0.90
1966	4,134,538	465,077	316,098	1,471,306	13,080	0.89
1967	4,364,759	486,043	324,222	1,499,106	13,462	0.90
1968	4,672,211	518,834	333,650	1,555,025	14,003	0.90
1969	5,044,857	557,220	348,648	1,598,231	14,470	0.91
1970	5,429,852	572,522	352,993	1,621,508	15,382	0.95
1971	6,133,964	592,700	355,967	1,665,042	17,232	1.03
1972	6,983,891	639,467	369,952	1,728,513	18,878	1.09
1973	8,073,636	687,235	413,383	1,662,465	19,531	1.17
1974	10,673,464	689,435	422,736	1,630,883	25,249	1.55
1975	12,707,490	661,558	414,665	1,595,404	30,645	1.92

[a] "Large light and power" and "Small light and power" data are not comparable on a yearly basis due to changes from one classification to another. See User's Guide, Note 2.

[b] Computed by author from data in table.

Note: All monies are in terms of current dollars.

Source: Edison Electric Institute, Statistical Yearbook of the Electric Utility Industry 1975, New York, October 1976, Table 19s, p. 31; Table 27s, p. 37; Table 33s, p. 43; Table 44s, p. 52; Table 45s, p. 53.

Table 7.11. Electric Industry Totals,[a,b] 1959-1975
(includes revenues, sales, and customers)

Year	Total revenues from ultimate customers ($)	Total sales (10⁶ kWhr)	Total ultimate customers	Average kWhr used by total ultimate customers	Average annual bill/customer, total ultimate customers ($)	Average revenues per kWhr, total ultimate customers (¢)
1959	10,572,652	627,529	57,504,761	11,020	186.24	1.69
1960	11,515,656	683,987	58,869,766	11,704	197.80	1.69
1961	12,169,303	721,645	60,130,180	12,099	204.47	1.69
1962	13,024,944	777,749	61,323,917	12,763	214.42	1.68
1963	13,697,206	832,796	62,857,451	13,366	220.54	1.65
1964	14,408,458	894,609	64,148,656	14,015	227.94	1.62
1965	15,158,379	957,113	65,557,520	14,694	233.63	1.59
1966	16,196,136	1,042,158	66,909,793	15,678	244.58	1.56
1967	17,222,720	1,111,373	68,167,525	16,384	255.59	1.56
1968	18,579,879	1,206,606	69,716,013	17,445	270.40	1.55
1969	20,139,349	1,311,008	70,929,138	18,563	285.87	1.54
1970	22,065,862	1,395,568	72,484,978	19,380	308.14	1.59
1971	24,725,159	1,469,955	74,265,071	19,956	337.26	1.69
1972	27,921,070	1,580,466	76,150,204	20,964	371.06	1.77
1973	31,662,859	1,705,773	78,461,251	21,955	408.36	1.86
1974	39,126,805	1,703,495	80,102,390	21,448	495.30	2.30
1975	46,853,456	1,738,107	81,844,890	21,417	578.26	2.70

[a] Total includes residential, commercial and industrial, street and highway lighting, other public authorities, railroads and railways, interdepartmental usage.

[b] Alaska and Hawaii includes since 1960.

Note: All monies are in terms of current dollars.

Source: Edison Electric Institute, Statistical Yearbook of the Electric Utility Industry 1975, New York, October 1976, Table 19s, p. 31; Table 33s, p. 43; Table 44s, p. 52; Table 45s, p. 53.

Table 7.12. Average Revenues[a] – Total Electric Utility Industry
(cents per kWhr sold)

Year	Residential	Commercial and industrial[b]		Total ultimate customers
		Small light and power	Large light and power	
1956	2.61	2.47	0.92	1.64
1957	2.56	2.44	0.94	1.67
1958	2.54	2.43	0.97	1.71
1959	2.51	2.38	0.96	1.69
1960	2.47	2.46	0.97	1.69
1961[c]	2.45	2.35	0.97	1.69
1962	2.41	2.37	0.96	1.68
1963	2.37	2.28	0.93	1.65
1964	2.31	2.19	0.91	1.62
1965	2.25	2.13	0.90	1.59
1966	2.20	2.06	0.89	1.56
1967	2.17	2.04	0.90	1.56
1968	2.12	2.00	0.90	1.55
1969	2.09	1.99	0.91	1.54
1970	2.10	2.01	0.95	1.59
1971	2.19	2.12	1.05	1.69
1972	2.29	2.22	1.09	1.77
1973	2.38	2.30	1.17	1.86
1974	2.83	2.85	1.55	2.30
1975	3.21	3.23	1.92	2.70

[a] All monies are in terms of current dollars.

[b] "Large light and power" data and "Small light and power" are not comparable on a yearly basis due to differences in classification. See User's Guide, Note 2 for further details.

[c] Alaska and Hawaii included since 1960.

Note: For further discussion of billing procedures and the validity of average revenues as a measure of cost, see User's Guide, Note 1.

Source: Edison Electric Institute, Statistical Yearbook of the Electric Utility Industry 1975, New York, October 1976, Table 45s, p. 53.

Table 7.13. Generation — Total Electric Utility Industry by Year and Type of Prime Mover Driving the Generator (10^6 kWhr)

	Total	Hydro	Percent hydro[a]	Thermal		
				Conventional steam	Nuclear steam	Internal combustion
1971[b]	1,613,936	266,320	17%	1,303,465	37,899	6,252
1972[b]	1,747,323	272,734	16%	1,413,882	54,031	6,676
1973	1,856,216	271,634	15%	1,494,901	83,334	6,347
1974[c]	1,866,436	300,928	16%	1,445,808	113,727	5,973
1975[b]	1,916,578	299,960	16%	1,439,062	171,923	5,633

[a] Percent generated by hydro power.

[b] Preliminary

[c] Revised

Source: Edison Electric Institute, Statistical Yearbook of the Electric Utility Industry 1975, New York, October 1976, Table 16s, p. 25.

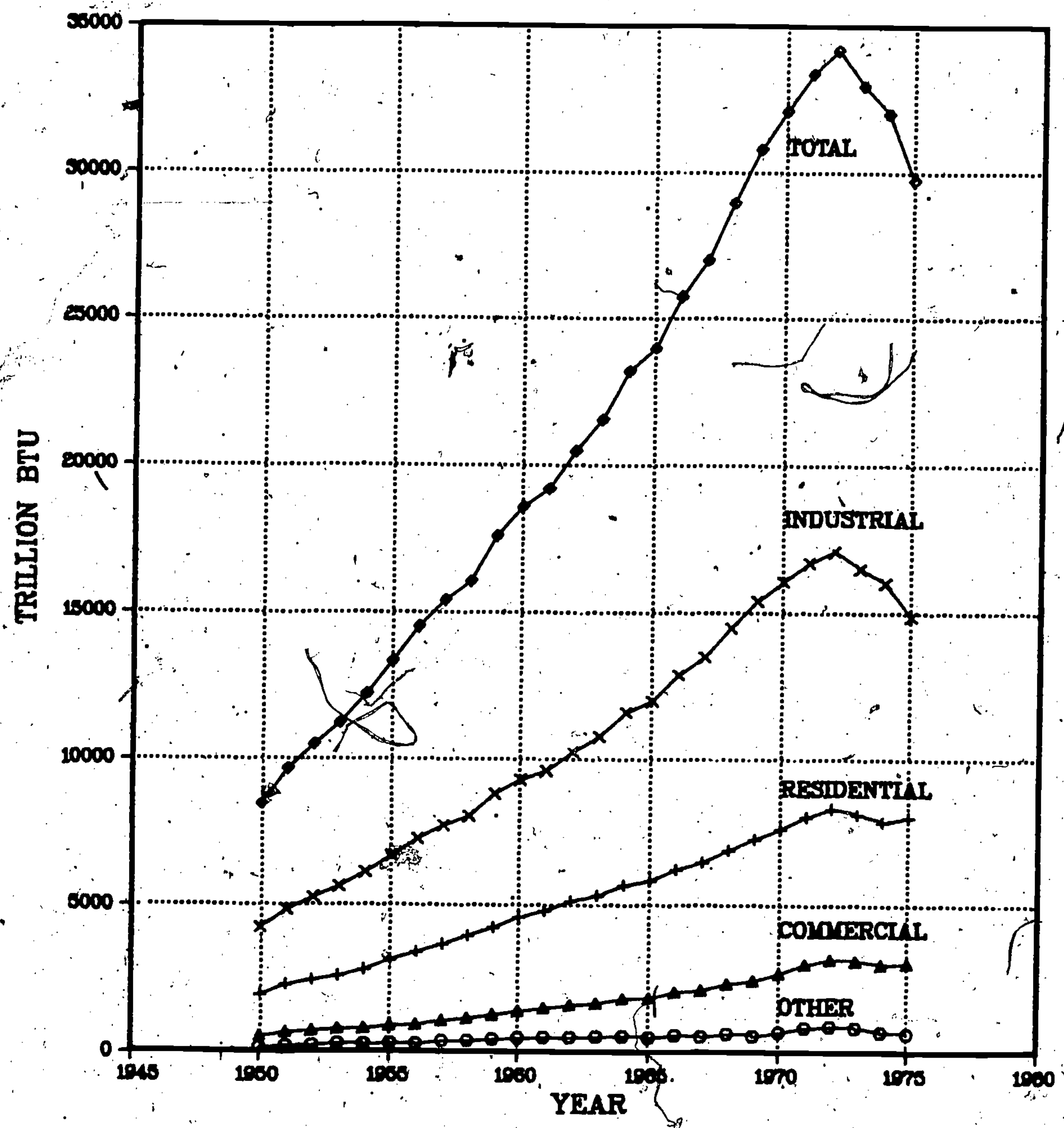

Figure 7.16. Gas Utility Industry Sales by Class of Service.

Source: American Gas Association, Historical Statistics of the Gas Utility Industry, 1966-1975, Arlington, Va., p. 89.

Table 7.14. Gas Utility Industry Sales, by Class of Service 1950–1975[a]
(10^{12} Btu)

Year	Total	Residential	Commercial	Industrial	Other
1950	4,209.1	1383.9	410.4	2288.7	126.1
1951	4,822.2	1620.5	455.9	2552.2	193.6
1952	5,239.2	1734.8	492.9	2799.0	212.5
1953	5,607.3	1803.3	498.0	3037.3	268.7
1954	6,102.6	2003.1	540.5	3309.5	249.5
1955	6,658.6	2238.7	602.9	3535.1	281.9
1956	7,254.2	2464.3	655.8	3868.7	265.4
1957	7,703.5	2598.5	698.9	4047.6	358.5
1958	8,028.6	2812.5	764.9	4076.4	374.8
1959	8,791.8	2973.9	827.5	4563.1	427.3
1960	9,287.7	3188.1	919.8	4709.4	470.4
1961	9,589.0	3321.0	988.1	4785.6	494.3
1962	10,234.8	3536.9	1092.9	5100.1	504.9
1963	10,766.3	3668.0	1136.6	5438.1	523.6
1964	11,591.2	3869.7	1273.5	5912.0	536.0
1965	11,980.3	3999.0	1344.8	6146.5	490.0
1966	12,859.1	4175.4	1462.8	6653.3	567.6
1967	13,488.3	4365.3	1577.6	7014.3	531.1
1968	14,472.4	4552.7	1704.9	7595.1	619.7
1969	15,391.6	4820.4	1878.1	8135.8	557.3
1970	16,043.5	4923.7	2006.6	8439.2	674.0
1971	16,685.7	5040.1	2155.5	8645.5	844.7
1972	17,082.1	5141.8	2275.7	8775.7	888.0
1973	16,479.9	4993.6	2280.8	8370.8	834.7
1974	16.000.3	4864.8	2293.4	8153.2	689.0
1975	14,862.9	4991.0	2386.8	6837.1	648.0

[a] Includes data for Hawaii subsequent to 1959 and for Alaska subsequent to 1960.

Source: American Gas Association, Historical Statistics of the Gas Utility Industry 1966-1975, Arlington, Va., 1977, p. 89.

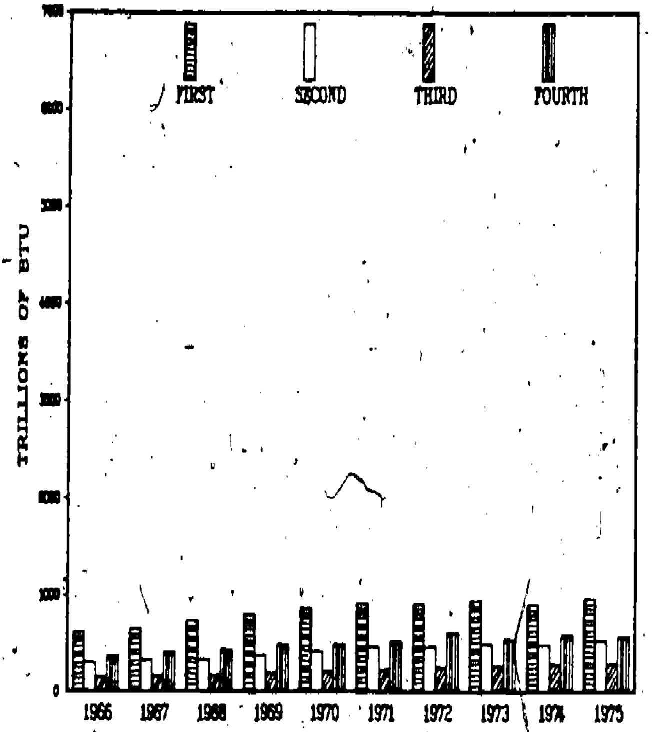

Figure 7.17. Gas Utility Industry Commercial Sales by Quarters, 1966-1975.

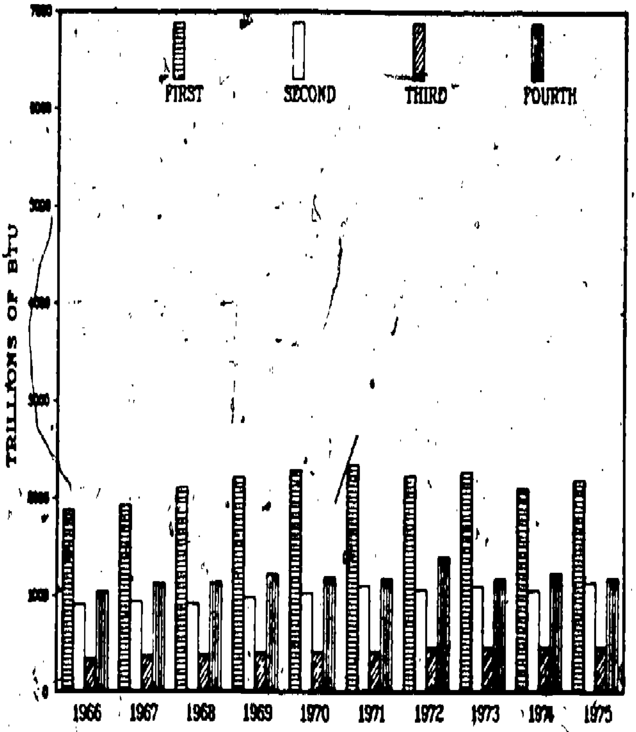

Figure 7.18. Gas Utility Industry Residential Sales by Quarters, 1966-1975.

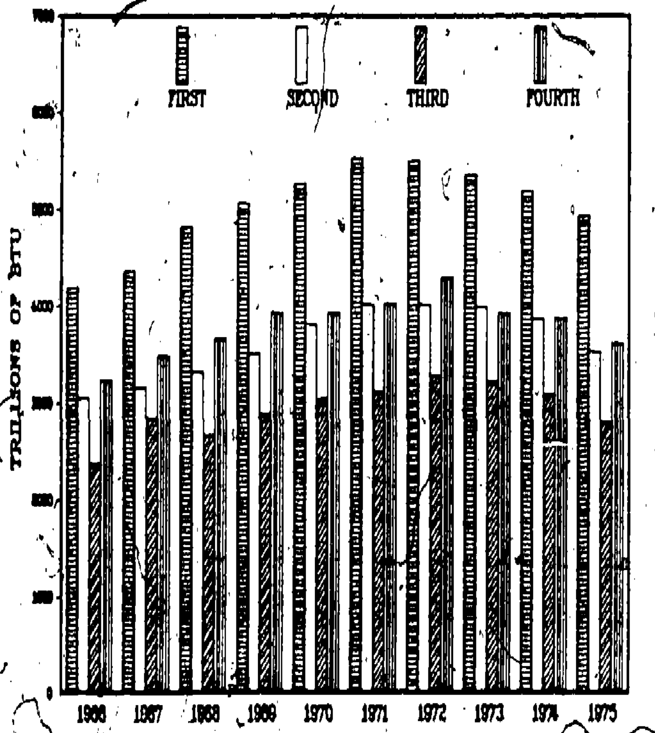

Figure 7.19. Gas Utility Industry Total Sales by Quarters, 1966-1975.

Source: American Gas Association, Historical Statistics of the Gas Utility Industry, 1966-1975, Arlington, Va., 1977, p. 105.

Table 7.15. Quarterly Gas Utility Industry Sales, by Class of Service, 1966-1975[a] (10^{12} Btu)

Year	Total[b]	Residential	Commercial
1966			
First	4,193.3	1,879.3	624.5
Second	3,049.3	907.8	311.4
Third	2,380.2	349.9	155.3
Fourth	3,236.3	1,038.4	371.6
1967			
First	4,359.2	1,924.2	655.3
Second	3,160.5	939.6	335.8
Third	2,481.7	376.5	170.1
Fourth	3,486.9	1,125.0	416.4
1968			
First	4,816.8	2,112.2	740.4
Second	3,322.1	915.0	339.6
Third	2,666.5	390.7	183.7
Fourth	3,667.0	1,134.8	441.2
1969			
First	5,061.8	2,213.3	804.9
Second	3,508.6	977.0	380.9
Third	2,889.7	410.3	203.3
Fourth	3,931.5	1,219.8	489.0
1970			
First	5,262.3	2,286.9	867.7
Second	3,808.1	1,024.3	423.8
Third	3,041.5	420.7	218.6
Fourth	3,931.6	1,191.8	496.5
1971			
First	5,529.6	2,341.6	922.1
Second	4,016.6	1,099.4	470.3
Third	3,114.4	425.7	239.0
Fourth	4,025.1	1,173.4	524.1
1972			
First	5,498.1	2,228.0	916.1
Second	4,012.7	1,059.7	477.6
Third	3,276.4	460.7	259.9
Fourth	4,294.9	1,393.4	622.1
1973			
First	5,354.8	2,264.0	950.7
Second	3,985.6	1,091.9	500.0
Third	3,215.0	465.3	280.4
Fourth	3,924.5	1,172.4	549.8
1974			
First	5,185.5	2,105.9	908.5
Second	3,865.1	1,055.0	496.4
Third	3,078.0	472.6	295.1
Fourth	3,871.6	1,231.2	593.4
1975			
First	4,931.5	2,192.8	970.4
Second	3,520.9	1,137.7	536.3
Third	2,794.9	474.9	301.2
Fourth	3,615.6	1,185.6	579.0

[a] Excludes liquefied petroleum sales prior to 1971.

[b] Total consists of residential, commercial, industrial, and "other."

Source: American Gas Association, Historical Statistics of the Gas Utility Industry, 1966-1975, Arlington, Va., 1977, p. 105.

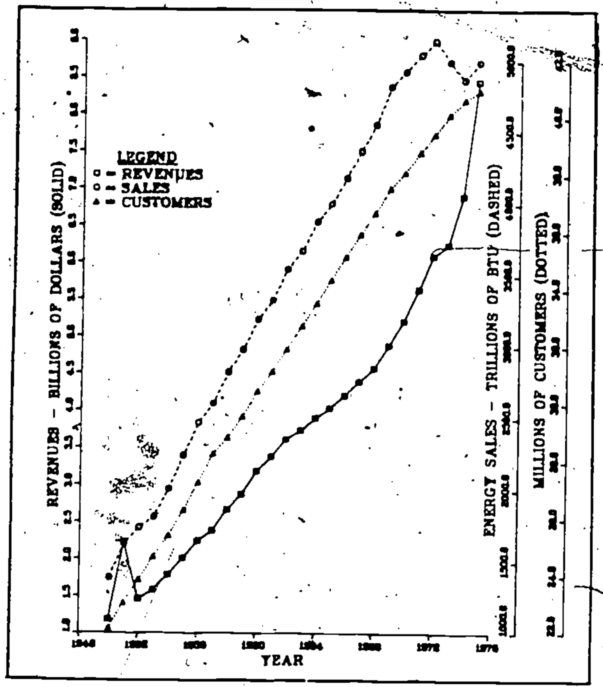

Fig. 7.20. Gas Utility Industry Sales to Residential Customers

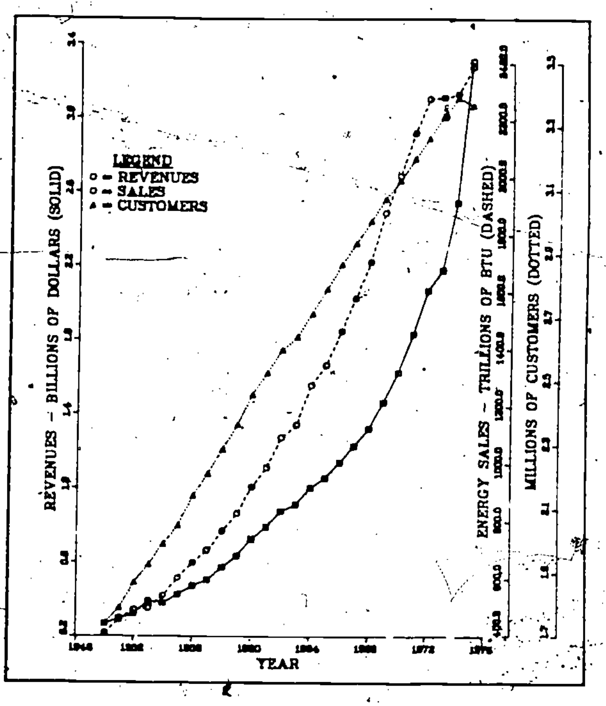

Fig. 7.21. Gas Utility Industry Sales to Commercial Customers

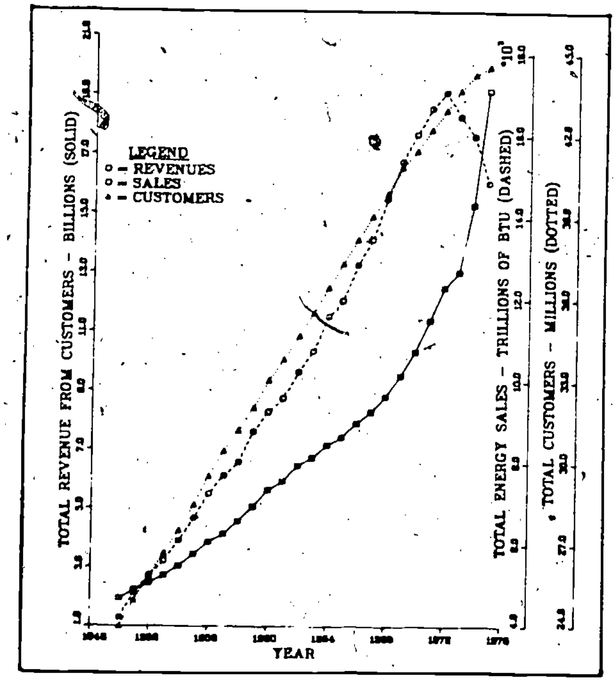

Fig. 7.22. Total Gas Utility Industry Sales

Note: All monies are in terms of current dollars.

Source: American Gas Association, Historical Statistics of the Gas Utility Industry, 1966–1975, Arlington, Va., 1977, pp. 68, 77, 89, 108, and 125.

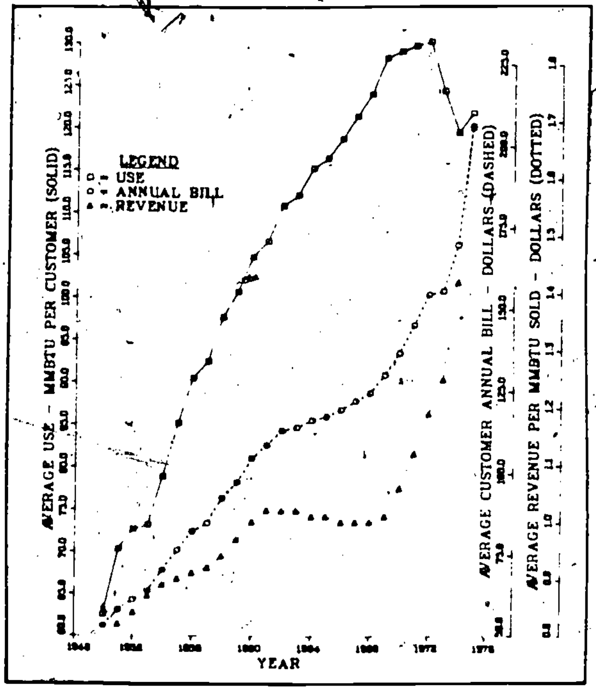

Fig. 7.23. Average Gas Utility Industry Sales to Residential Customers.

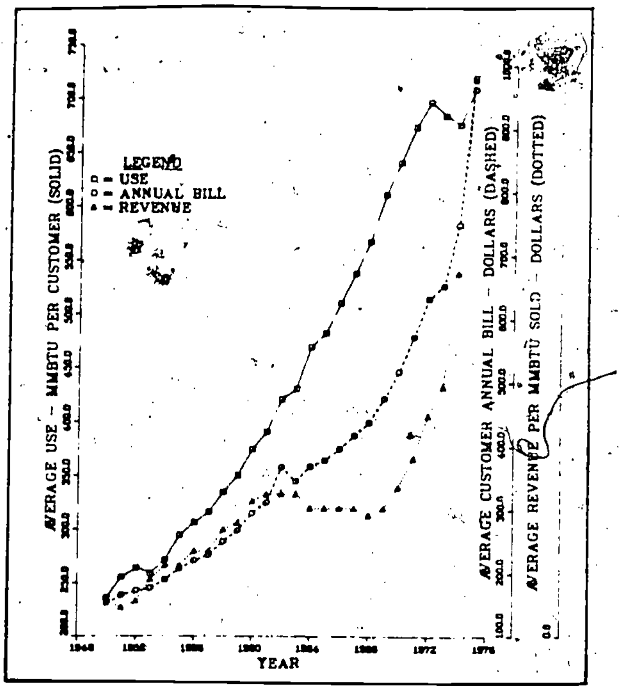

Fig. 7.24. Average Gas Utility Industry Sales to Commercial Customers.

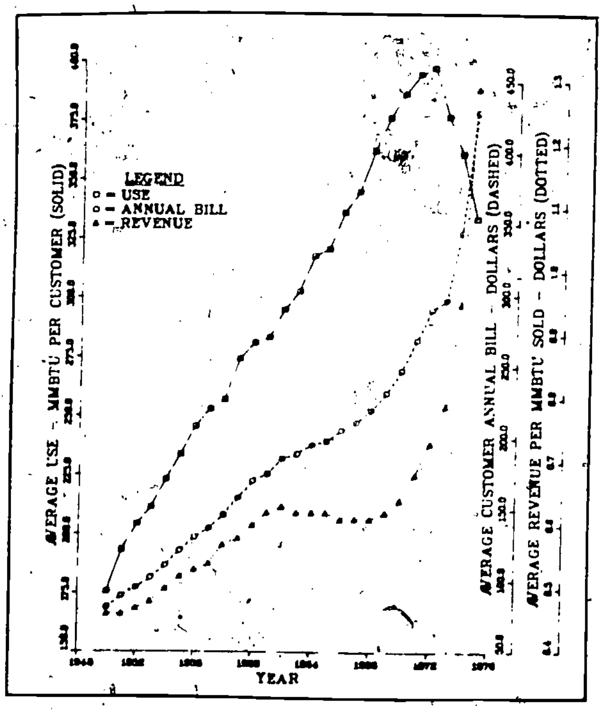

Fig. 7.25. Average Gas Utility Industry Sales to All Customers.

Note: All monies are in terms of current dollars.

Source: American Gas Association, Historical Statistics of the Gas Utility Industry, 1966–1975, Arlington, Va., 1977, pp. 68, 77, 89, 108, and 125.

Table 7.16. Gas Utility Industry Sales to Residential Customers, 1950–1975[a]
(includes revenues, sales, and customers)

Year	Revenues ($$10^3$)	Sales (10^{12} Btu)	Number of customers (in thousands)	Average use per customer (10^6 Btu/customer)	Average annual bill per customer ($)	Average revenue per 10^6 Btu sold ($)
1950	1,177,070	1383.9	22,146.1	62.5	53.15	0.85
1951	1,334,967	1620.5	23,042.0	70.3	57.94	0.82
1952	1,456,718	1734.8	23,852.0	72.7	61.07	0.84
1953	1,574,428	1803.3	24,647.0	73.2	63.88	0.87
1954	1,782,670	2003.1	25,398.0	78.9	70.19	0.89
1955	2,007,450	2238.7	26,282.6	85.2	76.38	0.90
1956	2,236,500	2464.3	27,241.0	90.5	82.10	0.91
1957	2,378,938	2598.5	28,101.2	92.5	84.66	0.92
1958	2,657,616	2812.5	28,786.5	97.7	92.32	0.94
1959	2,870,473	2973.9	29,529.6	100.7	97.21	0.97
1960	3,177,430	3188.1	30,417.5	104.8	104.46	1.00
1961	3,376,781	3321.0	31,118.2	106.7	108.51	1.02
1962	3,603,266	3536.9	31,893.0	110.9	112.98	1.02
1963	3,727,868	3668.0	32,710.8	112.1	113.96	1.02
1964	3,894,870	3869.7	33,551.2	115.3	116.09	1.01
1965	4,029,562	3999.0	34,340.8	116.5	117.34	1.01
1966	4,195,331	4175.4	35,141.8	118.8	119.38	1.00
1967	4,382,837	4365.3	35,915.1	121.5	122.03	1.00
1968	4,567,307	4552.7	36,691.1	124.1	124.48	1.00
1969	4,883,029	4820.4	37,538.3	128.4	130.08	1.01
1970	5,207,335	4923.7	38,097.0	129.2	136.69	1.06
1971	5,635,395	5040.1	38,788.7	129.9	145.28	1.12
1972	6,094,171	5141.8	39,428.0	130.4	154.56	1.19
1973	6,246,988	4993.6	40,115.5	124.5	155.73	1.25
1974	6,899,395	4864.8	40,626.7	119.6	169.82	1.42
1975	8,445,484	4991.0	40,950.3	121.9	206.24	1.69

[a] Includes data for Hawaii subsequent to 1959 and for Alaska subsequent to 1960.

Source: American Gas Association, *Historical Statistics of the Gas Utility Industry, 1966–1975*, Arlington, Va., 1977, pp. 77, 89, [illegible], 68, and 125.

Table 7.17. Gas Utility Industry Sales to Commercial Customers, 1950–1975[a] (includes revenues, sales, and customers)

Year	Revenues ($10³)	Sales (10¹² Btu)	Number of customers (in thousands)	Average use per customer (10⁶ Btu/customer)	Average annual bill per customer ($)	Average revenue per 10⁶ Btu sold ($)
1950	265,571	410.4	1739.4	235.9	152.68	0.65
1951	294,435	455.9	1787.0	255.1	164.76	0.64
1952	321,309	492.9	1869.0	263.7	171.91	0.65
1953	338,914	498.0	1926.0	258.6	175.97	0.68
1954	377,749	540.5	1990.0	271.6	189.82	0.70
1955	424,090	602.9	2047.5	294.5	207.17	0.70
1956	471,258	655.8	2140.3	306.4	220.21	0.72
1957	505,678	698.9	2211.1	316.1	228.70	0.72
1958	571,212	764.9	2286.6	334.5	249.81	0.75
1959	632,665	827.5	2363.9	350.1	267.64	0.76
1960	723,448	919.8	2458.3	374.2	284.29	0.79
1961	789,202	988.1	2528.9	390.7	312.07	0.80
1962	874,366	1092.9	2597.9	420.7	366.57	0.80
1963	910,497	1136.6	2639.6	430.6	344.94	0.80
1964	998,386	1273.5	2712.2	469.5	368.11	0.78
1965	1,053,647	1344.8	2789.7	482.1	377.69	0.78
1966	1,135,352	1462.8	2868.2	510.0	395.84	0.78
1967	1,223,897	1577.6	2933.6	537.8	417.20	0.78
1968	1,315,409	1704.9	3003.6	567.6	437.34	0.77
1969	1,459,054	1878.1	3073.8	611.0	474.67	0.78
1970	1,620,446	2006.6	3130.9	640.9	517.57	0.81
1971	1,829,309	2155.5	3199.0	673.8	571.84	0.85
1972	2,063,803	2275.7	3263.6	697.3	632.56	0.91
1973	2,172,460	2280.8	3331.4	684.6	652.12	0.95
1974	2,539,300	2293.4	3392.0	676.1	748.61	1.11
1975	3,302,669	2386.8	3367.2	708.9	880.83	1.38

[a] Includes data for Hawaii subsequent to 1959 and for Alaska subsequent to 1960.

Source: American Gas Association, Historical Statistics of the Gas Utility Industry, 1966–1975, Arlington, Va., 1977, pp. 77, 89, 108, 68, and 125.

Table 7.18. Total Gas Utility Industry Sales 1950–1975[a]
(includes revenues, sales, and customers)

Year	Revenues ($$10^3$)	Sales (10^{12} Btu)	Number of customers (in thousands)	Average use per customer (10^6 Btu/customer)	Average annual bill per customer ($)	Average revenue (per 10^6 Btu sold) ($)
1950	1,948,002	4,209.1	24,001.0	175.4	81.16	0.46
1951	2,228,109	4,822.2	24,953.0	193.3	89.29	0.46
1952	2,465,735	5,239.2	25,850.0	203.9	95.39	0.47
1953	2,715,900	5,607.3	26,705.0	211.4	101.70	0.48
1954	3,049,243	6,102.6	27,528.0	223.1	110.77	0.50
1955	3,449,699	6,658.6	28,478.8	233.8	121.13	0.52
1956	3,850,071	7,254.2	29,536.6	245.6	130.35	0.53
1957	4,133,555	7,703.5	30,476.0	252.8	135.63	0.54
1958	4,568,321	8,028.6	31,242.1	257.0	146.22	0.57
1959	5,065,228	8,791.8	32,065.9	274.2	157.96	0.58
1960	5,617,387	9,287.7	33,053.8	281.0	169.95	0.60
1961	5,922,879	9,589.0	33,830.5	283.4	175.08	0.62
1962	6,444,860	10,234.8	34,683.4	295.1	185.82	0.63
1963	6,726,815	10,766.3	35,551.0	302.8	189.22	0.62
1964	7,132,685	11,591.2	36,463.3	317.9	195.61	0.62
1965	7,406,978	11,980.3	37,337.5	320.9	198.38	0.62
1966	7,869,888	12,859.1	38,228.4	336.4	205.86	0.61
1967	8,260,739	13,488.3	39,076.5	345.2	211.40	0.61
1968	8,781,152	14,472.4	39,930.0	362.4	219.91	0.61
1969	9,479,566	15,391.6	40,854.0	376.7	232.04	0.62
1970	10,282,611	16,043.5	41,482.1	386.8	247.88	0.64
1971	11,357,392	16,685.7	42,241.8	395.0	268.87	0.68
1972	12,465,235	17,082.1	42,954.8	397.7	290.19	0.73
1973	12,987,272	16,479.9	43,711.0	377.0	297.12	0.79
1974	15,242,481	16,000.3	44,267.3	361.1	344.33	0.95
1975	19,101,498	14,862.9	44,554.8	333.6	428.72	1.29

[a] Includes data for Hawaii subsequent to 1959 and for Alaska subsequent to 1960.

Source: American Gas Association, Historical Statistics of the Gas Utility Industry, 1966–1975, Arlington, Va., 1977, pp. 77, 89, 108, 68, and 125.

THE BILLING SYSTEM FOR GAS IS NOT NEARLY AS COMPLEX AS THAT FOR ELECTRICITY.

Table 7.19. Gas Utility Industry Prices, by Class of Service, 1950–1975[a]
($/10^6 Btu)

Year	Total[b]	Residential	Commercial
1950	0.46	0.85	0.65
1951	0.46	0.82	0.64
1952	0.47	0.84	0.65
1953	0.48	0.87	0.68
1954	0.50	0.89	0.70
1955	0.52	0.90	0.70
1956	0.53	0.91	0.72
1957	0.54	0.92	0.72
1958	0.57	0.94	0.75
1959	0.58	0.97	0.76
1960	0.60	1.00	0.79
1961	0.62	1.02	0.80
1962	0.63	1.02	0.80
1963	0.62	1.02	0.80
1964	0.62	1.01	0.78
1965	0.62	1.01	0.78
1966	0.61	1.00	0.78
1967	0.61	1.00	0.78
1968	0.61	1.00	0.77
1969	0.62	1.01	0.78
1970	0.64	1.06	0.81
1971	0.68	1.12	0.85
1972	0.73	1.19	0.91
1973	0.79	1.25	0.95
1974	0.95	1.42	1.11
1975	1.29	1.69	1.38

[a] Includes data for Hawaii subsequent to 1959 and for Alaska subsequent to 1960.

[b] "Total" includes "Residential," "Commercial," "Industrial," and "Other."

Source: American Gas Association, Historical Statistics of the Gas Utility Industry, 1966–1975, Arlington, Va., 1977, Table 73, p. 125.

Table 7.20. Petroleum Consumption by the Residential and Commercial Sector (10^{15} Btu)

1973	January	0.707
	February	0.653
	March	0.620
	April	0.527
	May	0.562
	June	0.511
	July	0.503
	August	0.560
	September	0.538
	October	0.592
	November	0.658
	December	0.648
	Total	7.077
1974	January	0.662
	February	0.590
	March	0.56[illegible]
	April	0.530
	May	0.497
	June	0.503
	July	0.507
	August	0.519
	September	0.513
	October	0.589
	November	0.583
	December	0.628
	Total	6.688
1975	January	0.627
	February	0.526
	March	0.546
	April	0.489
	May	0.444
	June	0.435
	July	0.463
	August	0.447
	September	0.484
	October	0.539
	November	0.503
	December	0.635
	Total	6.135
1976	January	0.656
	February	0.575
	March	0.571
	April	0.500
	May	0.506
	June	0.489
	July	0.487
	August	0.506
	September	0.517
	October	0.567
	November	0.622
	December	0.726
	Total	6.722
1977	January	0.7[illegible]2
	February	R0.672
	March	0.605

Note: Asphalt and road oils are included as petroleum products in this table. For further enumeration of oil petroleum products, see the Glossary.

Source: Federal Energy Administration, Monthly Energy Review, Washington D.C., August 1976, p. 44; April 1977, p. 47; July 1977, p. 57.

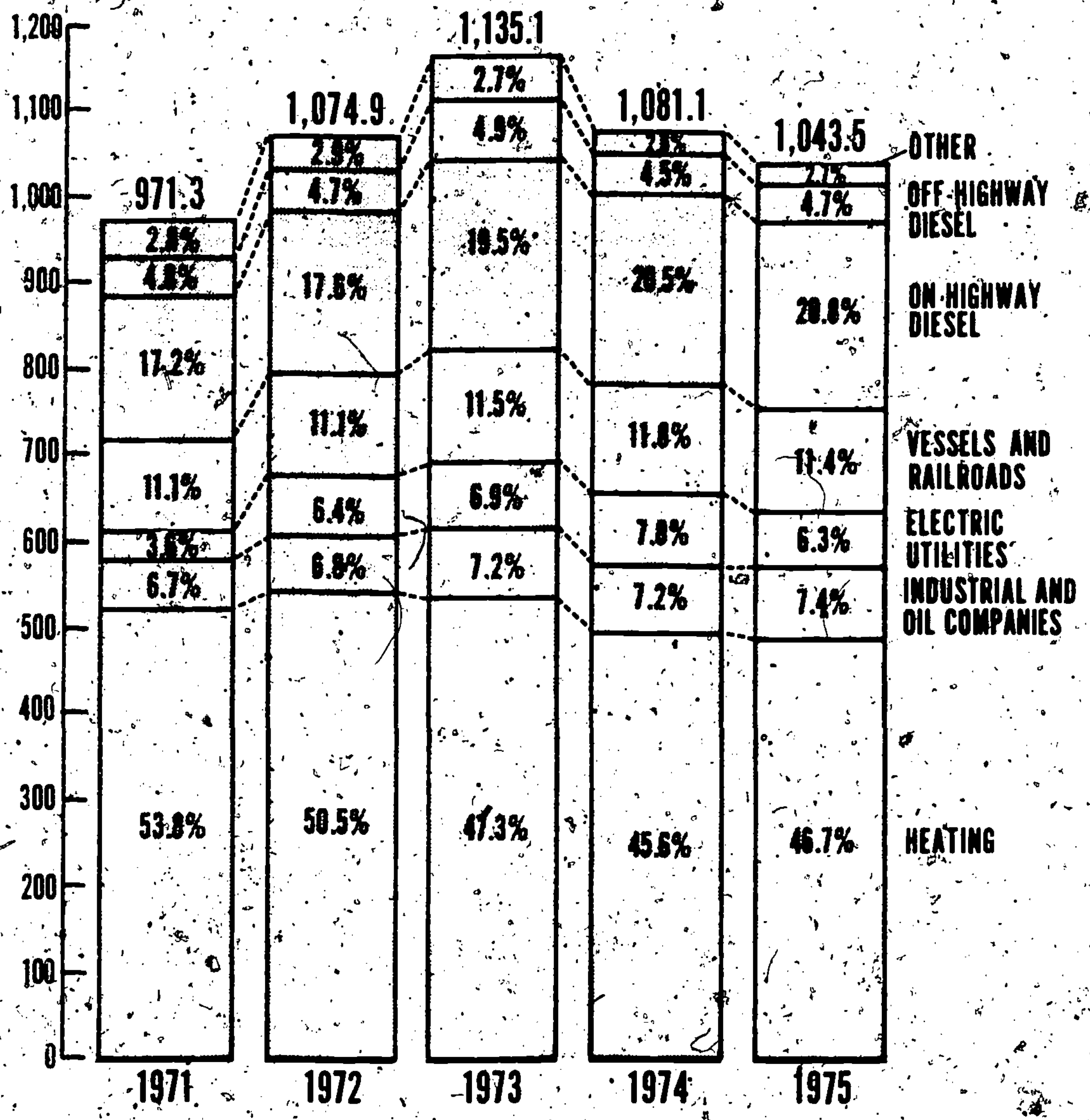

Figure 7.26. Sales of Distillate Fuel Oil by Use as Percent of Total. (millions of barrels)

Note: Numerous sources equate distillate fuel oil used for heating purposes with residential/commercial consumption of distillate fuel oil.

Source: U.S. Department of the Interior, Bureau of Mines, "Sales of Fuel Oil and Kerosine in 1975," Mineral Industry Surveys, Washington, D.C., September 1976, Figure 1, p. 2.

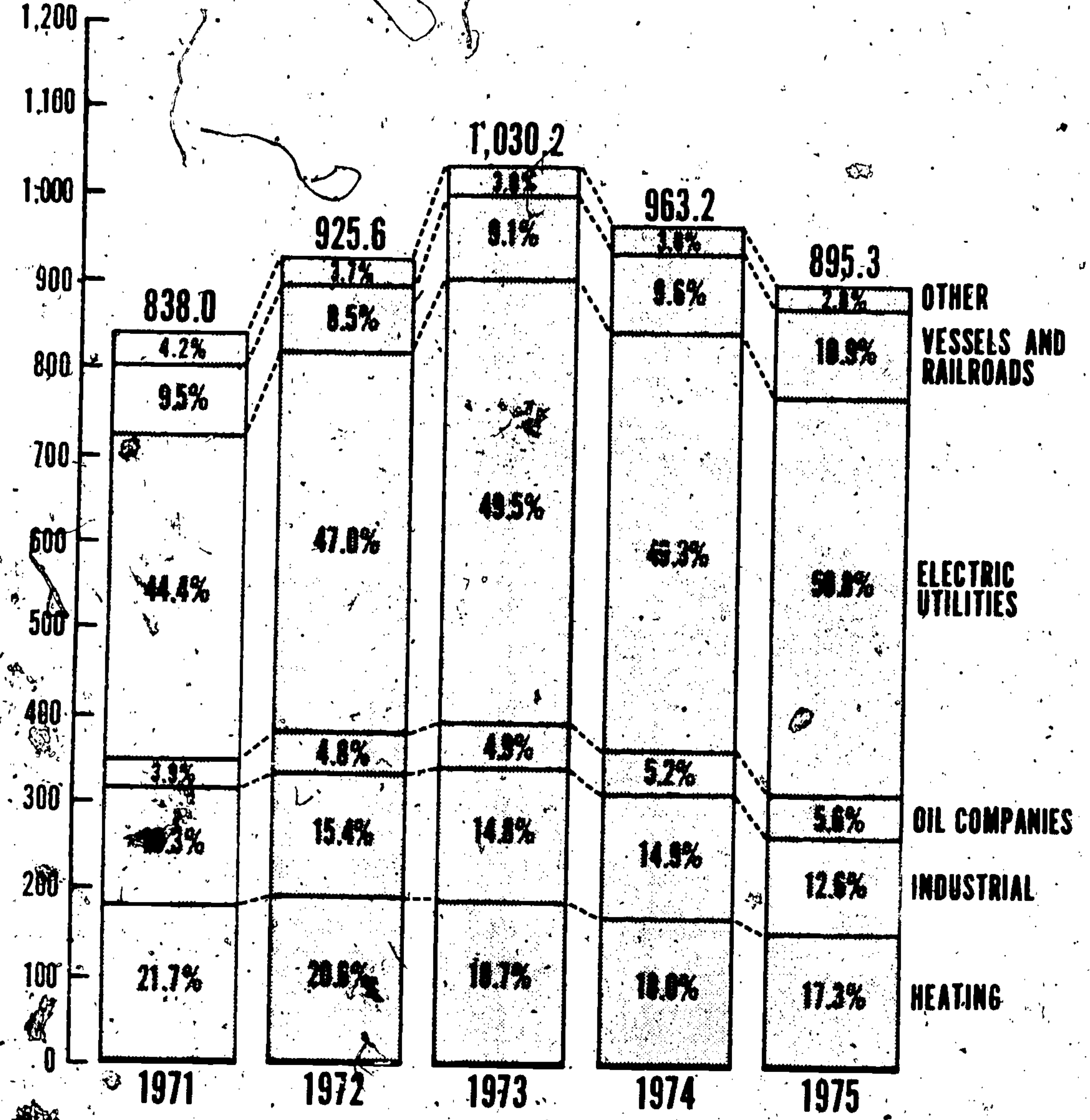

Figure 7.27. Sales of Residual Fuel Oil by Use as Percent of Total (millions of barrels)

Note: Numerous sources equate residual fuel oil used for heating purposes with residential/commercial consumption of residual fuel oil.

Source: U.S. Department of the Interior, Bureau of Mines, "Sales of Fuel Oil and Kerosine in 1975," Mineral Industry Surveys, Washington, D.C., September 1976, Figure 2, p. 3.

Table 7.21. Sales of Distillate Fuel Oil[a] by Use in the United States, 1971 through 1975 (10^6 bbl)

Use	1971	1972	1973	1974[b]	1975
Heating[c]	522,475	543,337	536,856	493,223	487,120
Industrial (excluding oil company use)	50,731	60,388	67,306	64,036	63,993
Oil-company use	14,088	13,405	14,902	13,805	13,633
Electric-utility companies	35,329	68,334	77,950	84,661[d]	65,203[d]
Railroads	86,251	97,001	102,828	102,949	93,191
Vessels	20,959	22,125	26,786	24,757	26,138
Military	17,427	20,187	19,598	17,748	18,004
On-highway diesel	166,981	189,055	221,420	221,033	217,206
Off-highway diesel	46,925	50,186	55,541	48,743	48,977
All other	10,154	10,852	11,876	10,131	10,096
United States, total	971,320	1,074,870	1,135,063	1,081,086[d]	1,043,561[d]

[a] Includes diesel fuel.

[b] Revised.

[c] Includes range oil.

[d] Data for 1975 includes 19,656,000 barrels of distillate #2 and 2,510,000 barrels of distillate #4 fuel oil used at steam-electric plants. Also included are 3,161,000 barrels of kerosine-type jet fuel used by electric-utility companies. The 1974 data includes 23,646,000 barrels of distillate #2, 3,037,000 barrels of distillate #4 fuel oil used at steam-electric plants, and 5,170,000 barrels of kerosine-type jet fuel used by electric-utility companies.

Source: U.S. Department of the Interior, Bureau of Mines, "Sales of Fuel Oil and Kerosine in 1975," Mineral Industry Surveys, Washington, D.C., September 1976, Table 2, p. 4.

Table 7.22. Sales of Residual Fuel Oil[a] by Use in the United States, 1971 through 1975 (10^6 bbl)

Use	1971	1972	1973	1974[b]	1975
Heating	182,062	191,111	192,252	172,896	155,103
Industrial (excluding oil company use)	136,221	142,320	152,267	143,726	112,362
Oil-company use	32,626	44,291	50,652	50,236	50,487
Electric-utility companies	371,820	435,348	509,457	475,204[c]	454,935[c]
Railroads	1,262	1,137	1,214	1,176	583
Vessels	78,727	77,932	92,415	91,052	96,673
Military	29,217	24,622	22,892	20,423	19,068
All other	6,109	8,886	9,028	8,503	6,066
Unites States, total	838,044	925,647	1,030,177	963,216	895,277

[a] Includes Navy grade and crude oil burned as fuel.

[b] Revised.

[c] Data for 1975 excludes 22,166,000 barrels of distillate fuel oil used at steam-electric plants. The 1974 data excludes 26,683,000 barrels of distillate fuel oil used at steam-electric plants.

Source: U.S. Department of the Interior, Bureau of Mines, "Sales of Fuel Oil and Kerosine in 1975," Mineral Industry Surveys, September 1976, Table 3, p. 4.

Table 7.23. Sales of Kerosine (Excluding Jet Fuel) in the United States, 1971 through 1975
(10^6 bbl)

Use	1971	1972	1973	1974	1975
Heating	70,710	66,199	61,272	49,849	45,126
All other uses	20,207	19,655	17,643	14,503	12,864
United States, total	90,917	85,854	78,915	64,352	57,990

Source: U.S. Department of the Interior, Bureau of Mines, "Sales of Fuel Oil and Kerosine in 1975," Mineral Industry Surveys, September 1976, Table 1, p. 4.

Table 7.24. Total Gas Sales of Ethane and Liquefied Petroleum in Liquid Form, 1950–1975[a]
(10⁶ gal)

Year	Total[b]	Residential and commercial
1950	3,4[illegible]67	2,034,464
1951	4,2[illegible]75	2,166,813
1952	4,477,379	2,266,178
1953	4,932,009	2,479,180
1954	5,125,533	2,626,808
1955	6,122,718	2,801,379
1956	6,635,763	3,001,021
1957	6,939,121	3,067,070
1958	7,462,089	3,293,677
1959	8,919,161	3,934,792
1960	9,554,649	4,224,53
1961	9,797,883	4,318,215
1962	10,729,394	4,712,682
1963	11,570,278	5,053,157
1964	12,473,258	5,180,794
1965	12,908,899	5,345,972
1966	13,594,755	5,681,636
1967	14,466,144	6,221,839
1968	16,165,632	6,718,108
1969	18,716,376	7,656,872
1970	18,789,162	7,568,691
1971	19,183,542	7,668,413
1972	21,833,700	8,253,340
1973	22,199,048	7,845,991
1974	21,538,692	7,231,035
1975	20,430,690	7,019,989

[a] Excludes Liquefied Petroleum Gas for export or for use in gasoline production. Includes ethane, propane, butane, and butane-propane mixtures.

[b] "Total" includes "Residential," "Commercial," and "Other" to ultimate consumer (excludes re[illegible]

[illegible]: American Gas Association, *Historical Statistics of the Gas Utility Industry, 1966–1975*, Arlington, Va., 1977, Table 63, p. 106.

Table 7.25. Residential Heating Oil Average Selling Prices

		Cents per gallon, including taxes
1974	January	31.1
	February	32.8
	March	33.8
	April	34.0
	May	35.1
	June	35.3
	July	35.2
	August	35.8
	September	36.3
	October	35.6
	November	37.9
	December	36.9
	Average	34.7
1975	January	37.4
	February	37.0
	March	36.6
	April	36.1
	May	36.7
	June	37.1
	July	37.2
	August	38.0
	September	38.4
	October	39.3
	November	39.4
	December	40.1
	Average	37.7
1976	January	40.1
	February	40.1
	March	39.4
	April	39.0
	May	39.0
	June	39.3
	July	39.3
	August	39.8
	September	40.2
	October	40.7
	November	41.9
	December	43.0
1977	January	44.4
	February	45.3
	March	45.8
	April	45.9

Source: Federal Energy Administration, *Monthly Energy Review*, April 1977, p. 66, July 1977, p. 76.

Table 7.26. Retail Price of Residual Fuel Oil, July 1975 through April 1977 (dollars per barrel)

		No. 5[a]	No. 6				Bunker C	Total[c]
			0.0 to 0.3% sulfur	0.31 to 1.0% sulfur	Greater than 1.0% sulfur	Total[b]		
1975	July	11.28	12.86	12.05	10.59	11.70	10.54	11.27
	August	11.04	13.22	12.34	10.53	11.89	10.43	11.32
	September	11.07	12.94	11.65	10.52	11.52	10.29	11.09
	October	11.12	12.98	12.09	10.38	11.69	10.31	11.13
	November	11.27	12.96	12.03	10.34	11.68	10.43	11.24
	December	11.64	12.87	11.83	10.06	11.42	10.15	10.97
1976	January	11.63	12.39	11.61	10.23	11.35	10.35	11.02
	February	11.57	12.78	11.84	10.35	11.52	10.27	11.15
	March	11.89	12.81	11.80	10.21	11.43	10.35	11.12
	April	11.58	12.34	11.77	10.28	11.43	10.12	11.02
	May	11.49	11.87	11.40	9.89	10.95	10.65	10.63
	June	11.23	12.24	11.36	10.03	11.04	10.10	10.70
	July	11.70	12.12	11.36	10.04	11.04	10.34	10.74
	August	11.48	12.79	11.46	10.22	11.20	9.98	10.82
	September	11.37	12.50	11.55	10.28	11.30	10.05	10.91
	October	11.64	12.94	12.12	10.73	11.82	10.81	11.43
	November	12.04	13.15	12.21	10.98	11.95	10.83	11.61
	December	12.64	13.32	12.76	11.48	12.44	11.24	11.94
1977	January	13.39	14.34	13.68	12.32	13.32	11.89	12.94
	February	13.66	14.60	R14.08	12.74	R13.71	12.00	R13.22
	March[p]	R13.75	R14.57	R14.51	R12.69	R13.84	11.74	R13.27
	April[p]	13.26	14.63	14.10	12.50	13.61	11.75	13.02

P - Preliminary

R - Revised

[a] Refers to the price at which residual fuel oil is sold to ultimate consumers such as utility, industrial, institutional, commercial, and residential accounts.

[b] Refers to average retail price of all No. 6 oil sold.

[c] Refers to average retail price of all residual fuel oil sold.

Source: Federal Energy Administration, Monthly Energy Review, Washington, D.C., July 1977, p. 79.

Table 7.27. The Role of Coal in U.S. Fuel Consumption, Selected Years - 1850-1975

Year	Coal consumption (10^{12} Btu)	Coal consumption as percent of nonwood fuel consumption	Coal consumption as percent of all fuel consumption
1850	219	100.0	9.3
1860	518	100.0	16.5
1870	1,048	99.0	26.5
1880	2,05[illegible]	95.5	41.1
1890	4,062	90.3	57.9
1900	6,841	90.3	71.4
1910	12,714	85.9	76.8
1920	15,504	81.6	72.5
1930	13,639	61.3	57.5
1940	12,535	52.5	49.7
1945	15,972	50.8	48.8
1947	15,824	47.9	NA
1950	12,913	38.0	36.8
1957	11,168	26.8	NA
1960	10,140	22.8	NA
1965	11,908	22.3	NA
1970	12,922	19.2	NA
1975	13,376	18.8	NA

NA — Not available.

Source: U.S. Department of the Interior, Bureau of Mines, *Historical Trends in Coal Utilization and Supply*, Washington, D.C., August 1976, Table III 2, p. 3-4.

Table 7.28. Percent Breakdown of Total Coal Use by Sector[a]

Year	Industrial	Household and commercial	Transportation	Electricity generation	Miscellaneous
1947	46.12	21.48	19.15	13.17	0.08
1948	43.74	21.74	17.61	16.06	0.85
1949	44.11	23.95	14.98	16.00	0.86
1950	46.13	22.56	13.17	17.25	0.89
1951	48.42	20.02	11.53	19.18	0.85
1952	47.79	20.35	9.15	21.80	0.90
1953	51.33	17.42	6.80	23.59	0.86
1954	47.67	17.18	5.06	28.11	1.97
1955	49.62	15.12	4.02	30.17	1.07
1956	49.40	13.86	3.22	32.47	1.06
1957	50.99	10.97	2.42	34.75	0.87
1958	47.46	12.05	1.35	38.00	1.14
1959	46.19	9.88	1.04	41.30	1.59
1960	46.08	9.69	0.86	41.93	1.43
1961	45.20	8.76	0.21	44.16	1.67
1962	44.36	8.54	0.18	45.42	1.50
1963	44.37	6.82	0.17	47.27	1.36
1964	44.95	5.41	0.17	47.90	1.58
1965	45.06	5.69	0.15	49.05	0.03
1966	43.79	5.42	0.13	50.64	0.02
1967	42.42	4.77	0.11	52.69	0.01
1968	40.48	4.18	0.09	55.25	0.01
1969	39.67	3.51	0.06	56.76	0.00
1970	38.72	3.30	0.06	57.91	0.00
1971	35.87	3.38	0.05	60.71	0.00
1972	34.15	3.01	0.03	62.72	0.00
1973	32.92	2.23	0.02	64.84	0.00
1974	32.97	2.38	0.02	64.63	0.00
1975	31.92	2.11	0.01	65.97	0.00

[a] Actual coal consumption by the different sectors can be calculated from Table 7.27 and Table 7.28. For example, for the year 1975, household and commercial use was 2.11% of 13,376 × 10^{12} Btu = 282.23 × 10^{12} Btu.

Note: For additional numerical data, see Table 7.3

Source: U.S. Department of the Interior, Bureau of Mines, Historical Trends in Coal Utilization and Supply, Washington, D.C., August 1976, Table III.3, p. 3-7.

THIS TABLE PROVIDES DATA ON THE RELATIVE IMPORTANCE OF COAL TO EACH SECTOR. FOR EXAMPLE, THE 282.23 × 10^{12} BTU OF ENERGY PROVIDED BY COAL TO THE HOUSEHOLD-COMMERCIAL SECTOR IS ONLY 2.09% OF THE TOTAL ENERGY USED BY THAT SECTOR IN 1975.

Table 7.29. Coal Use as Percent of Total Gross Energy Input to Sector

Year	Industrial	Household and commercial	Transportation	Electricity generation	Total direct fuel use
1947	56.92	50.17	34.47	48.87	47.90
1948	52.88	46.06	29.88	50.64	43.97
1949	49.00	43.94	23.43	43.78	40.11
1950	48.23	38.36	19.74	44.73	37.99
1951	46.74	33.70	16.57	48.04	35.96
1952	43.31	30.28	11.85	46.90	32.56
1953	44.23	26.71	8.79	47.62	31.64
1954	38.83	21.99	5.66	48.25	28.11
1955	40.71	20.30	4.82	52.80	29.07
1956	39.79	18.17	3.73	53.87	28.18
1957	39.27	14.10	2.64	52.95	26.78
1958	34.61	12.54	1.29	51.15	23.62
1959	32.26	9.98	0.98	51.44	22.73
1960	31.92	9.66	0.80	51.45	22.75
1961	30.61	8.73	0.19	51.24	22.37
1962	29.69	7.96	0.16	51.09	21.52
1963	29.88	6.64	0.15	52.31	21.73
1964	30.32	5.47	0.15	52.06	21.98
1965	31.24	5.73	0.14	52.76	22.33
1966	30.35	5.46	0.12	52.49	22.15
1967	28.52	4.50	0.09	50.73	21.03
1968	26.46	4.04	0.07	50.35	20.50
1969	25.12	3.29	0.05	47.38	19.60
1970	24.49	3.05	0.05	44.45	19.16
1971	21.62	2.87	0.04	42.56	18.20
1972	20.75	2.63	0.02	42.23	17.33
1973	20.26	2.07	0.02	43.51	17.79
1974	21.34	2.26	0.01	42.67	18.09
1975	22.53	2.09	0.01	47.72	18.82

Source: U.S. Department of the Interior, Bureau of Mines, <u>Historical Trends in Coal Utilization and Supply</u>, Washington, D.C., August 1976, Table III.3, p. 3-8.

Table 7.30. Consumption[a] and Representative Price[b] of Coal

Period	Consumption (10^6 short tons)		Representative price (\$/short ton)[c]		
	Bituminous and lignite	Anthracite	Bituminous and lignite		Anthracite
			f.o.b.[d] mines	f.o.b. utilities	
1960	380,429	17,600	4.69	NA	7.82
1961	374,405	15,900	4.58	NA	8.04
1962	387,774	14,300	4.48	NA	7.94
1963	409,225	14,100	4.39	NA	8.40
1964	431,116	14,400	4.45	NA	8.65
1965	459,164	12,900	4.44	NA	8.21
1966	486,266	11,400	4.54	NA	7.78
1967	480,255	10,800	4.62	NA	7.85
1968	498,830	10,160	4.67	NA	8.48
1969	507,275	8,809	4.99	NA	9.62
1970	515,619	8,248	6.26	NA	10.83
1971	494,862	7,338	7.07	NA	11.86
1972	516,776	5,915	7.66	NA	12.00
1973	556,022	5,671	8.53	9.01	13.22
1974	552,709	5,448	15.75	15.46	22.19
1975	556,301	5,108	19.23	17.63	32.00
1976E	597,47[illegible]	5,100	20.00	18.55	34.00

[a] Includes the consumption by electric power utilities, manufacturing and mining industries, and retail deliveries to other consumers.

[b] Average f.o.b. mine price of coal.

[c] Data of retail coal prices for the residential-commercial sector are sparse. Even for the industrial sector, such data are poorly documented.

[d] f.o.b. is an abbreviation for 'free on board' which is defined as being "without charge for delivery to and placing on board a carrier at a specified point" (Webster's New Collegiate Dictionary).

NA = Not available

E = Estimated

Source: U.S. Department of the Interior, Bureau of Mines, Minerals and Materials: A Monthly Review, Washington, D.C., July 1977, Table 3, p. 15 and Table 4, p. 17.

Table 7.31: Industrial Coal Prices
(real 1967 dollars per 10^6 Btu)

1960	0.32
1961	0.32
1962	0.30
1963	0.30
1964	0.29
1965	0.27
1966	0.26
1967	0.27
1968	0.26
1969	0.26
1970	0.31
1971	0.35
1972	0.38
1973	0.35
1974	0.47
1975	0.55

Source: G. E. Liepins, Oak Ridge National Laboratory, private conversation with Wen S. Chern, Oak Ridge National Laboratory, 1977.

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Chapter 8

Review of Selected Energy Studies

G. E. Liepins

M. A. Smith

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Arthur D. Little, Inc., *Project Independence Blueprint, Residential and Commercial Energy Use Patterns, 1970-1990.*

Energy and Environmental Analysis, Inc., *Energy Consumption Data Base, Household Sector*

Jack Faucett Associates, Inc., *Energy Consumption in Commercial Industries by Census Division - 1974*

Tishman Research Corporation, *Energy Conservation in Existing Office Buildings*

Washington Center for Metropolitan Studies, "A Questionnaire on Lifestyles and Energy"

Rand Corporation, *Energy Use and Conservation in the Residential Sector: A Regional Analysis*

J. R. Jackson and W. S. Johnson, *Commercial Energy Use: A Disaggregation by Fuel, Building Type, and End Use*

General Electric Company, *Commercial Sector Energy Consumption Data Base Development Project*

E. Hirst and J. Jackson, "Historical Patterns of Residential and Commercial Energy Uses," *Energy*, 2, No. 2-C

The purpose of Chapter 8 is to identify and review some of the energy studies that are currently available. The studies included were chosen on a basis of availability, current applicability and comprehensiveness. Time limitations precluded the inclusion of all studies. No lack of quality in the omitted studies is implied. The scopes and methodologies of the studies are briefly compared in Table 8.1 (chronologically ordered), and more detailed comparative results are given in the following tables. Each table contains energy use figures disaggregated by fuel and end use (whenever applicable) as published by each of the studies reviewed. These tables are followed by more general descriptions and analyses of the studies.

The greatest difficulty one encounters in evaluating energy studies is that there is no established yardstick against which to measure the results. Even the raw data, as they currently are available, must be manipulated before they accurately reflect the true energy use of either the residential or commercial sector. Thus, one can only evaluate a study in terms of the methodology and general "reasonableness" of the results. Invariably, detailed data are only available as estimates, the reliability of which are often indeterminate. It is generally accepted that the more aggregated the data, the more likely they are to be accurate (in percentage terms). The extent to which the lack of reliable data is a handicap varies with the purpose for which the data are being used. However, it would appear that additional sensitivity analysis and primary data gathering efforts (such as those currently being undertaken by the Energy Information Administration, Department of Energy) would be in order.

Table 8.1. Table of Definitions, Methodologies

STUDY	DATE PUBLISHED	YEARS COVERED	SECTORS COVERED	DEFINITION OF COMMERCIAL SECTOR	REGIONS COVERED	DETAIL OF END USE OF FUEL	METI CALI
Stanford Research Institute Patterns of Energy Consumption in the United States	Jan. 1972	1960 and 1968, Interpolated for Intermediate Years	Residential Commercial Industrial Transportation	Those activities that are not classified as mining, manufacturing, transportation, and residential. It includes commercial farms, fisheries, construction contractors, wholesale and retail trade, finance and insurance companies, real estate and law offices, hotels and restaurants, repair services, health services, motion pictures and other recreational services, schools, museums, art galleries and all governmental installations	U. S. Total (no regional breakdown)	Energy use by sector, end use, and fuel. (Secondary effects, e.g. coal inputs to electric production, are also calculated.)	Ene meth to I aver yea lus
Arthur D. Little, Inc. Project Independence: Residential and Commercial Energy Use Patterns 1970-1990	Nov. 1974	1970-1990	Residential Commercial	The buildings used for commercial purposes are considered to fall into the following categories. 1. Office buildings (including general office space, public and administration buildings, etc.) 2. Retail establishments (including both urban and suburban commercial stores, and other merchandising activities) 3. Schools (including educational classrooms, laboratories, libraries, and related institutions on all levels) 4. Hospitals (including hospitals, clinics, and other intensive medical care facilities) 5. Other (including hotels, motels, dormitories, amusement and recreational facilities, and religious buildings)	Four Regions 1) Northeast 2) North Central 3) South 4) West U. S. Totals	Energy use by 1. Sector, appliance, and fuel (per unit appliance) 2. End use, subsector, and fuel 3. Region, sector, and fuel	Hos ele [illegible] are
S. H. Dole of Rand Corp. Energy Use and Conservation in the Residential Sector: A Regional Analysis	June 1975	1970, 1980, 1990, 2000	Residential	Not applicable	9 Census Divisions U. S. Total	Energy use by sector, census division, end use, and fuel.	Ener meth to I equ whet als ti Fact Res term of
Energy and Environmental Analysis, Inc. Energy Consumption Data Base (Household Sector) To be used in DOE Energy Consumption Data Base	April 1977	1967, 1970, 1971, 1975	Residential	Not applicable	States 9 Census Divisions U. S. Total	Energy use by 1. Division, sector, and fuel 2. End use, sector, and fuel.	Not
Jack Faucett Assoc. Energy Consumption in Commercial Industries by Census Division-1974 To be used in DOE Energy Consumption Data Base	March 1977	1974	Commercial	The following activities are considered Commercial 1. Retail trade 2. Wholesale trade 3. Communications 4. Utilities (excluding material inputs to electric generation process) 5. Finance, insurance, real estate (FIRE) and services 6. Schools 7. Hospitals and nursing homes 8. Public Administration (Federal-including military, state and local)	9 Census Divisions U. S. Total	Energy use by 1. Subsector, end use, and Census Division, and fuel.	3412 in t give
J. R. Jackson and W. S. Johnson of Oak Ridge National Laboratory Commercial Energy Use: A Disaggregation by Fuel, Building Type, and End Use.	February 1978	1965-1975	Commercial	The following activities are considered Commercial 1. Retail trade 2. Wholesale trade 3. Finance, insurance and real estate (FIRE) 4. Public Administration 5. The nontransportation and nongeneration activities (eg. offices and terminals) of transportation, communication, electricity, gas and sanitary services.	U. S. Total	Energy use by fuel, end use, and building type.	Not are conv indi of I 1975
Syska and Hennessy, Inc. Tischman Research Corp. Energy Conservation in Existing Office Buildings (Phase 1)	June 1977	1971, 1975	(Buildings in New York City (a subpopulation of the Commercial Sector))	Not applicable	New York City	The Syska & Hennessy Tischman Research Corp. study is concerned with energy use and how it is affected by building characteristics (see p. III-24, Table III-2 of the report for a full listing of the characteristics studied).	Elec

Results for Existing Energy Studies

METHODOLOGY OF ESTIMATION AND/OR PROJECTION	REMARKS
Commercial sector. Assigned individual fuels to individual end uses and hypothesized about consumption of gas and electricity in certain uses (e.g. air conditioning, water heating, cooking, and refrigeration.) Industrial sector: On the basis of SIC codes, the sector was divided into 20 major groups. Energy use for each group was derived from the 1963 Census of Manufactures. Information on the major groups was analyzed to determine 1) fuels utilized in each group, 2) end uses of fuel in each major group, 3) end uses of fuel as feedstock in each major group, and 4) end uses of electricity in each major group. Residential sector: Estimates of residential use of energy by functional use are based on the estimated number of appliances in use and their unit consumption. The number of units in use for individual years was usually based on Census of Housing data for 1960, to determine the number of each appliance in service for each year, a percentage of domestic sales was added to the total in service at the end of the previous year. Those not added to the preceding year total were taken to be replacement. Unit consumption of electricity energy for individual years was calculated using straight line interpolation between 1960 and 1968. For these years, Edison Electric Institute estimates of typical annual fuel consumption [illegible] selected appliances are available. Unit consumption for gas appliances was [illegible] calculated using straight line interpolation between 1962 and 1968, for which years American Gas Association, Inc. estimates are available.	Annual consumption data are derived from the Bureau of Mines, personnel of major energy-using industries, trade associations, governmental agencies, and technical literature. Much of the end use information has been estimated.
The 1970 energy demand was divided into 500 cells along four dimensions: geographic regions (4), building types (5), end uses (5), and fuels (5). Unit demand for each fuel, in each building type, for each end use, and in each region was estimated, together with the penetration of that fuel in that market. All the unit demands were multiplied by the penetrations and by size of the inventory to aggregate the total demand. This aggregation was compared with the base energy demand for each fuel in each region - further analysis was done to develop consistent totals. Projections were made for the building inventory to 1990 by type and region, projecting the unit demand and penetrations to develop estimated total demand.	ADL estimates that 55% of the residential-commercial energy use can be attributed to residential use. Growth rates are expected to differ significantly among sectors, regions, fuels, and end uses. Increases in energy costs (within the range $4 per barrel of oil to $11 per barrel of oil) are not expected to slow growth in the combined sectors. Estimates of energy conservation achievable in residential and commercial buildings are given.
Computes future saturations of four major end uses according to the fuels used by them (space heating, water heating, cooking, and clothes drying) and of two electric appliances with rapidly increasing saturations (air conditioners - both room and central, and home freezers). The methodology compares actual saturations in 1970 (from Bureau of Census) with saturations for 1970 computed from actual saturations in 1960 using fuel prices as predictive variables. The saturations on the basis of effects other than price are projected to the year 2000, and these are then modified to account for projected increases in fuel prices.	Well documented study. Special care is taken to consider relative humidity as well as cooling degree-days in the calculation of air conditioning demand. General data on thermal integrity of housing by Census Division are calculated. Efficacies of conservation measures are evaluated.
To create the data base for the residential sector, FEAI used a magnetic tape produced by Mathematica Inc. to study the impact of fuel price increases on low-income families. The primary source used to develop the tape was the 1/100, 5% Public Use Sample of the 1970 Census of Population and Housing. An additional level of detail, unavailable from the tape, was the kerosine and distillate fuel oil breakdown. FEAI maintained these fuels in aggregate form through the updating procedures and disaggregated the final product on the basis of U. S. Bureau of Mines state breakdowns. To update the data to 1971 and 1974 and backdate the data to 1967, changes in price, income and household inventory, as well as variation in climate, were accounted for. Income, price, and heating degree-day elasticities were the main factors.	The procedure employed by the Census in gathering fuel expenditure information resulted in overreporting of 15 to 50%. Census noted that data for single-family homes were overreported by a greater percentage than for multifamily homes. Midwest Research Institute indicated that the lack of cost incentive resulting from gang-metered electricity in apartments resulted in an average of 35% more energy used. FEAI has made appropriate corrections.
The specific character of each of the eight industry groups constituting the commercial sector was taken into account. Values that measure energy use per unit of activity (energy coefficients) were then applied to measures of activity, in order to produce the estimate of energy use. Energy used in the industry was affected by several types of energy coefficients. Quality codes are incorporated in the data base for commercial industries. A technique used in developing part or all of the estimates utilized employee space use factors developed by Ide Assoc. of Philadelphia. These space use factors are in sq. ft./employee and are categorized by SIC. Space inventories were developed; functional use patterns of consumption were estimated in several industries by applying "functional use matrices" to the estimated consumption data.	SRI and A. D. Little, Inc. relied on commercial sector control totals from the Bureau of Mines. The Bureau of Mines data include several industries not considered commercial in the Jack Faucett report. Fisheries, commercial farms, and contract construction. A. D. Little eliminated these but didn't document their adjustment process. ADL eliminated commercial laundries. Important is the degree to which the commercial sector is disaggregated. Data are presented in physical units (e.g. barrels of petroleum products, cubic ft. of natural gas, etc.) and in Btu.
The 1970 buildings' stock is estimated in three steps. 1. The stock of floor space in 1925 is estimated. 2. F. W. Dodge data yield additions to the existing stock. 3. The National Bureau of Standards estimates building half-life to be 45 years. The removal rate is based on this estimate. Estimates of relative age of stock and relative distribution of stock by building types are available from Business Building Statistics. These data, in conjunction with the F. W. Dodge data, are sufficient for an estimation of the stock of certain building types. Other types are estimated from floor space/employee, floor space/student, and floor space/hospital bed estimates. Estimates of hours of use and types of fuel used for each end use yield energy use indexes (EUI).	Reliance on F. W. Dodge data. Results appear consistent with data generated by the use of activity indexes. Well documented study.
population of 1000 buildings in New York City is identified. A subpopulation of 36 buildings (those for which preliminary questionaires were returned) is selected. representative sample of 44 buildings is selected from the 436. Detailed studies and evaluations of building's characteristics are made. Data on fuel consumption by fuel, building, and month are collected. Normalization factors for weather and for utilization are introduced. Statistical analysis identifies correlation between building characteristics.	Effects of changing various building parameters in New York City are calculated. The greatest effects seem to result from 1) changing from constant volume to terminal reheat, 2) using double glazing, and 3) changing lighting by one watt/sq. ft.

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Table 8.2. Residential Sector Energy Use by Fuel and End Use as Given in the Stanford Research Institute Study

Sector: Residential, Year: 1968

Electric Energy Calculated at 3413 Btu/kWhr – Total Energy Use: 9.188×10^{15} Btu
(in terms of average heat rate[a] – Total Energy Use: 11.616×10^{15} Btu)

	Electricity 15.1%–(32.9%)	1.8%–(3.9%)	1.7%–(3.7%)	2.4%–(5.3%)	1%–(2.3%)	2.7%–(6.0%)[b]	–(1.9%)[b]	[c]	0.6%–(1.2%)	4.9%–(8.8%)
	Natural gas 50.1%–(39.7%)	35.2%–(27.9%)	[c]	10.7%–(8.4%)	3.5%–(2.8%)	[c]	[c]		0.6%–(0.5%)	[c]
Petroleum products 34.7%–(27.5%)	Distillate fuel oil									
	Residual fuel oil	32.5%–(25.7%)		1.6%–(1.3%)	0.5%–(0.4%)				0.1%–(0.1%)	
	LPG									
	Coal	[c]		[c]	[c]					
	Steam									
	Unallocated									
		Space heating 69.5%–(57.5%)	Space cooling 1.7%–(3.7%)	Water heating 14.7%–(14.9%)	Cooking 5.1%–(5.5%)	Refrigeration 2.8%–(6.0%)[b]	Freezing –(1.9%)[b]	Lighting [c]	Clothes drying 1.3%–(1.7%)	Misc. 4.9%–(8.8%)

[a] Calculations indicate that the heat rate used by SRI is 9375 Btu/kWhr (for 1968).

[b] Electricity use at 3413 Btu/kWhr is not given separately for refrigeration and freezing. The implicit figures are 2.13% for refrigeration and 0.67% for freezing.

[c] Either specific fuel not used for this purpose, used in insignificant amounts, or this category not calculated separately.

Note: Figures may not add due to rounding.

Source: S. H. Clark, Stanford Research Institute, Patterns of Energy Consumption in the United States, Office of Science and Technology, Executive Office of the President, Washington, D.C., January 1972, Figure 7, p. 35 and Figure 24, p. A-7 and p. 33.

Table 8.3. Residential Sector Energy Use by Fuel or End Use as Given in the Arthur D. Little Study

Sector: Residential, Year: 1970

Electric Energy Calculated at 3413 Btu/kWhr – Total Energy Use: 11.4 × 10^{15} Btu
(at 10,000 Btu/kWhr – Total Energy Use: 14.6 × 10^{15} Btu)

Electricity
13.3%–(31.1%)

Natural gas
49.0%–(38.9%)

Oil
30.5%–(24.2%)
- Distillate fuel oil
- Residual fuel oil

Other
7.2%–5.8%)
- LPG
- Coal
- Steam
- Unallocated

Energy use by end use and fuel is not given in the ADL study

Space heating
71.4%–(58.7%)

Space cooling
1.4%–(3.3%)

Water heating
15.5%–(16.5%)

Cooking
4.0%–(4.5%)

Other
7.7%–(17.0%)
- Refrigeration
- Freezing
- Lighting
- Clothes drying
- Misc.

Source: Arthur D. Little, Inc., Federal Energy Administration, Project Independence Blueprint, Final Task Force Report, Residential and Commercial Energy Use Patterns, 1970–1990, Vol. 1, Washington, D.C., November 1974, Figure 1.2, p. 8 and Figure 1.3, p. 9.

Table 8.4. Residential Sector Energy Use by Fuel and End Use as Given in the S. H. Dole, Rand Corporation Study

Sector: Residential, Year: 1970

Electric Energy Calculated at 3413 Btu/kWhr – Total Energy Use: 10.01 × 10^{15} Btu
(in terms of primary energy[a] – 13.12 × 10^{15} Btu)

		Space heating 67.6%–(55%)	Space cooling 1.9%–(4.6%)	Water heating 14.2%–(14.6%)	Cooking 4.6%–(5.1%)	Refrigeration / Freezing Refrigeration/freezing 3.3%–(7.7%)	Lighting 2.4%–(5.7%)	Clothes drying 1.0%–(1.7%)	Misc. 5.1%–(5.7%)
	Electricity 15.3%–(35.4%)	2.3%–(5.1%)	1.9%–(4.6%)	2.4%–(5.6%)	1.1%–(2.4%)	3.3%–(7.7%)	2.4%–(5.7%)	0.6%–(1.4%)	1.3%–(2.7%)
	Natural gas 52.5%–(40.0%)	36%–(27.7%)	b	9%–(6.9%)	3%–(2.3%)	b	b	0.3%–(0.22%)	3.8%–(2.9%)
Petroleum products 28.5%–(21.7%)	Fuel oil 23.4%–(17.8%) Distillate fuel oil Residual fuel oil	21.6%–(16.5%)		1.8%–(1.4%)	b			b	b
	Bottled gas 5.1%–(3.9%)	3.7%–(2.8%)		0.8%–(0.6%)	0.5%–(0.4%)				
Coal and other 3.9%–(3.0%)	Coal Other Unallocated	3.6%–2.7%)		0.2%–0.2%)	b				

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[a] Calculations indicate that the average heat rate used by S. H. Dole is 10,350 Btu/kWhr (for 1970).

[b] Either specific fuel not used for this purpose, or used in insignificant amounts.

Source: S.H. Dole, Rand Corporation, Energy Use and Conservation in the Residential Sector: A Regional Analysis, Santa Monica, Calif., June 1975, Table 5-1, p. ix.

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Table 8.5. Residential Sector Energy Use by Fuel and Use as Given in the Energy and Environmental Analysis, Inc. Study

Sector: Residential, Year: 1974

Electric energy conversion factor not explicitly given. Calculations indicate that electric energy is calculated at 3413 Btu/kWhr

Total Energy Use: 11.148 × 10^{15} Btu

	Space heating 63.6%	Space cooling 2.7%	Water heating 18.4%	Cooking 5.9%	Refrigeration 3.2%	Freezing *a*	Lighting 2.3%	Clothes drying 1.5%	Misc. 2.4%
Electricity 18.0%	2.1%	2.6%	3.0%	1.3%	3.2%	*a*	2.2%	0.9%	2.4%
Natural gas 47.7%	33.7%	*a*	10.5%	3.0%	*a*		*a*	0.6%	*a*
Kerosine 3.3%	2.5%		0.3%	0.4%				*a*	
Fuel oil 24.6%	20.7%		3.3%	0.4%					
LPG 6.4%	4.3%		1.3%	0.7%					
Other: Coal	*a*								
Other: Steam									
Other: Unallocated									

[a] Either specific fuel not used for this purpose, used in insignificant amounts, or this category not calculated separately.

Note: Totals may not add due to rounding.

Source: Energy and Environmental Analysis, Inc., Energy Consumption Data Base, Household Sector, Final Report, Vol. III, Arlington, Va., April 1977, Table III-7.2, p. 10.

Table 8.6. Commercial Sector Energy Use by Fuel and End Use as Given in the Stanford Research Institute

Sector: Commercial, Year: 1968

Electric Energy Calculated at 3413 Btu/kWhr – Total Energy Use: 6.881 × 10^{15} Btu
(in terms of average heat rate[a] – Total Energy Use: 8.766 × 10^{15} Btu)

	Electricity 15.7%-(33.8%)	*b*	5.4%-(11.6%)	1.2%-(2.6%)	0.1%-(0.3%)	3.5%-(7.6%)		*b*	*b*	5.4%-(11.7%)
	Natural gas 26.8%-(21%)	17.6%-(13.8%)	1.4%-(1.1%)	6.1%-(4.8%)	1.7%-(1.3%)	*b*				*b*
Petroleum products 49.3%-(38.7%)	Distillate fuel oil									
	Residual fuel oil	35%-(27.4%)	*b*	*b*	*b*					
	LPG									(feedstock) 14.3%-(11.2%)
	Coal 8.3%-(6.5%)	8.3%-(6.5%)								*b*
	Steam	*b*	*b*							
	Unallocated									
		Space heating 60.8%-(47.7%)	Space cooling 6.8%-(12.7%)	Water heating 7.4%-(7.4%)	Cooking 1.8%-(1.6%)	Refrigeration	Freezing	Lighting *a*	Clothes-drying *a*	Misc. 5.4%-(11.7%)[c] 19.7%-(22.9%)[d]
						Refrigeration/freezing 3.5%-(7.6%)				

[a] Calculations indicated that the heat rate used by SRI is 9375 Btu/kWhr (for 1968).

[b] Either specific fuel not used for this purpose, used in insignificant amounts, or this category not calculated separately.

[c] Excluding feedstock.

[d] Including feedstock.

Source: S. H. Clark, Stanford Research Institute, Patterns of Energy Consumption in the United States, Office of Science and Technology, Executive Office of the President, Washington, D.C., January 1972, Figure 9, p. 65 and Figure 26, p. A-10.

Table 8.7. Commercial Sector Energy Use by Fuel or End Use as Given in the Arthur D. Little Study

Sector: Commercial, Year: 1970

Electric Energy Calculated at 3413 Btu/kWhr – Total Energy Use: 3.9×10^{15} Btu
(at 10,000 Btu/kWhr – Total Energy Use: 5.5×10^{15} Btu[a])

Electricity 31.4%–(57.3%)

Natural gas 28.1%–(17.5%)

Oil 34.5%–(21.5%)
- Distillate fuel oil
- Residual fuel oil

Other 6.0%–(3.7%)
- LPG
- Coal
- Steam
- Unallocated

Energy use by end use and fuel is not given in the ADL study

Space heating 65.4%–(41.2%)

Space cooling 4.4%–(8.1%)

Refrigeration 3.8%–(6.9%)

Lighting 12.6%–(23.1%)

Other 13.8%–(20.7%)
- Water heating
- Cooking
- Freezing
- Clothes drying
- Misc.

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[a] Estimated by author.

Source: Arthur D. Little, Inc., Federal Energy Administration, Project Independence Blueprint, Final Task Force Report, Residential and Commercial Energy Use Patterns, 1970-1990, Vol. 1, Washington, D.C., November 1974, Figure 1.2, p. 8 and Figure 1.3, p. 9.

Table 8.8. Commercial Sector Energy Use by Fuel or End Use as Given in the Jack Faucett Associates Study

Sector: Commercial, Year: 1974

Electric Energy Calculated at 3413 Btu/kWhr – Total Energy Use: 5,411 × 10^{15} Btu

	Space heating Space cooling	Water heating	Cooking	Refrigeration	Freezing	Lighting	Clothes drying	Misc.
Electricity 33.5%	12.9%	0%	0.8%	2.3%		14.7%		2.7%
Natural gas 41.6%	31.6%	3.9%	2.3%	0%		0%		3.9%
Petroleum products 19.8%: Fuel oil 17.9%: Distillate fuel oil 5.3%	4,1%	0.6%	0%	0%		0%		0.5%
Petroleum products 19.8%: Fuel oil 17.9%: Residual fuel oil 12.6%	11.3%	0.9%	0%	0%	*a*	0%	*a*	0.4%
Petroleum products 19.8%: LPG 1.9%	0.9%	0.3%	0.7%	0%		0%		0%
Coal 2.6%	2.4%	0.2%	*a*	*a*		*a*		*a*
Steam 2.4%	2.1%	0.1%	0%	0%		0%		0.2%
Unallocated	*a*	*a*	*a*	*a*		*a*		*a*
	Space conditioning 65.3%	6.0%	3.8%	2.3%	*a*	14.7%	*a*	7.7%

[a] This item not calculated.

Source: H. A. Kaufman et al., Jack Faucett Associates, Inc., Energy Consumption in Commercial Industries by Census Division - 1974, Final Report, Chevy Chase, Md., March 1977, Table 1-5, p. 23.

Table 8.9. Commercial Sector Energy Use by Fuel and End Use as Given in the J. R. Jackson and W. S. Johnson, ORNL Study

Sector: Commercial, Year: 1975

		Space heating 43.4%	Space cooling 21.3%	Water heating 2.5%	Cooking	Refrigeration	Freezing	Lighting 22.7%	Clothes drying	Misc.
	Electricity 54.5%	3.4%	19.8%	0.4%	*a*	*a*	*a*	22.7%	*a*	8.3%
	Natural gas 22.3%	18.0%	1.5%	0.9%				*a*	*a*	1.8%
Petroleum products 21.7%		20.5%	*a*	1.2%						*a*
Other 1.5%	Coal Steam Unallocated	1.5%	*a*	*a*						
						included in Misc.			10.1%	

[a] Either specific fuel not used for this purpose, used in insignificant amounts, or this category included in "Misc."

Note: Totals may not add due to rounding.

Source: J. R. Jackson and W. S. Johnson, Commercial Energy Use: A Disaggregation by Fuel, Building Type, and End Use, ORNL/CON-14, Oak Ridge National Laboratory, Oak Ridge, Tenn., Appendix B.

STANFORD RESEARCH INSTITUTE

In 1972, the Stanford Research Institute (SRI) published a document describing national energy use — Patterns of Energy Consumption in the United States. The report explicitly states that it is based on historical material and that it does not attempt to forecast future energy use nor to advise on policy considerations.

What the report does attempt to do is to determine the end uses of each fuel studied and the efficiencies of these end uses. The report also attempts to determine the importance of each fuel in terms of total energy use and also in terms of the use growth of each fuel. Total energy use is disaggregated into sectors: residential, commercial, transportation, and industrial. The commercial sector is actually defined by SRI in negative terms as "those activities which are not defined as mining, manufacturing, transportation or residential." Since the data sources for the SRI document do not always report in terms of these sectors, the SRI document openly admits that the data was deduced. Unfortunately, the precise deduction process is not uniformly documented.

Although the SRI report primarily presents data for the years 1960 and 1968, it suggests that because of relatively smooth trends in energy-use patterns, the growth rates for the entire 1960—1971 period can be determined from the 1960—1968 usage differential. The report converts all quantities to Btu measurements, yet the conversion factors are not explicitly presented. The kinds of estimates available include: (1) Btu consumption per appliance, (2) percentage of total consumption by end use and fuel, and (3) growth rates between 1960 and 1968.

The major source of data for the SRI report is annual consumption data from the Bureau of Mines (BOM). Other sources include private and governmental agencies, technical literature, trade associations, and SRI estimates. Since most of the data are estimated, it is important, though not always possible, to understand the SRI estimation procedure.

The sectoral use of energy by fuel is comparable to the BOM data, as shown below. The differences between the two data sets are not accounted for in the SRI report. Because of the lack of available data, the consumption of fuel by end use must be deduced. Essentially, the estimation procedure for the residential and commercial sectors involves a combination of the estimates of numbers of appliances in end use and the unit consumption of fuel per appliance; the exact procedure varies according to end use. Generally, data on the number of appliances were obtained from the 1960 Census of Housing. Data for the years 1961 to 1968 were obtained from subsequent sales updates. Each year a percentage of domestic sales from that year was added to the previous year's total. Those units not added were taken to be replacements. (Such a procedure is basically sound, yet for maximum accuracy close attention must be given to the replacement rate.)

Other estimates presented are not nearly as sound, or at least are not well justified. For example, with regard to commercial air conditioning, the following descripion appears on page 70 of the SRI report.

> The estimates were developed assuming that some 40% of all commercial floor space was air conditioned in 1960 and that 90% of the incremental floor space built after 1960 was air conditioned. It was also assumed that each year air conditioning would be installed in 2% of the nonairconditioned floor space. The total commercial floor space was calculated assuming an average of 250 square feet per employee.

In this particular case, justification of the methodology is lacking.

As a whole, the SRI document is useful as a rough description of energy use in the United States. Most of the estimation procedures appear reasonable; either constant growth or straight line approximations can be expected to result in reasonable first-order interpolation unless there is strong evidence to the contrary. The main caution is that the numbers presented are actually estimates generated by first-order estimation.

Table 8.10. Combined Residential and Commercial Energy Use by Fuel, 1968 (10^{12} Btu)

	SRI	BOM
Coal	568	529
Dry natural gas	6,451	6,451
Petroleum products	6,581	6,129
Electricity	2,469[a]	2,467
Total	16,069	15,576

[a] Electricity conversion is 3412 Btu/kWhr.

Source: L.H. Crump, U.S. Department of the Interior, Bureau of Mines, Division of Interfuels, Historical Fuels and Energy Consumption Data, 1960-1972, United States by States and Census Districts East of the Mississippi, Information Circular 8704, Washington, D.C., 1976, Table 1; S.H. Clark, Stanford Research Institute, Patterns of Energy Consumption in the United States, Menlo Park, Calif., January 1972, Figures 7, 9, 24 and 26.

ARTHUR D. LITTLE, INC.

In 1974, Arthur D. Little, Inc. (ADL) prepared a report for the Federal Energy Administration — Project Independence Blueprint, Final Task Force Report, Residential and Commercial Energy Use Patterns, 1970–1990. This report differs from the Stanford Research Institute (SRI) report in that ADL: (1) describes 1970 energy use, (2) forecasts energy demand to 1990, and (3) suggests areas to be considered in the formulation of public policy. This report deals strictly with residential and commercial energy use. Data concerning 1970 to 1990 are discussed and are available by census regions as well as by U.S. totals.

The report discusses electrical energy at the point of use, and therefore total energy used is understated by the amount of power plant and distrubtion losses. However, these losses are accounted for in the national summary charts (where the conversion factor used is 10,000 Btu/kWhr) which more accurately describe supply and demand conditions. Oil and gas are also subject to transmission and distribution losses, but only to a small degree (as reported by ADL).

The methodology used to describe residential and commercial energy use involves a computer simulation of each ~~sector separately.~~ For the year 1970, energy use was described in 500 cells along four dimensions including the four geographic regions, five building types, five end uses and five fuel types (Table 8.11). The estimated unit demand for each of these elements, along with the estimated penetration of a particular fuel in that market, was multiplied by penetration and inventory size for aggregate demand. Estimated total demand from 1970 to 1990 was computed using projections of building inventory, unit demand, and market penetrations with varying assumptions.

Fuel consumption data are taken from Bureau of Mines (BOM) data, although adjustments were made to divide the aggregate BOM data into separate residential and commercial sectors. Other adjustments in the BOM data include, for example, reclassifying multifamily housing units from commercial to residential. Arthur D. Little, Inc. recognizes the definitional problems of the commercial sector, and their particular approach reflects a data base designed to fit the definitional parameters of computer simulation. The ADL report estimates residential energy use to be 75% of the total residential-commercial energy use, whereas ADL reports the SRI estimate to be 62% (for 1968).* Some of this difference can be attributed to ADL's reallocation of Bureau of Mines data to conform to their sector classifications.†

Residential buildings inventory data are taken from the 1970 Census of Housing. The data are quantified according to structure, region, size, appliance use, type of heating system, and type of fuel. The commercial buildings inventory is presented in the form of square footage floor space as derived from construction reports for the years 1925 through 1970. The consistency of the data was checked against data from 1972 Census of Retail Trade. Because of data unavailability, much of the commercial data was estimated.

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*The author calculates the SRI percentage to be 58%. Apparently Rand Corporation feels that the 75% figure is more nearly correct than the percentage indicated by the SRI document (see footnote, page 7, ADL report).

†Gang-metered apartments are allocated to the commercial sector in utility records.

The difference between SRI and ADL residential data is about 2 × 10^{15} Btu — about 33% of SRI's reported commercial energy use.

Various forms of unit demand data are presented. Some of these data are described on p. 6 of the ADL document:

> "The unit demands published throughout this report are weighted averages and therefore should not be used as absolutes. For example, the average unit demand in a single-family house in the Northeast represents a weighted average that takes into account the degree-day variation within the region, the building size and configuration variations in the region, the varying efficiencies of the heating fuels, and the number of houses that are either not heated, partially heated, or fully heated.
>
> Unit demand figures (i.e., *average* annual energy consumption estimates) for appliances were developed from Edison Electric Institute, American Gas Association, and other industry data. These demands, however, were reduced slightly in our model to allow for the fact that the appliances in service represent both units made recently and those made some years ago; for the most part the older units are smaller and consume less energy."

A good example of the estimation procedures used by ADL is the calculation of energy used for commercial refrigeration. As discussed in the report, commercial statistics are not collected on a regular basis by trade associations or manufacturers. Consequently, the assumption was made that refrigeration capacity is directly related to the amount of food refrigerated by each commercial establishment. An interview of major food chains and manufacturers of commercial refrigerators was taken in order to estimate refrigeration energy use per dollar sales in a typical grocery store. It was assumed that restaurants and bars use half as much energy for refrigeration as the typical grocery store. These figures were multiplied by total sales data to arrive at aggregate commercial refrigeration energy use for 1970.

The report recommends policy action dependent upon 1990 population projections and various fuel price scenarios. Conclusions are also based on a study of price elasticity. The author finds that the methodology for the determination of price elasticity is a little ambiguous. On p. 27 of the ADL document, one reads:

> "Traditionally the effects of changes in price on demand for a product are measured by multivariate analysis of historical data. From such an analysis, coefficients of elasticity may be determined, and these coefficients applied to the anticipated changes in price and income to derive anticipated demand. We studied extensively the work done to date in this area and concluded that a novel approach was warranted.
>
> We attempted to determine the response of the sector to changes in energy prices by analyzing in detail the costs to the decision maker of *discrete* measures which would reduce energy consumption, and the benefits, in terms of reduced energy expenses, of these measures. We then estimated the responses of the decision makers in these two sectors to those economic relationships. Our estimates of industry response were based on several hundred interviews with builders, building owners, architects, and engineers throughout the country.
>
> Our analysis indicates that energy demand is relatively inelastic over the range represented by the CEQ/FEA price scenarios. Despite the significant potential for energy conservation in the residential and commercial sectors, energy demand is subject to a wide variety of factors and constraints, other than energy prices, which tend to moderate price effects."

Explanation of the low price elasticity is offered. First, building structure is the responsibility of the builder, and "his motivation is to avoid investment in any features that increase the first cost of the structure." Also, the homeowner, interested in minimizing building costs, is basically uneducated as to conservation techniques. In existing structures, the initial cost of substituting less energy-intensive equipment may be costly. Arthur D. Little, Inc. concludes that fuel pricing policies will be relatively ineffective in bringing about conservation measures.

Figures 8.1 and 8.2 depict energy demand by end use and fuels in 1970 from the ADL report. These figures are useful because they depict both power plant supply of electricity and point-of-energy.

Were one to describe succinctly the methodology used by ADL in preparing its report, one would conclude that it consists of separating the data into component parts, estimating various coefficients and factors for each of the parts, and aggregating the parts to a whole. This process forms the basis for computer simulation. As with any estimation procedure, there can always be debate as to the accuracy of the estimated parameters. Some of the objections which might arise may be allayed by the sensitivity analysis discussed in the Appendix of the ADL document. However, the scope of the analysis described therein is severely limited.

Table 8.11. Categories Studied by ADL

Regions	Fuels	Residential		Commercial	
		Building type	End use	Building type	End use
Northeast	Gas	Mobile home[a]	Space heating	Office buildings	Space heating
North Central	Oil	Single-family attached	Air conditioning	Retail stores	Air conditioning
South	Electricity	Single-family detached	Water heating	Schools	Water heating and appliances
West	LPG	Multifamily low-rise	Cooking	Hospitals	Refrigeration
	Coal	Multifamily high-rise	Lighting and appliances	Other[a]	Lighting

[a] Includes amusement, social and recreational, religious, nonhousekeeping residential, and miscellaneous nonresidential (excluding industrial) buildings.

Source: Arthur D. Little, Inc., Federal Energy Administration, Project Independence Blueprint, Final Task Force Report, Residential and Commercial Energy Use Patterns, 1970–1990, Vol. 1, Washington, D.C., November 1974, pp. 32–53.

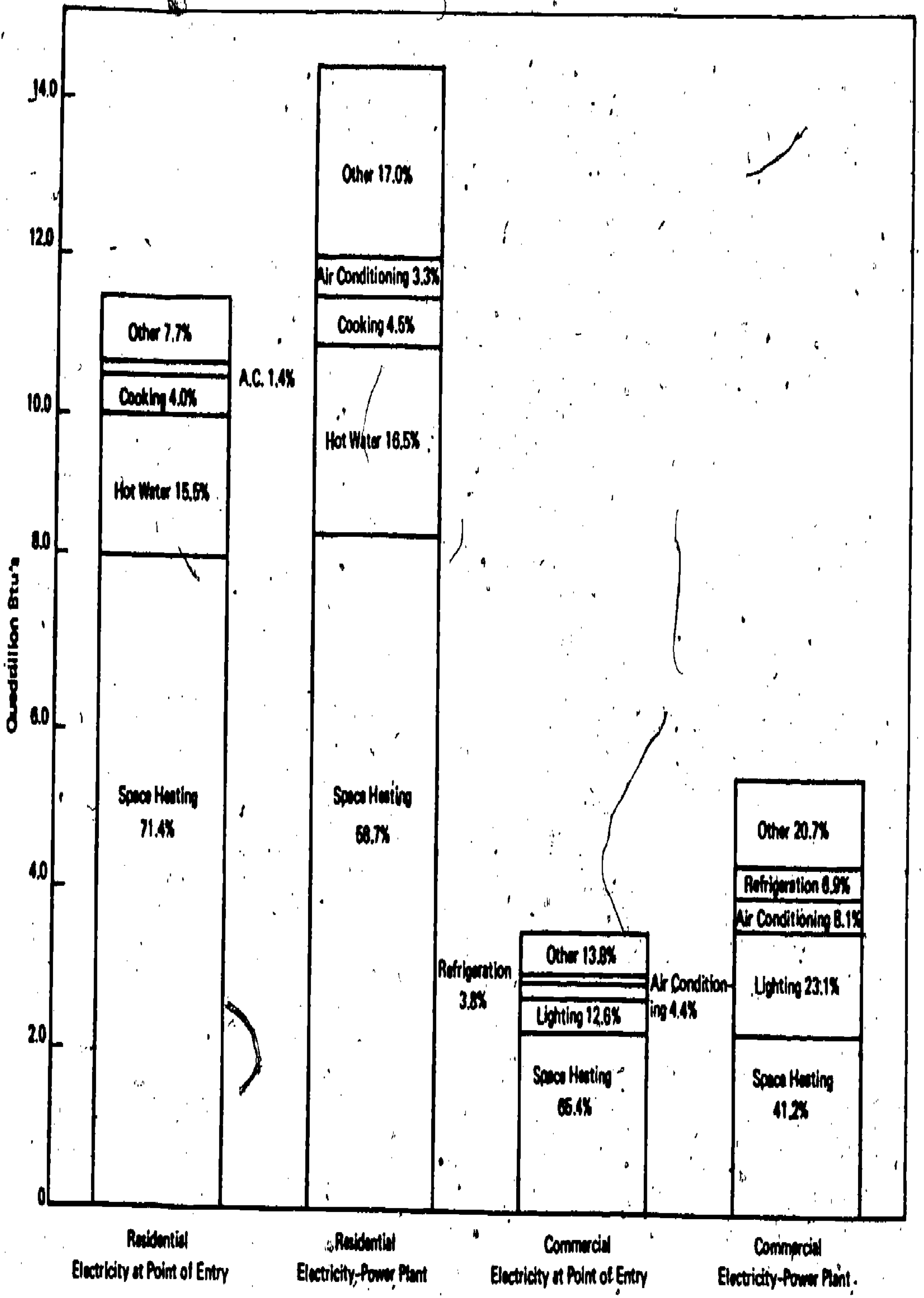

Figure 8.1. 1970 Energy Demand by End Use.

Source: Arthur D. Little, Inc., Federal Energy Administration, Project Independence Blueprint, Final Task Force Report, Residential and Commercial Energy Use Patterns, 1970-1990, vol. 1, Washington, D.C., November 1974, p. 8.

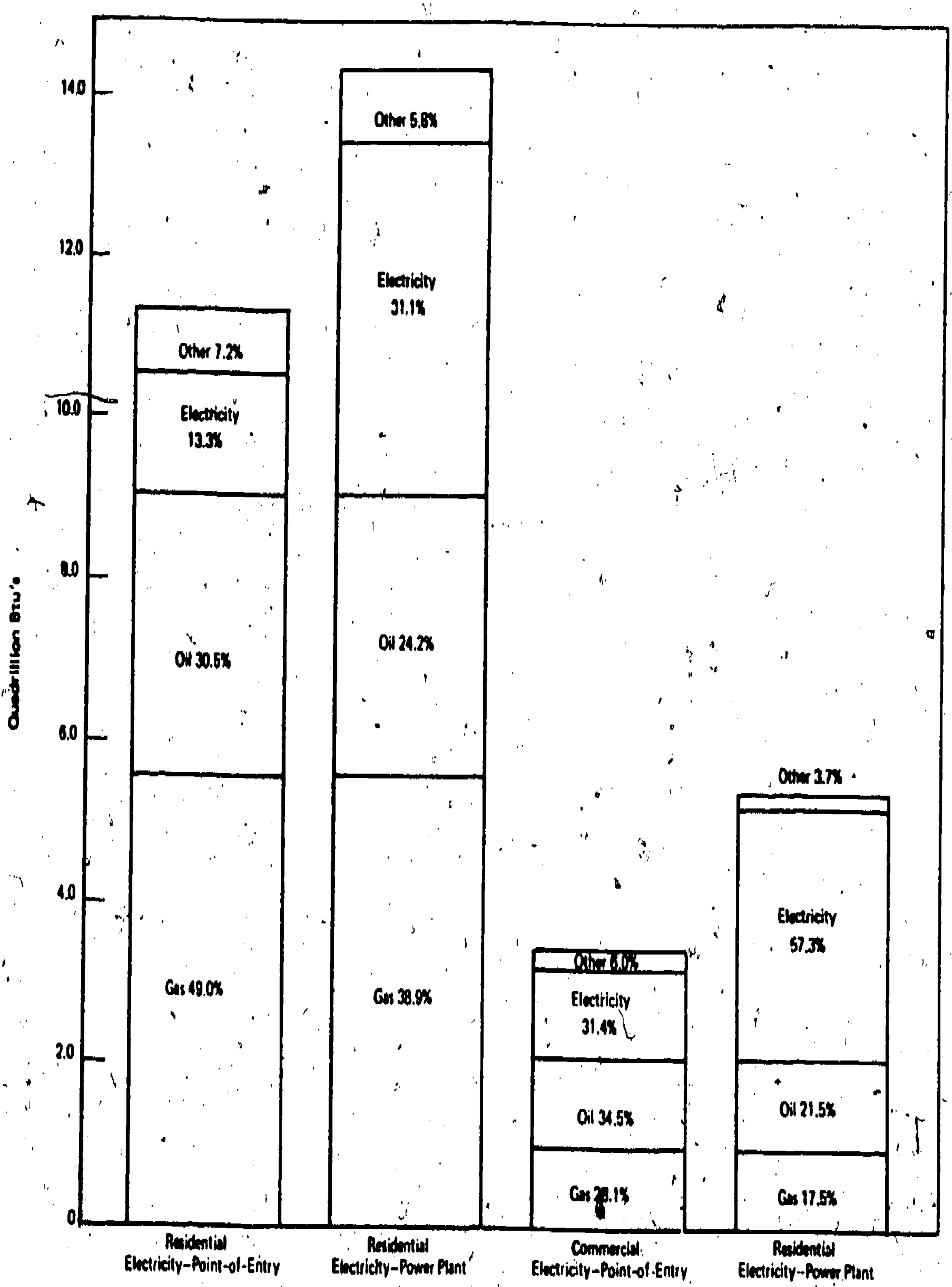

Figure 8.2. 1970 Energy Demand by Fuel Type.

Source: Arthur D. Little, Inc., Federal Energy Administration, <u>Project Independence Blueprint, Final Task Force Report, Residential and Commercial Energy Use Patterns, 1970-1990</u>, vol. 1, Washington, D.C., November 1974, p. 9.

ENERGY CONSUMPTION DATA BASE

The Energy Information Administration (previously the FEA) is assembling a data base describing U.S. energy use — the Energy Consumption Data Base (ECDB). Information is disaggregated by: (1) year: 1967, 1971, 1974, (2) eight sectors: household, commercial, agricultural, transportation, mining, construction, manufacturing, and electric utilities, (3) fuel type: coal, coke, petroleum products, natural gas, electricity, nuclear, hydro, and miscellaneous, (4) end use, and (5) geographic area: census regions, states, and U.S. totals. The household sector also includes data on income level and type of structure. Energy use data are presented in the following units of measurement: (1) physical units, (2) Btu, and (3) dollars. In addition, a detailed discussion of methodology by sector is provided.

Household Sector

The household sector report of the ECDB was submitted to FEA by Energy and Environmental Analysis, Inc. (EEAI) in April, 1977. Derived data are available for 1967, 1971, and 1974 by state, census region, and U.S. total. Primary sources of information are industry reports [e.g., American Gas Association (AGA) and Edison Electric Institute (EEI) data], census and other governmental reports [e.g., Bureau of Mines (BOM), Statistical Abstract, Survey of Purchases and Ownership], and previous energy use studies (e.g. Stanford Research Institute and Hittman Associates).

The general methodology of the household data base involves a description of 1970 energy use (as the base year) and an adjustment of this data to obtain 1967, 1971, and 1974 estimates. The 1970 base-year data come primarily from a tape, Impact of Energy Price Increases on

31

Low Income Families, prepared in 1975 by Mathematica, Inc. for FEA. The tape includes fuel expenditures by housing type, income class, state, and fuel type for 1970. The primary source of the Mathematica data was a Public Use Sample of 1970 Census of Population and Housing. The sample was drawn purposely to overrepresent the low-income groups and smaller states. Also, the Public Use Sample covered only those renters who pay their own utility bills. A multiple classification analysis was used to estimate the nonreporting households.

Three adjustments were made in the Mathematica data to fit the definitional needs of the ECDB. First, Mathematica assumes that renters who pay their utility bills use the same amount of energy as those who do not. A recent Midwest Research Institute report suggests that apartment dwellers with gang-metered electricity use 35% more energy. The ECDB reflects adjustments made to correct this assumption. The ECDB also calls for a breakdown of fuel oil into kerosine and distillate fuel oil. The BOM data is disaggregated into these categories by state. Finally, consumption data are derived by applying 1970 price data to the Mathematica expenditure data.

Adjusting the 1970 base year data to 1967, 1971, and 1974 involved analyzing changes in price, income, household inventory, and climate conditions. Price and income elasticity estimates are obtained from Mathematica, Inc. The formula used to convert base year consumption totals (Q_{70}) to the adjusted totals (Q_i) by elasticity (E_p)[1] was

$$Q_i = \left(1 + E_p \frac{\Delta P}{P_{70}}\right) Q_{70}$$

---

[1] The price elasticities were estimated by Mathematica Inc.

where ΔP is the real price change from 1970 to year i, and P_{70} is the real price in 1970. The same formula is applied to obtain income adjustments.

Climatological changes were used to approximate changes in fuel consumption for space heating. It is assumed that the elasticity of space-heating fuel in relation to heating degree-days is 1, so that, for example, a 20% increase in degree-days will cause an equal increase in space-heating fuel consumption.

A change in household inventory, size, and structure is used as a proxy for change in energy use. The assumption is justified because space heating is the primary end use in the residential sector and the change in the household inventory is a measure of the change in space-heating requirements.

Table 8.12 is taken from the ECDB household report and describes the functional use disaggregation procedure. Census reports were used to evaluate the inventory of major household appliances; trade associations and engineering standards describe unit consumption. These two values multiplied give consumption values by fuel, income, region, and structure.

One set of results are presented in Table 8.13 along with the corresponding estimates from the SRI and ADL studies. The computer program, as well as data sources and references, is presented. Estimates are made of probable errors in the national and state data. A short discussion of data gaps and alternative approaches is presented.

Since the ECDB report begins with Census data as its base, presumably the weakest links in the study are the estimation of the necessary elasticities and the necessity to allocate various energy use determinants according to preselected distributions. Specifically, elasticities are estimated from a finite collection of observations and are prone to imprecision. Moreover, EEAI feels that the lack of available elasticities by income class renders their work somewhat less precise than it might otherwise have been. With regard to preselected distributions, one example is the type of housing by income, which was keyed to the 1970 distribution.

Ironically, it develops that a large potential error is already inherent in the Census data: consumption figures reported are 15% to 50% greater than in actuality. Page 35 of the ECDB report states,

> The procedure employed by Census in gathering fuel expenditure information resulted in overreporting of 15 to 50 percent. The Census information form asked the respondent to list average monthly fuel bill for electricity, gas and other fuels. In a recent study done by Census, it was found that respondents tended to report their maximum fuel bill for the year.
>
> The results of the Census study show that natural gas was overreported by 25 to 50 percent, while electricity was overreported 15 to 30 percent.

Energy and Environmental Analysis, Inc. makes an attempt to quantify the accumulative effect of these various inaccuracies and gives ranges for the errors. This is done both mathematically and subjectively.

Table 8.12. Variables and Sources Influencing Functional Use Breakdowns

Information	Variables	Sources
Usage		
1. Percentage of households using a particular appliance (e.g., 24% of the poor/mobile homes in Alabama have electric clothes dryers)	Varies by income class, six breakdowns	1970 Current Population Report
2. Percentage of households by fuel used for space heating, cooking and water heating	Varies by state	1970 Census of Housing
3. Percentage of households using fuel for air conditioning	Varies by region and income	1967, 1971 Consumer Buying Indicator, 1974 Survey of Purchases and Ownership
Average consumption		
4. Average amount consumed by: clothes dryer, washing machines, TV, dishwasher, and water heating	Same for all households	EEI, AGA, and engineering standards
5. Average amount of energy consumed in space heating and air conditioning	Varies by region and housing type	A. D. Little
6. Average amount of energy consumed in lighting and cooking	Varies by housing type	EEI, AGA, and engineering standards
7. Average amount of energy consumed by refrigerator, stove	Varies by two breakdowns of housing types: apartments and mobile homes vs. single-family housing	EEI, AGA

Source: Energy and Environmental Analysis, Inc., Energy Consumption Data Base, Household Sector, Final Report, Vol. III, Chapter 7, Arlington, Va., April 1977.

Table 8.13. Comparison of Residential End Use Consumption Studies (10^9 Btu)

End use	SRI (1968)	ADL (1970)	ECDB (1974)
Space heating	6,675,000	8,146,000	7,052,000
Water heating	1,736,000	1,769,000	2,038,000
Cooking	637,000	454,000	651,000
Refrigeration	692,000		357,000
Air conditioning	427,000	163,000	295,000
Television	352,000		
Clothes drying	208,000		170,000
Food freezing	220,000		
Lighting			248,000
NEC[a]	669,000	879,000	265,000
Total	11,616,000	11,411,000	11,108,000

[a] Not elsewhere classified.

Sources: S. H. Clark, Stanford Research Institute, Patterns of Energy Consumption in the United States, Office of Science and Technology, Executive Office of the President, Washington, D.C., January 1972, p. 6; Arthur D. Little, Inc., Federal Energy Administration, Project Independence Blueprint, Final Task Force Report, Residential and Commercial Energy Use Patterns, 1970–1990, Vol. I, Washington, D.C., November 1974, p. 8; Energy and Environmental Analysis, Inc., Energy Consumption Data Base, Household Sector, Final Report, Vol. III, Arlington, Va., April 1977, Chapter 7, p. 10.

The commercial sector report of the ECDB was submitted by Jack Faucett Associates, Inc. Definitional problems and lack of data limit the scope and reliability of the Faucett report. In particular, the report yields energy use data only for 1974 (in contrast to the EEAI portion of the ECDB study). Moreover, most of the data were derived by use of various estimated parameters.

For the purpose of the ECDB, the following commercial activities are analyzed: (1) retail trade, (2) wholesale trade, (3) communications, (4) utilities (excluding materials input to electric generation), (5) finance, insurance, real estate (FIRE), and services, (6) schools, (7) hospitals and nursing homes, and (8) public administration (federal, military, state and local).

The methodology of this report is difficult to describe because the specific estimation technique depends on the commercial activity analyzed. For each activity, energy use per unit activity (an energy coefficient) is determined. These energy coefficients, in conjunction with measures of activity, produce estimates of energy use. The energy coefficient may describe a specific energy type for a specific region, or it may measure the total Btu per activity of an entire industry. Therefore, the energy used by a specific commercial activity may be affected by several types of energy coefficients.

The procedure used to develop some of the estimates for communications, utilities, wholesale trade, retail trade, FIRE/service, and schools involves employee space factors determined by Ide Associates of Philadelphia. These space-use factors (in square feet per employee), multiplied by employment statistics, yield an estimate of space inventory (and, indirectly, energy use) for each region.

Some sectors were not estimated using the space-use technique. An example of this is hospitals and nursing homes. Hospital data were divided into general and psychiatric hospitals, and data on electricity use per bed were calculated. These estimates, multiplied by the number of beds, yield electricity use in each census region.

The methodology used to study functional use patterns of energy use is described on page 3 of the Faucett report. Functional use patterns of energy use were estimated in several industries by applying "functional use matrices" to the estimated use data. For most of the industries, these matrices were derived from data developed in a study to evaluate the conservation potential of ASHRAE Standard 90-75 (for new building construction). That study developed functional use patterns for four types of commercial buildings in each of the four Census regions. The matrices used in this report were based on those patterns, but were adjusted to be fuel-specific (electricity versus fossil fuels) and to fit the functional use categories specified in the contract.

The study itself includes a discussion of the quality of the data and the shortcomings of the methodology. As such, it can be considered to contain a self-critique. As an example, on p. 187 of the study one finds the following discussion.

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*Energy Conservation in New Building Design: An Impact Assessment of ASHRAE Standard 90-75, Conservation Paper Number 43B, Federal Energy Administration, USGPO, Washington, D.C., 1975.

Shortcomings of Space Inventory Methodology

Space Use Factors

> Most of the defects derive from the "space requirements per employee" factors that are used to generate the inventory. The factors may be biased or distorted in a number of ways. From available information, however, it is not possible to determine what biases actually exist. Some potential sources of biases and distortion are discussed below:
>
> 1. The survey data on which the space use factors are based were obtained from pooling many separately designed and conducted surveys from more than 150 city, county, state, and other agencies. . . .
>
> The definitions of the universe of employees and space included in survey results are surely not uniform since each of the different surveys was designed to meet the particular needs of the agency sponsoring it; and information on these survey designs is not available. The surveys in the pool were not the result of a grand consistent design.

In short, the Jack Faucett report yields yet another estimate of energy use in the United States, simultaneously indicates to the user the errors which may be inherent in the data (reliability indicators, the integers 1—4, are associated with the data), and compares these data with those of previous studies (ADL and SRI). Certain data from the Jack Faucett report appear in Tables 8.14 and 8.15, and the comparative data appear in Table 8.16.

Table 8.14. Energy Use in the Commercial Sector by Industry – 1974
(10^9 Btu)

Commercial industry	All energy	Electricity	Distillate fuel oil	Residual fuel oil	Natural gas	LPG	Coal	Steam
Communications	67,318	44,686	768	6,037	13,470	372		1,984
Utilities	146,980	25,486	817	4,692	115,985			
Wholesale trade	253,096	125,049	5,904	33,550	88,594			
Retail trade	1,213,491	679,922	5,814	59,595	377,969	90,191		
FIRE and services	1,064,306	459,813	26,232	109,080	387,025			82,156
ospitals and nursing homes	591,793	87,715	91,885	54,367	322,779	446	5,370	29,231
Schools	881,702	167,788	108,354	105,418	420,995	7,114	64,639	7,394
Public administration	1,192,419	219,578	47,130	310,312	525,543	6,580	72,117	11,158
Total[a]	5,411,105	1,810,036	286,904	683,051	2,252,360	104,703	142,126	131,923

[a] May not sum due to rounding.

Source: H. A. Kaufman et al., Jack Faucett Associates, Inc., Energy Consumption in Commercial Industries by Census Division - 1974, Final Report, Chevy Chase, Md., March 1977, Table 1-1, p. 14.

Table 8.15. Energy Use in the Commercial Sector by Census Division – 1974
(10^9 Btu)

	Electricity	Distillate fuel oil	Residual fuel oil	Natural gas	LPG	Coal	Steam	All energy
New England	97,427	57,452	127,055	28,975	6,388	4,500	7,656	329,452[a]
Middle Atlantic	288,859	76,112	255,151	232,466	18,285	20,517	58,135	949,524
South Atlantic	328,394	101,086	110,631	227,500	15,085	17,626	10,850	811,171
East North Central	284,169	20,380	79,280	514,849	20,306	50,280	37,297	1,006,561
East South Central	101,884	2,046	7,472	116,087	5,310	21,089	1,704	255,589
West North Central	133,842	19,747	19,398	310,491	10,726	7,347	5,719	507,270
West South Central	180,552	565	12,517	309,129	9,885		3,001	515,646
Mountain	111,721	675	9,794	174,767	4,999	12,621	1,883	316,160
Pacific	283,187	8,842	61,754	338,097	13,722	8,146	5,682	719,429
United States[a]	1,810,036	286,904	683,051	2,252,360	104,704	142,126	131,923	5,411,105

[a] May not sum due to rounding.

Source: H. A. Kaufman et al., Jack Faucett Associates, Inc., Energy Consumption in Commercial Industries by Census Division - 1974, Final Report, Chevy Chase, Md., March 1977, Table 1-2, p. 15.

Table 8.16. Comparison of Commercial End Use Consumption Studies
(10^9 Btu)

End use	SRI[a] (1968)	ADL (1970)	ECDB (1974)
Water heating	506,000	108,000	331,483
Cooking	125,000	NE[c]	208,388
Refrigeration	244,000	127,000	122,066
Space conditioning	4,648,000	2,356,000	3,570,131
Lighting	373,000	427,000	810,044
NEC[b]		866,000	419,507
Total	5,896,000	3,884,000	5,461,619

[a] SRI data adjusted to remove consumption of asphalt and road oil in construction and to measure net, rather than gross, consumption of electric energy.

[b] Not elsewhere classified.

[c] Not estimated.

Source: H. A. Kaufman et al., Jack Faucett Associates, Inc., Energy Consumption in Commercial Industries by Census Division - 1974, Final Report, Chevy Chase, Md., March 1977, Tables 1-3 and 1-4, p. 19.

TISCHMAN RESEARCH CORP.

Tischman Research Corp., in conjunction with Syska and Hennessey, Inc. has recently completed part of a three-part study entitled Energy Conservation in Existing Office Buildings. This study combines a detailed data-gathering effort with both statistical and deterministic analyses. The goal and constituent steps of part one are identified on page I-3 and I-4 of the document. "Determine the physical and operational energy related characteristics of office buildings, and energy patterns."

The steps in this first phase consist of:

1. Classification and description of the major office building inventory in New York City in terms of building characteristics which appear to bear upon energy consumption.
2. Selection of an appropriate sample through a statistical analysis of the building inventory.
3. Obtaining pertinent data on levels of energy use for buildings in the sample and information on physical characteristics of the buildings and their use.
4. Analyzing the data and information obtained, categorizing and explaining differences.
5. Comparing energy consumption before and after the crisis brought on by the 1973 oil embargo.

This study identifies a population of one thousand office buildings in New York, selects a subpopulation of 436 (only 436 completed questionnaires were returned by building owners), and chooses a sample of 44 (representatives of the subpopulation) to be analyzed in depth. Some of the energy-use data collection is described on p. III-6 of the study.

> For each of the 44 buildings, electrical and other fuel consumption data were collected for the 5-year study period. The other fuel data included utility provided district steam, No. 2 oil, No. 4 oil, No. 6 oil and natural gas. The electrical, steam and gas data were

> obtained from the Consolidated Edison Company of New York (after acquiring written permission from the owners) based on their records of the periodic reading of appropriate building meters. Where tenant metering was involved it was impractical to obtain releases so Consolidated Edison furnished the data as an aggregate of all meters in the building. Apparent discrepancies were verified with the owners' records. The oil data were obtained from the delivery records of the owners, managers, or the oil companies. All the data obtained from the sources other than the owner/manager of the buildings were compared with their records for accuracy where available.

Difficulties were encountered because not all meter readings had been taken for the same period. These difficulties were overcome by the calculation of daily average use (between consecutive meter readings) which were summed to a monthly total for each month. Other difficulties were related to the inavailability of data. On page III-4 of the study, such a case is documented.

> Some of the information required in the questionnaire could not be obtained, and although many managers responded to some of these questions it was felt by the interviewers their responses were based on representative figures they might have been exposed to rather than on actual fact or measurement. Questions relating to lighting watts per square foot and figures relating to air circulated fell into this category.

To factor out the effect of the weather (i.e., so as not to mistakenly attribute low energy usage to conservation instead of mild weather conditions), a weather index is calculated for each of the relevant years. Specifically, the formula is $Iw_{75} = 1 + .35\left(\frac{ddy - dd_{75}}{dd_{75}}\right) + 0.15\left(\frac{cdy - cd_{75}}{cd_{75}}\right)$ where ddy = degree-days for year y and cdy = cooling degree-days for year y. Obviously, the index is normalized in terms of 1975 ($Iw_{75} = 1$). The scalers 0.35 and 0.15 represent the relative energy intensity of heating and cooling respectively. A similar index is derived for building utilization. There are some shortcomings with this particular weather normalization index and the document points this out in the Introduction. "Even at this early stage, all the preceeding suggests: . . . the need for a national accepted system of normalization of energy consumption for occupancy/utilization and weather conditions." Nevertheless, such work is important to the establishment of an accurate understanding of energy use. One of the results derived with these normalization factors is that (p. III-10) "the 5-year period (1971—1975) shows a normalized reduction of 20 MBTU/sq. ft/yr from the original data ..."

Much of the remaining material in the study directly describes the characteristics of the sample and, to a lesser degree, the subpopulation. Some conclusions are drawn in the Introduction.

> The strongest correlation between energy consumption and energy related attributes appears to be age, hours of lighting, hours of perimeter heating and cooling, and types of perimeter system. However, some buildings which evidence some of these high consumption attributes do not show high overall energy consumption. For this reason, Phase II is directed to assessing the value, impact, and feasibility of proposed conservation measures in the total context.

Again, with regard to the population of buildings in New York City (p. III-26),

> The approximate effect of changing selected building parameters on energy use is as follows:

Change of parameter	Energy use effect
— Occupant densigy reduced from 100 sq ft/person to 200 sq ft/person	less than 1%
— Increase outside air from 20% to 30%	
— Increase indoor summer design from 75 deg F to 80 deg F	1—5%

Change of parameter	Energy use effect
— Reduce night temperature from 65 deg F to 55 deg F	
— Reduce night temperature from 65 deg F to 55 deg F and day temperature from 70 deg F to 65 deg F	5–10%
— Omit economizer cycle	
— Increase glass area from 35% to 50%	
— Reduce roof "U" factor from 0.25 to 0.10	
— Change lighting by one watt/sq ft	10–15%
— Use double glazing	
— Change from constant volume to terminal reheat	50%

This study has collected important information about the characteristics of office buildings and energy-use patterns in New York City. Should the raw data on the individual buildings studied be available to other studies, the Tischman report could form the foundation for a better understanding of energy-use patterns in all cities in the United States.

WASHINGTON CENTER FOR METROPOLITAN STUDIES

"A Questionnaire on Life Styles and Energy" was developed by the Washington Center for Metropolitan Studies (in conjunction with Response Analysis Corp. and for a project by the Federal Energy Administration). The Center surveyed 1455 households in 1973 and an additional 3149 households in 1975. The results of these surveys have been encoded and are available for public use. Included in the types of questions asked are:

1. Let's start with air and water pollution. In the United States today, do you think that air and water pollution is a major problem, a minor problem or not a problem at all?

   1 MAJOR PROBLEM
   2 MINOR PROBLEM
   3 NOT A PROBLEM AT ALL
   4 NO OPINION

35. This past winter, what was the usual temperature in your home <u>during the day</u>?

   ____________ DEGREES
   X DON'T KNOW

36. In the winter, what was the usual temperature in your home <u>during the night</u>, when people were asleep?

   ____________ DEGREES
   X DON'T KNOW

46. What temperature do you like to keep your home during the summer?

   ____________ DEGREES
   X DON'T KNOW

85b. Just approximately, how many miles was the car driven between May 1974 and the time you disposed of the car?

Within the limitations of the sample this survey presents the analyst with information which otherwise would not be available. (The sampling procedure is discussed in Dawn and Newman, <u>American Energy Consumer</u>, Ballinger Publishing Co., Cambridge, Mass., 1975. Additional documentation appears in Response Analysis Corp., Report on Methodology, 1975 National Survey, Lifestyles and Household Energy Use, Princeton, N. J., 1976). In particular, access to the raw data will enable the researcher to determine the joint distribution of phenomena that he might consider to be of potential interest. Additionally, the data provide for a point of departure for an analysis of sociological impacts on energy use. One such example is the relative tolerance for positive and negative temperature differentials (measured from the "comfort zone"). Questions 35, 36, and 46 are relevant to the establishment of these tolerances. (Such tolerances, in conjunction with data on degree-days, cooling loads, and efficiencies and distribution of heating and cooling units, would enable the researcher to better understand the significance of the gradual southward shift in population).

The types of questions which should be addressed by the serious researcher using this data are indicated below.

1) Are any serious inaccuracies introduced by dependence on the interviewee's memory? (See question 85b.)

2) Does the requirement of a release of utility records by the interviewee introduce biases? (The multiple utility records are part of the data base for those who signed releases.)

In short, intelligent use of this data base should help to answer many of the questions puzzling energy analysts today.

RAND CORPORATION

In June 1975, The Rand Corporation published a document entitled <u>Energy Use and Conservation in the Residential Sector: A Regional Analysis.</u> The document was authored by Stephen H. Dole, and was prepared with the support of the National Science Foundation. The objectives of the study are best described in its summary, p. V.

> This study estimates consumption of all forms of energy in the residential sector, broken down by the major end uses, for each of the nine census regions of the United States for the base year 1970. A forecasting methodology based in part on econometrics then makes projections to the year 2000. Various conservation measures are then considered for application in future years and, finally, alternative sets of policy actions are postulated. The region-by-region effects of these policy actions in producing reductions in energy consumption are estimated.
>
> The objective of this study has been to evaluate various residential energy conservation policies for their effectiveness in producing energy savings. A regional approach was adopted to account for the possibility of significant differences among climatic regions.

For each of the major end uses a method of estimation of fuel consumption was developed. The methodologies are generally quite complex and cannot be given here in their entireties. However, it should be noted that they are clearly described and well documented in the study. For example, fuel consumption for space heating in each region is computed in several steps. First, five primary fuels are identified: natural gas, electricity, fuel oil, bottled or tank gas, and coal or wood products. Next, for each fuel, the energy used for space heating (in the residential sector) is computed. The computations for electricity and natural gas are the most complex and are given below.

$$Q_{GT} = \text{AGA (res)} + 0.22\ \text{AGA (comm)} \qquad (1)$$

Where Q_{GT} represents total residential gas consumption,

AGA (res) represents residential gas consumption as reported by the American Gas Association (AGA),

AGA (comm) represents commercial gas consumption as reported by the AGA.

$$Q_{GT} = kD + Q_{GO} \qquad (2)$$

Where Q_{GO} represents gas consumption for zero degree days (this term is to represent the non-space heating gas requirements),

D represents heating degree-days,

k is a coefficient.

$$Q_{GH} = Q_{GT} - Q_{GO} \qquad (3)$$

Where Q_{GH} represents gas consumption for space heating for the residential sector.

$$X_G(\text{Btu/yr/HU}) = Q_{GH}/N_{GH} \qquad (4)$$

Where X_G represents the number of households that use gas for space heating,

N_{GH} represents the number of households that use gas for space heating.

$$X_E = X_G \times 0.65 \times 0.8 = 0.52\ X_G \qquad (5)$$

Where X_E represents electricity consumption (in Btu) per household for space heating. The coefficients 0.65 and 0.8 arise because electric resistance heating is assumed to be 100% efficient, whereas gas heating is assumed to be 65% efficient, and electrically heated houses are assumed to incur only 80% of the heat loss that a gas-heated house incurs.

$$E_{EH} = \frac{X_E \times N_{EH}}{3413} \qquad (6)$$

Where E_{EH} represents electricity consumption (in kWhr) for space heating by all household in the region studied.

N_{EH} represents the number of households in the region which use electricity for space heating.

$$P_{EH}(\text{Btu/yr}) = E_{EH} \times C \qquad (7)$$

Where $C = R[tF + h(1 - F)]$,

P_{EH} represents primary energy used for residential space heating,

R is the inverse of transmission efficiency,

t is the heat factor associated with thermal generation,

F is the fraction of electricity generated by thermal means in the region,

h is conversion factor 3413. (This calculation corresponds to method 5 as described in the introduction of Chapter 7.)

Ultimately, the energy used for residential space heating by all fuels is calculated by the summation of the components.

Gas + electricity + fuel oil + bottled or tank gas + coal or wood products

= total energy used for space heating.

Similar computations are made for water heating, refrigeration and freezing, lighting, cooking, air conditioning, and clothes drying. With regard to air conditioning energy requirements, a correction factor that accounts for relative humidity is introduced on page 21 of the Rand report.

COOLING DEGREE-DAYS (CDD)

> There are at least two different meanings of the term 'cooling degree-days'. One, as used in the Weather Bureau, assigns one cooling degree-day for each degree (F) that the *mean* dry-bulb temperature on a given day arises above a base of 75°F. This usage does not take relative humidity into account; consequently, it does not correlate ~~well~~ with the need for air conditioning.
>
> The meaning used herein attempts to make cooling degree-days more nearly proportional to the energy consumed for air

conditioning. It is taken from the *Handbook of Air Conditioning, Heating and Ventilating*,* and is based on the ASHRAE Effective Temperature. Basically, the cooling degree-days in a given day (when the Discomfort Index is above 60) equals the average Discomfort Index for the day minus 60. The Discomfort Index (DI) is defined as:

$$DI = 0.55\ T_d + 0.2\ T_{dp} + 17.5$$

where T_d = dry-bulb temperature, °F,

T_{dp} = dew point temperature, °F.

The number of cooling degree-days in a year is the sum of all the CDD on days where the DI > 60.

The results of these computations appear in Fig. 8.3. Some of the preliminary data are in Table 8.17.

The methodology for computation of energy use projections is even more complex that the methodology used to determine existing energy use patterns. On p. 76 of the Rand report, one finds that "it [the methodology] computes future saturations of four major appliances (space heating, water heating, cooking, and clothes drying) according to the fuels that are used in them and of two electric appliances with rapidly increasing saturations (air conditioning, both room and central, and home food freezers)." Involved are "retention rates" and elasticities (between fuel price and purchases.)

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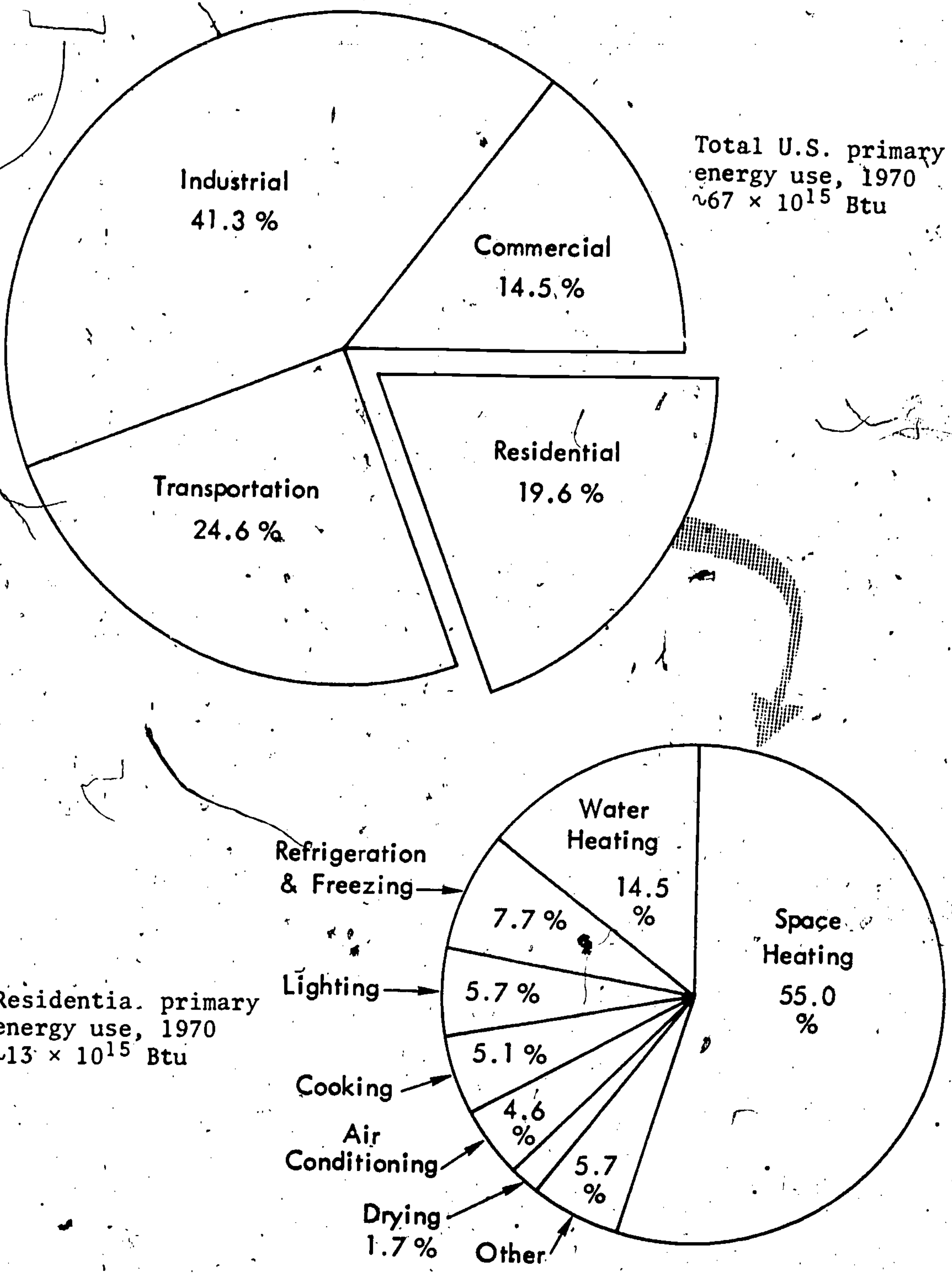
*C. Strock and R. L. Koral (eds.), Handbook of Air Conditioning, Heating, and Ventilating, 2nd edition, Industrial Press, Inc., New York, 1965.

Table 8.17. Percentage of Housing Units Using Various Fuels, 1970

Census Division	Utility gas	Electricity	Fuel oil	Bottled Gas	Coal and other	Total
			Space heating			
New England	22.0	4.2	71.2	1.4	1.1	99.9
Middle Atlantic	41.7	2.7	49.2	1.0	5.3	99.9
East North Central	67.9	3.3	20.2	3.7	4.8	99.9
West North Central	63.9	2.7	18.2	12.5	2.7	100.0
South Atlantic	33.1	14.2	36.4	9.1	6.1	98.9
East South Central	48.3	20.3	4.9	13.0	13.4	99.9
West South Central	77.9	7.0	0.4	12.5	1.9	99.7
Mountain	73.2	7.7	7.2	7.2	4.5	99.8
Pacific	70.4	12.9	9.3	2.8	1.8	97.2
U.S.	55.2	7.7	26.0	6.0	4.5	99.4
			Water heating			
New England	31.0	21.3	41.4	4.1	0.5	98.3
Middle Atlantic	48.4	13.0	32.6	2.5	2.3	98.8
East North Central	67.9	22.8	1.6	3.9	1.8	98.0
West North Central	61.3	23.4	1.0	10.4	0.4	96.5
South Atlantic	31.0	50.1	5.3	5.1	0.6	92.1
East South Central	37.0	43.5	0.1	5.4	0.5	86.5
West South Central	75.1	8.6	0.1	9.7	0.1	93.6
Mountain	67.7	22.9	0.4	6.0	0.5	97.5
Pacific	69.3	26.1	0.8	2.9	0.3	99.4
U.S.	55.1	25.4	9.8	5.0	0.9	96.2
			Cooking			
New England	40.2	48.1	1.3	9.5	0.5	99.6
Middle Atlantic	65.5	26.6	0.9	6.2	0.5	99.7
East North Central	54.3	37.8	0.3	6.9	0.4	99.7
West North Central	43.3	41.7	0.3	13.9	0.5	99.7
South Atlantic	28.7	56.0	0.7	12.1	2.2	99.7
East South Central	29.2	56.5	0.2	10.7	3.1	99.7
West South Central	63.1	24.1	0.2	11.7	0.7	99.8
Mountain	38.2	53.1	0.1	6.5	1.7	99.6
Pacific	52.2	43.9	0.2	2.8	0.3	99.4
U.S.	49.2	40.6	0.5	8.4	1.0	99.7
			Clothes drying			
New England	7.2	31.5				38.7
Middle Atlantic	13.3	24.1				37.4
East North Central	21.5	32.1				53.6
West North Central	17.1	33.7				50.8
South Atlantic	4.0	27.0				31.0
East South Central	3.1	30.2				33.3
West South Central	11.4	24.6				36.0
Mountain	6.7	35.0				41.7
Pacific	12.9	33.2				46.1
U.S.	12.4	29.4				41.8

Source: S. H. Dole, Rand Corporation, Energy Use and Conservation in the Residential Sector: A Regional Analysis, Santa Monica, Calif., June 1975, p. 38.



Total U.S. primary energy use, 1970 ~67 × 10^{15} Btu

Residential primary energy use, 1970 ~13 × 10^{15} Btu

Figure 8.3. Residential Energy Use in the U.S.

Source: S. H. Dole, Rand Corporation, Energy Use and Conservation in the Residential Sector: A Regional Analysis, Santa Monica, Calif., June 1975, p. VI.

One must study the calculations carefully in order to determine if one agrees with the methodology.*

The types of conclusions offered by the Rand study are illustrated in Fig. 8.4 and summarized below.

> Over the next 25 years the principal trends in energy usage in the residential sector are projected to be decreased in the proportion of energy used for space heating and lighting, and increases in the proportions used for refrigeration, air conditioning, home food freezing, clothes drying, and in other appliances. Space heating continues to rank first in all regions and water heating second, except in the West South Central region where it is edged out by air conditioning. This was also the case in 1970. Air conditioning is a large use of energy only in the South Atlantic, East South Central, and West South Central regions; none of the other end uses account for more than 10 percent of the total in any region. (P. 128).

As in all energy studies, the results of the Stephen Dole study are only as good as the available raw data, which unfortunately are less than completely reliable. Nevertheless, the Dole study offers a thorough, well-documented analysis of the current energy-use patterns in the United States and presents some evaluation of future trends as well as the efficacies of various conservation measures.

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*On p. 79, the rotation "$A(i, 1970)$" appears. It can easily be seen that $\Sigma A(i, 1970) = 1$. This latter result implies that "on the basis of price alone" the number of any appliance sold between 1960 and 1970 is equal to the number of households in 1970 minus the "retention rate" times the number of households in 1960. If one were to assume that no household owns more than one of any particular type of appliance, it then follows that the number of appliances sold equals the increment in the number of households between 1960 and 1970 plus the number of households which failed to retain their unit during that decade.

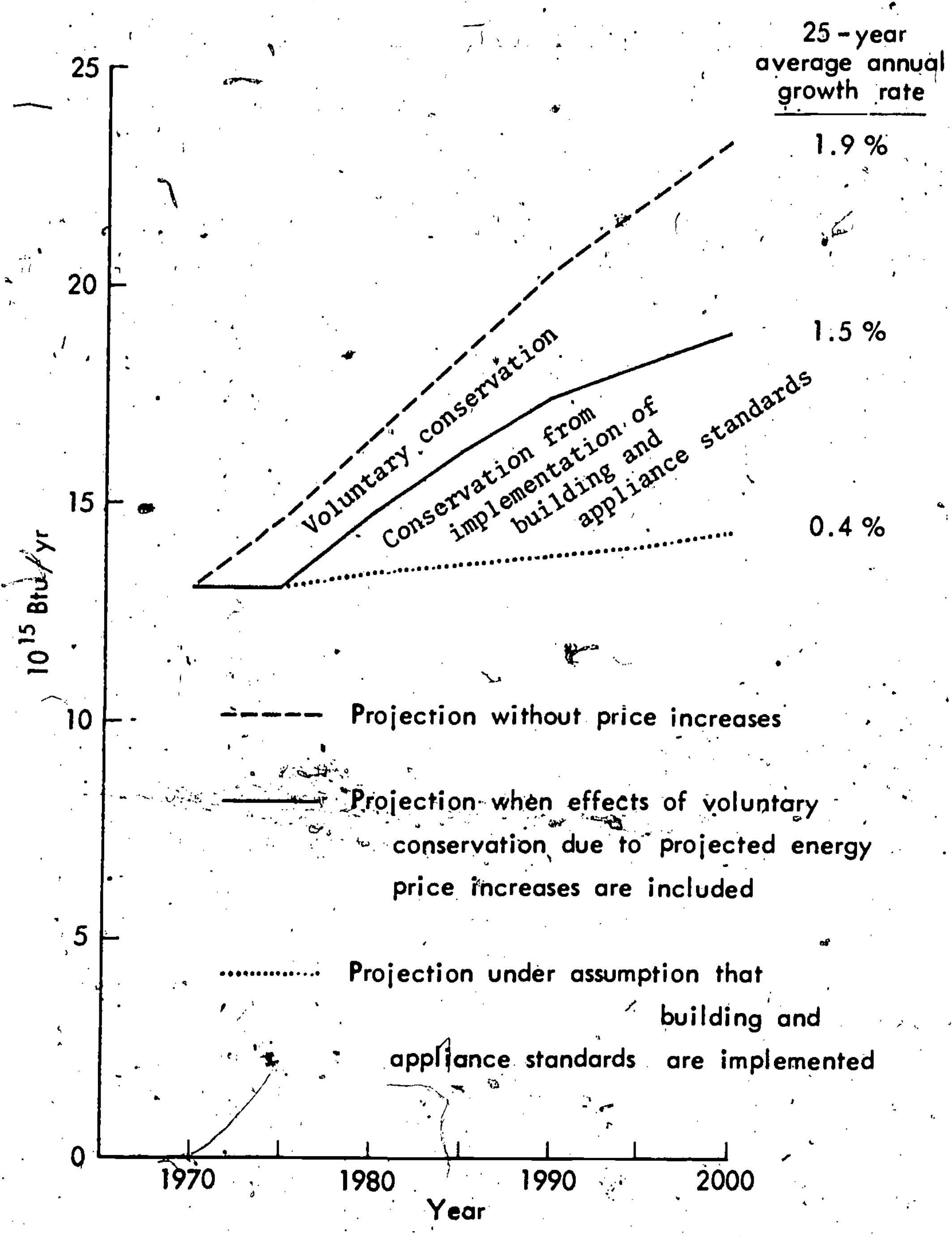

Figure 8.4. Projected U.S. Residential Primary Energy Use and Effects of Selected Conservation Policies.

Source: S. H. Dole, Rand Corporation, Energy Use and Conservation in the Residential Sector: A Regional Analysis, Santa Moncia, Calif., June 1975, p. XVIII.

J. R. JACKSON AND W. S. JOHNSON

A study entitled Commercial Energy Use: A Disaggregation by Fuel, Building Type, and End Use, by Jerry R. Jackson and William S. Johnson of Oak Ridge National Laboratory, is to be published. As the title indicates, the study concerns itself exclusively with the commercial sector and yields data at a level of detail that includes five end uses (space heating, water heating, cooling, lighting, and other), four fuel types (gas, electricity, oil, and other), and ten commercial subsectors (retail and wholesale, auto repair and garages, finance and other office activities, warehouse activities, public administration, educational services, health services, religious services, hotels and motels, and miscellaneous commercial activities). Detailed energy use figures are developed for the years 1965 to 1975. As in previous studies, much of the data were estimated. The authors state, "The surprising paucity of detailed information on commercial energy use prompted us to document our estimates and methodology in the hope that these data will prove useful to others concerned with energy consumption in the commercial sector." Indeed, one of the strengths of the study is the extensive documentation.

Once again, lack of a universally accepted definition of the commercial sector causes some difficulties. For purposes of the study, the commercial sector is defined by Standard Industrial Classification (SIC) division.

SIC Division	Description
F	Wholesale trade
G	Retail trade
H	Finance, insurance, and real estate
I	Services
J	Public administration
part of E	Transportation, communication, electricity, gas and sanitary services
	Social and miscellaneous

> Only nontransportation and nongeneration activities occurring in post offices, transportation terminals, and communications and utilities buildings are of interest in division E. Since the focus in this study is on energy use in commercial buildings, we exclude asphalt and road oil consumption in the commercial sector and exclude transportation energy use related to the commercial sector.

Unfortunately, the primary sources do not report in terms of the definition given above, and certain adjustments are deemed necessary. For gas consumption, these adjustments are determined by the equation gas (comm) = AGA (comm) - 0.222 AGA (comm) - AFF + AGA ("other") - elect.[*] Implicit in the above equation is the assumption that 22.2% of the AGA-reported commercial gas consumption can actually be attributed to gang-metered residential consumption. For electricity, the adjustments are determined by the equation elect. (comm) = "Small light and power" (S.L.& P.) - 0.04 (S.L.& P.) + EEI ("other").[†] Again implicit is the

---

[*] AGA (comm) = commercial gas consumption as reported by the American Gas Association (AGA).

AFF = gas consumption by the agricultural, forestry and fishing sectors.

AGA ("other") = gas consumption allocated to "other" by the AGA. The AGA "other" category is defined by the AGA in the <u>1975 Gas Facts</u> as "service to municipalities or divisions (agencies) or state for federal governments under special contracts or agreements or service classifications which are applicable only to public authorities using gas for general or institutional purposes."

elect = gas consumed by the electric industry for generation of electricity and included in the category "other" by the AGA.

[†] EEI ("other") = electricity use allocated to "other" by the Edison Electric Institute (EEI). The EEI "other" category is defined by the EEI in the <u>Glossary of Electric Utility Terms</u>, 1970, p. 10, to include "electric energy supplied to municipalities or divisions of agencies of federal or state governments (as ultimate customers) under special contracts or agreements or service classification applicable only to public authorities, except such items as are includable in the other EEI classifications (sales for resale, street and highway lighting, etc.)".

fact that about 4% of the S.L.& P. consumption can actually be attributed to the residential sector. What has not been taken into account is the fact that some industrial users are classified as S.L.& P. and some commercial users are classified as "Large light and power". For Jackson and Johnson's electric accounting scheme to be accurate, these two biases must cancel. For petroleum, the equation becomes pet (comm) = all residual oil used for space heating + 0.35 distillate. For coal, a scarcity of available data results in an even less precise estimate. The estimate is given as coal (comm) = 0.38 coal (residential and commercial). The factor 0.38 is the approximate fraction of combined residential-commercial energy use by the commercial sector.

Some interesting inferences are made in Jackson and Johnson's study. They state "since the only significant end use for the fossil fuels is in space heating, we can interpret shifts in these fuels as shifts in space heating preferences." A similar inference is made for electricity use. "Since very little electricity is used for space heating, the tremendous growth of electric energy use can be attributed to increased air conditioning penetration, increased lighting standards, and increased use of electromechanical equipment (i.e., office machines, computers, etc.) in the commercial sector."

As previously mentioned, the methodology is well documented (though not always easy to follow). For example, as part of the determination of the stock of commercial floor space by year and type, the following observations and calculations are made. Data from Business Building Statistics (BBS) indicate that in 1969 the rates of retail garage and warehouse floor space (R) to office floor space (F) is 1.838, that is, R = 1.838 F. Business

<u>Building Statistics</u> reports that 50.55% of all office buildings and 71.35% of retail, garage and warehouse floor space standing in 1969 were added to the stock in the previous twenty years. The BBS study also reports that 26.4% of the 1969 stock of office buildings and 13.4% of retail buildings were added before 1925. The stock decay is assumed to be represented by the exponential decay rate corresponding to a building half-life of 45 years (as reported by the National Bureau of Standards). F. W. Dodge data indicate that the additions between 1950 and 1969 totaled 5,903 x 10^6 ft^2. The equations which determine the 1924 stock are

$$0.7135R + 0.5055F = 5903.3 \times 10^6 \text{ ft}^2 \tag{1}$$

$$R = 1.838F \tag{2}$$

$$DCS_{24} = (0.264F + 0.134R) \exp [(1.53)(1969-1924)] \tag{3}$$

These three equations yield $DCS_{24} = 3314 \times 10^6$ ft^2. Table 8.20 displays the results of the more detailed estimates of floor space by year and type of commercial subsector.

The study proceeds to develop energy use indexes (EUI) in terms of Btu/ft^2 for each of the commercial subsectors studied. The calculations rely on data published by A. D. Little, Hittman Associates, Rand Corporation, SRI, and Westinghouse. Some discussion of the results and comparison with the results of the Jack Faucett study is included (see Table 8.19). The Jackson-Johnson study concludes with an analysis of some results. "The effect of climate on national aggregate energy use appear to be less than one might suspect ... Several conclusions can be drawn ... First, the national heating degree days do not display much temporal variation. The coldest year represents only 8% more heating degree days than the warmest year in our seven-year sample ... In fact, the simple correlation coefficient between national heating degree-days and oil space heating EUI suggests no significant relationship between the two variables."

Table 8.18. Commercial Energy Use by Fuel Type, 1950 through 1975 (10^{15} Btu)

Year	Electricity[a]	Gas	Oil	Other[b]	Total
1950	0.90	0.40	0.93	1.14	3.37
1955	1.32	0.61	1.22	0.71	3.86
1960	1.43	0.99	1.64	0.47	4.53
1965	2.43	1.22	1.96	0.43	6.04
1970	3.83	1.77	2.25	0.43	8.28
1971	4.11	1.98	2.12	0.43	8.64
1972	4.46	2.05	2.32	0.45	9.28
1973	4.71	2.03	2.30	0.41	9.45
1974	4.73	2.01	2.06	0.39	9.19
1975	5.04	2.05	1.92	0.37	9.38

[a] Electricity is reported in terms of primary energy; that is, losses in generation, transmission and distribution are included. The conversion factor varies for the years presented in the table from 11,300 to 11,500 Btu/kWhr. For conversion to SI units, 1 Btu = 1,055 joules.

[b] Includes coal and liquid gases.

Source: J. R. Jackson and W. S. Johnson, Commercial Energy Use: A Disaggregation by Fuel, Building Type, and End Use, Oak Ridge National Laboratory, Oak Ridge, Tenn. (to be published).

Table 8.19. Comparison of Faucett and ORNL EUI $(\text{Btu/ft}^2)^a$

	Building type			
	Office	Hospitals	Educational	Hotel-motel
Faucett	306,327	302,627	130,314	225,000
ORNL	274,574	347,883	167,974	291,918
Difference, %	12	13	22	23

[a] ORNL EUI are converted from primary energy to point-of-use to be consistent with Faucett estimates.

Source: J. R. Jackson and W. S. Johnson, Commercial Energy Use: A Disaggregation by Fuel, Building Type, and End Use, Oak Ridge National Laboratory, Oak Ridge, Tenn. (to be published).

Table 8.20. Floor Space Estimates by Type of Commercial Subsector[a]

					10^6 ft^2							
Year	Commercial	Office	Retail-wholesale	Garage	Warehouse	Educational	Public	Hospital	Religious	Hotel-motel	Misc.	Total commercial
1925	3,444					2,136	273	531	450		782	7,640
1930	4,013					2,312	321	599	501		883	8,678
1935	3,966					2,282	384	608	494		889	8,662
1940	4,101					2,387	447	652	502		1,071	9,114
1945	4,287					2,406	488	732	506		1,498	9,957
1950	4,731					2,683	512	888	594		1,681	11,123
1955	5,275					3,359	585	1,028	795		2,049	13,071
1960	6,328					4,203	720	1,175	972		2,368	15,801[a]
1965	7,767	2,851	3,163	375	1,381	5,049	870	1,413	1,185	1,273	2,650	20,269
1966	8,139	2,957	3,328	404	1,953	5,258	899	1,462	1,221	1,293	2,718	21,023
1967	8,489	3,037	3,496	433	1,526	5,961	928	1,516	1,254	1,313	2,782	21,777
1968	8,910	3,164	3,676	466	1,605	5,659	959	1,574	1,204	1,337	2,853	22,602
1969	9,404	3,313	3,891	501	1,700	5,833	985	1,648	1,306	1,360	2,936	23,506
1970	9,849	3,452	4,084	531	1,784	5,985	1,002	1,705	1,324	1,369	3,000	24,252
1971	10,316	3,614	4,278	554	1,869	6,126	1,034	1,771	1,339	1,378	3,071	25,061
1972	10,868	3,769	4,535	583	1,982	6,239	1,062	1,840	1,356	1,407	3,136	25,934
1973	11,491	3,940	4,837	601	2,114	6,339	1,100	1,900	1,372	1,425	3,225	26,883
1974	12,009	4,088	5,088	609	2,224	6,766	1,134	1,962	1,388	1,445	3,311	27,745
1975	12,327	4,180	5,241	618	2,291	6,564	1,168	2,010	1,405		3,383	28,328

[a] Total floor space figures prior to 1960 do not include hotel-motel floor space.

Source: J. R. Jackson and W. S. Jackson, Commercial Energy Use: A Disaggregation by Fuel, Building Type, and End Use, Oak Ridge National Laboratory, Oak Ridge, Tenn (to be published).

GENERAL ELECTRIC COMPANY

In October 1977, the General Electric Company (G.E.) completed the preliminary draft of Commercial Energy Consumption Data Base Development Project. One of the objectives of the study was to obtain "a base inventory of commercial buildings" by building type (listed in Table 8.21) and by business economic area. The U.S. Department of Commerce has compiled statistics of building additions (by six major building types) for the years 1925 through 1954. The F. W. Dodge statistics are available for 1955 to 1976 and yield building additions by fifteen different building types. Together with estimates of the original 1924 stock and removal rates, these Department of Commerce and Dodge statistics are sufficient to estimate the existing 1975 U.S. aggregate stock. G.E. estimated the original 1924 stock in six different ways, then used as their base figure an average of certain of these estimates. The annual removal rate was estimated to be 1.0% for commercial buildings and 0.9% for religious, educational and hospital buildings (these estimates were based on Bulletin F, issued by the U.S. Treasury Department). In the process of developing their time series inventory of commercial floor area, G.E. took into account the time lag between the appearance of a new building in the Dodge statistics and the actual date of completion of the building (summarized on pp. IV-2 and IV-3 of the G.E. report). The G.E. estimates for commercial floor area inventory for 1975 appear in Table 8.21.

The regional inventory of floor space for 1975 was determined by allocating the total U.S. inventory for 1971 to the regions and then adding regional construction additions for 1971 – 1974, as reported in the F. W. Dodge statistics (such regional statistics are not available prior to 1971). Two methods were used in making the regional allocations.

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Method 1 consists of allocating floor space in direct proportion to the average of 1962 and 1970 relevant business earnings. For example; store sq.ft. (BEA, 1971) ≈ WHOLESALE AND RETAIL TRADE EARNINGS (BEA, AVERAGE 1962 AND 1970). Method 2 consists of a time series regression for 1960 — 1973, and can be expressed as a linear function,

$$\frac{\text{sq.ft.}}{\text{population}} = A_0 + A_1 \frac{\text{dollars of relevant business earnings}}{\text{population}}$$

In the process of conducting its study, G.E. researched the data available through the Building Owners and Managers Association (BOMA). The 1975 BOMA data base was derived from a relatively small sample of 1023 office buildings (the data base actually used data from 640 buildings from the larger sample). Selected statistics from the BOMA data base are published in the G.E. report. G.E. has also attempted to explain energy use in buildings of the BOMA sample through regression analysis using age, number of occupied square feet, the ratio of total square feet to height, cooling degree-days, and heating degree-days as independent variables. Additional analytical study involved testing some of the energy use simulation models (ECUBE, TRANE, AXCESS) against actual building energy use for certain selected buildings.

Certain additional comparative data derived from Jack Faucett Associates, Tishman-Syska and Hennessy, Inc., CFES estimates generated by R. H. McMahan, Jr. in Initial Steps Toward Modeling Electricity Consumption in the Commercial Sector, May 1975, Washington, D.C., CFES, and the Rand Corporation are presented.

In short, the G.E. study is difficult to describe because it contains not only estimates of floor space actually calculated by G.E. but also data from various previous energy studies and simulation models. At times the documentation is sparse; but as a whole, the study is an interesting introduction to understanding energy use in the commercial sector.

Table 8.21. Total Inventory by Major Building Category in Millions of Square Feet, 1975

Major Building Categories	1924 (assumed)	1975 (estimated)	Growth 1956-1975
1. Store and other mercantile bldgs.	771	4347	5.1%
2. Warehouses (excl. mfr. owned)	416	2578	6.1%
3. Office and bank buildings	539	3158	4.9%
4. Commercial garages and service stations	164	946	5.2%
5. School and college classroom buildings	872	4948	3.9%
6. Laboratories (excl. mfr. owned)	61	346	3.9%
7. Libraries, museums, etc.	67	380	3.9%
8. Total hosp. & other health treat. bldgs.	310	1806	3.8%
9. Government administration buildings	119	625	4.0%
10. Other government service buildings	91	473	3.9%
11. Houses of worship	115	655	4.0%
12. Other religious buildings	115	574	3.3%
13. Total amusement, social & recreat. bldgs.	340	1451	3.4%
14. Total miscellaneous nonres. bldgs.	240	1284	3.6%
15. Non-housekeeping residential bldgs. (hotels and motels)	340	1909	4.6%
Total	4560	25,468	4.5%

Source: General Electric Company, Marketing and Business Services, Commercial Energy Consumption Data Base Development Project - Commercial Buildings Inventory, Bridgeport, Conn., October 20, 1977, p. IV-5.

E. HIRST AND J. JACKSON

"Historical Patterns of Residential and Commercial Energy Uses" by Eric Hirst and Jerry Jackson (Energy 2(2), June 1977) is a review of data and trends concerning buildings energy use by fuel for the residential and commercial sectors. Data are presented for the years 1950 to 1975 and, for the purpose of analysis, a definite distinction is made between pre-embargo and post-embargo consumption and fuel pricing patterns. No explicit modeling is presented and no projections of energy use are made. A minimal amount of data manipulation is performed in the disaggregation process and hypotheses and reference sources underlying those manipulations are well documented. Not so explicit is the relationship of energy use to the explanatory variables such as population, per capita income, fuel prices, and commercial floor space.

The paper begins with a presentation of fuel use in residential and commercial buildings as documented by the Bureau of Mines (available as a combined household/commercial sector only). A simple method of disaggregation yields energy use for both sectors individually. The disaggregation by Hirst-Jackson of the Bureau of Mines data is particularly important because it raises issues of data discrepancies and definitional inconsistencies. For example, Hirst and Jackson indicate that:

1. Building fuel-use data should not include asphalt and road oil as a raw material; they are included by the Bureau of Mines in the household/commercial sector data.

2. Residential energy use is understated each year because gang-metered multifamily units are often classified as "commercial" by utilities. The adjustments made in the Hirst-Jackson paper are 4% and 22% for electricity and gas, respectively (percentages taken from Jack Faucett Associates, National Energy Accounts: Energy Flows in the U.S., 1947-1972). That is, the residential

use of electricity is determindd to be 104% of the figure cited by the Edison Electric Institute. Also the residential use of gas is computed as residential gas use plus 22% of commercial gas use, as reported by the American Gas Association.

3. The distinction between primary energy use and distributed energy use is not always made, although this is an important distinction for electricity use data.

The buildings studied in this report are defined (p. 4) as:

> The residential sector: "those structures (single-family units, apartments, trailers) occupied by households."
>
> The commercial sector: "those structures (e.g., office buildings, schools, hospitals, stores) that house the service sectors of our economy (e.g., retail and wholesale trade, government enterprises, health services)."

The section detailing household energy use includes a chart of residential energy use by fuel and end use for 1973 (Figure 8.5). These data are derived from a combination of the following:

1. Household ownership of fuel-using equipment (from the <u>1970 Census of Housing</u>, the <u>Annual Housing Survey</u>, and <u>Merchandising Week</u>),
2. Energy use per household for each type of equipment (from a 1975 Stephen Dole/Rand Corporation report),
3. "Control totals" (historical residential fuel consumption by fuel type from the Edison Electric Institute, the American Gas Association, and the Bureau of Mines).

Additionally, a graph showing retail fuel prices in constant (1967) dollars is included, as is a short analysis of household expenditures for energy (that is, expenditures for energy as a percentage of Personal Consumption Expenditures). These expenditure figures show a sharp increase in prices and expenditures in recent years.

Commercial sector energy intensiveness and energy use is expressed in three ways. Energy intensiveness (EI) is defined as the ratio of

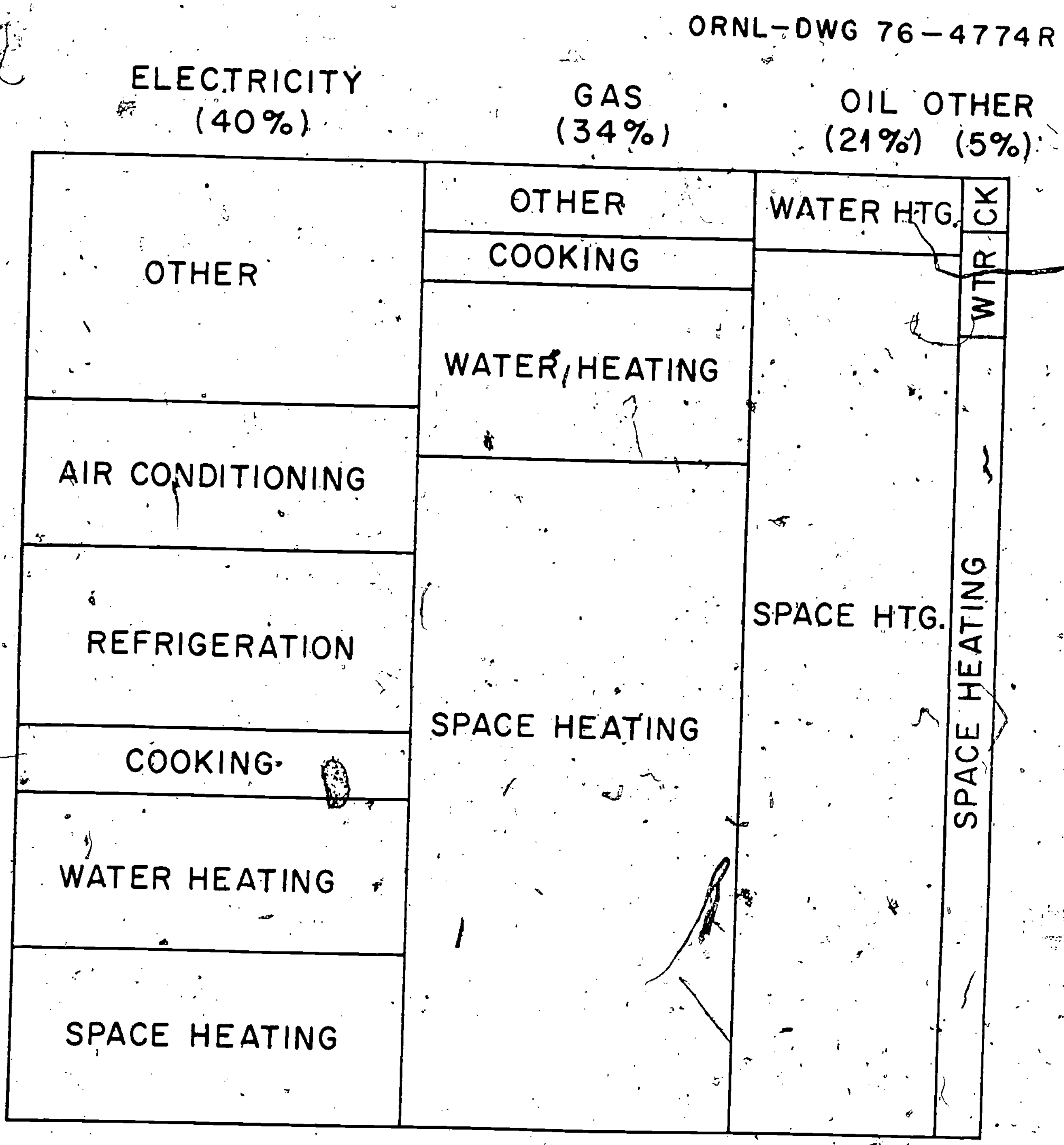

Fig. 8.5. Distribution of Energy in the Household Sector by Fuel and End Use for 1973.

Source: E. Hirst and J. Jackson, "Historical Patterns of Residential and Commercial Energy Uses," Energy, 2, No. 2-C (June 1977), p. 136.

commercial energy use to the "services" portion of Gross National Product. Secondly, EI is expressed as a ratio of commercial energy use to commercial building floor space (floor space data is taken from Westinghouse Research Laboratories, Assessing the Potential for Optimal Off-Peak Power). Finally, energy use is represented in terms of fuel expenditures [in current dollars, constant (1967) dollars, and as a percentage of GNP].

The Hirst-Jackson paper summarizes with Table 8.22.

Table 8.22. Comparison of Energy Use Trends and Determinants

	Average annual growth rate (%)			
	1950–1975		1972–1975	
Population	1.4		0.8	
Households	2.0		2.2	
Personal income	3.7		0.9	
Services GNP	4.1		2.7	
Average fuel price[a]	0.8		7.8	
Commercial floor space	4.6		2.4	
Energy use	Res	Com	Res	Com
Electricity	7.3	7.1	4.3	4.2
Gas	5.4	6.8	–0.9	0.1
Oil	2.3	2.9	–5.2	–7.8
Total	3.4	4.4	–0.8	0.0

[a] Average fuel price is defined as the ratio of residential and commercial expenditures on fuels (in constant dollars) to residential and commercial consumption of fuels.

Source: E. Hirst and J. Jackson, "Historical Patterns of Residential and Commercial Energy Uses," Energy, 2, No. 2-C (June 1977), p. 139.

Other conclusions of the research include:

1. Household energy use is approximately twice commercial sector energy use, although commercial energy is growing at a faster rate than household energy use.
2. Household energy use over the historical period (1950–1975) can be explained as a function of population, household size, income, and fuel prices.*
3. Commercial energy use over the historical period can be explained as a function of population, fuel prices, commercial output, and building floor space per dollar of output activity.*
4. Both sectors experienced a relative increase in the use of electricity and gas, and decrease of oil, coal, and liquefied gas over the historical time period.

The Hirst-Jackson paper contributes to the analysis of residential and commercial buildings energy use in that it identifies selected data sources, and corrects or explains data discrepancies. The study was a first-cut effort of an ongoing project at the Oak Ridge National Laboratory. Further investigation includes research of state-level data (as opposed to national) and a more accurate description of commercial activity (J. Jackson, S. Cohn, J. Cope, and W. S. Johnson, The Commercial Demand for Energy: A Disaggregation Approach, ORNL/CON-15, March 1978).

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*Although the Hirst-Jackson paper implies a functional relationship between energy use and the explanatory variables, no explicit functional form is given.

CHAPTER 8 — REFERENCES

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USER'S GUIDE

NOTE 1

Average price is given only as an aggregate convenience. The actual price for electricity varies regionally and by type of supplier, i.e. public or private. The Federal Power Commission reports its data in terms of public or private, and, according to their figures, privately owned utilities have historically charged higher rates than publicly owned utilities. The privately owned portion of the industry has been 76—78% by generation and 81—83% by sales. An appropriately weighted average of private and public industry rates seems to be consistent with total electric industry figures (see data below).

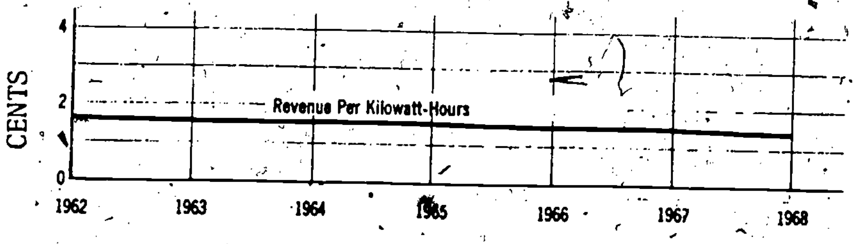
With the increase in fossil fuel costs and the recent shortage of hydroelectric power in the West, electric utilities have tended to use an increasingly complicated billing system (especially for larger customers). Some of the features of the new billing system are time-of-day pricing, peak-demand pricing, fuel adjustment costs, and differential rate structures scaled to usage. An appropriate billing system is thought to result in levelized (and possibly reduced) demand. For further details on billing, see Edison Electric Institute, <u>Edison Electric Institute Rate Book</u>, New York, 1970.

Table U.G.1. Average Revenue Per kWhr Sold to the Residential Sector by Privately Owned Utilities

Year	Cents
1962	2.56
1963	2.52
1964	2.45
1965	2.40
1966	2.34
1967	2.31
1968	2.25

Source: Edison Electric Institute, Statistical Yearbook of the Electric Utility Industry for 1975, No. 43, New York, 1976, Table 47s, p. 54.

Figure U.G.1. Average Revenue Per kWhr Sold to the Residential Sector by Publicly Owned Utilities



Source: Federal Power Commission, Office of Accounting and Finance, Statistics of Publicly Owned Electric Utilities in the United States: 1968, FPC S-200, Washington, D.C., 1968, p. XX.

Table U.G.2. Percent of Privately Owned Utilities by Generation[a]

Year	Privately owned
1966	77.0
1967	76.5
1968	76.7
1969	76.8
1970	77.4
1971	77.4
1972	77.6
1973	78.1
1974	77.3
1975	77.5

[a] Revised 1973 to separate Power Districts and State Projects from Municipals and Cooperatives.

Source: Federal Power Commission, Office of Accounting and Finance, Statistics of Privately Owned Electric Utilities in the United States: 1975, FPC S-260, Washington, D.C., 1975, p. 7.

Table U.G.3. Total Electric Sales to all Sectors by Privately Owned Electric Utilities

Year	10^6 kWhr
1962	621,040
1963	665,808
1964	717,951
1965	770,804
1966	840,093
1967	890,755
1968	984,542

Source: Edison Electric Institute, Statistical Yearbook of the Electric Utility Industry for 1975, No. 43, New York, 1976, Table 20s, p. 31.

Table U.G.4. Total Electric Sales to all Sectors by the Total Electric Utility Industry

Year	10^6 kWhr
1962	777,749
1963	832,796
1964	894,609
1965	957,113
1966	1,042,158
1967	1,111,373
1968	1,206,606

Source: Edison Electric Institute, Statistical Yearbook of the Electric Utility Industry for 1975, No. 43, New York, 1976, Table19s, p. 31.

NOTE 2

Although the purpose of the document Historical Trends of Electricity Sales by Sector, Region and State, 1951—1974 is not primarily to identify the changes in classification between small light and power and large light and power, such reclassification can be inferred from the charts presented. For example, the jump upwards in the 1962 Idaho large light and power sales and the corresponding jump downwards in the small light and power sales implies reclassification.

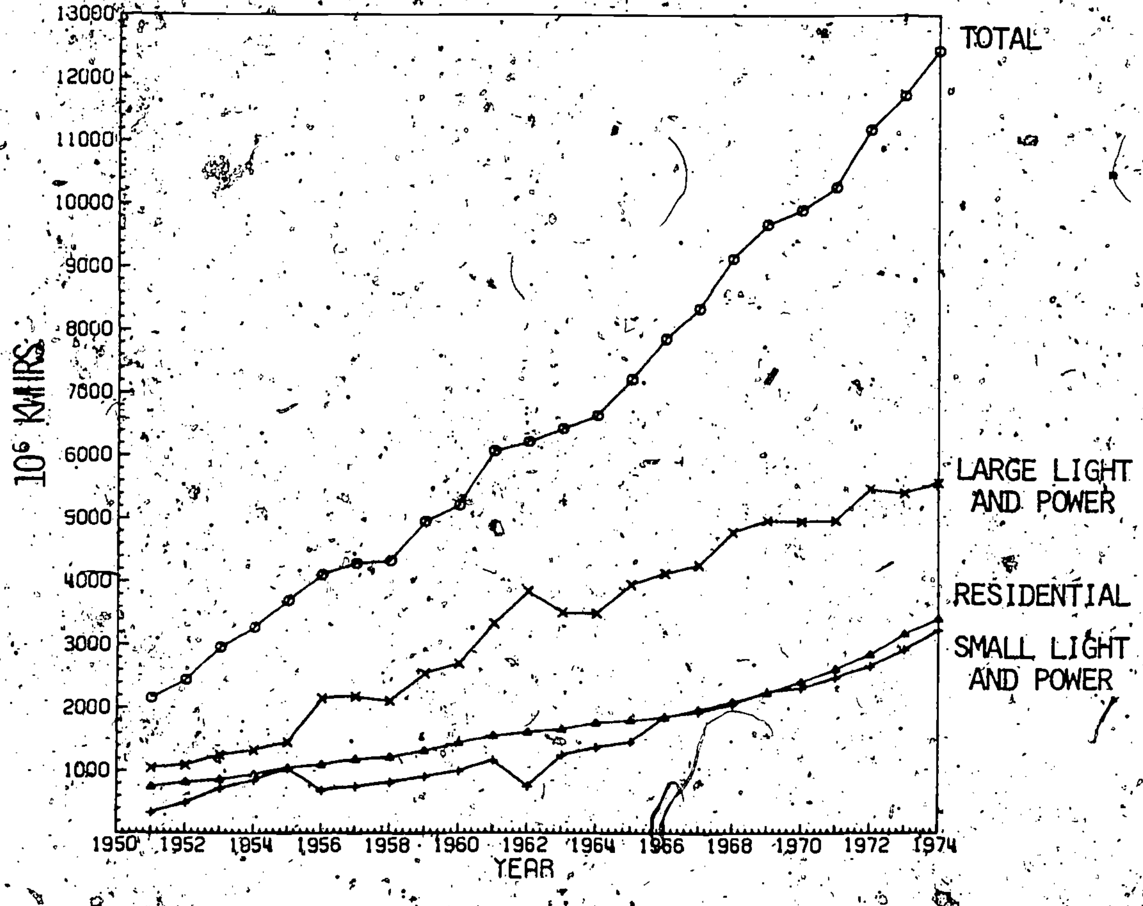


Figure U.G.2. Electricity Sales - Idaho

Source: W. S. Chern, B. D. Holcomb, S. B. Caudill, Historical Trends of Electricity Sales by Sector, Region, and State 1951-1974, Unpublished document, Oak Ridge National Laboratory, Oak Ridge, Tenn., September 1976, p. 59.

NOTE 3

The staff responsible for the publication of the FEA's Monthly Energy Review receives from the Bureau of Mines data on barrels of petroleum products consumed. The products are allocated to the various sectors according to the following scheme. (Monthly Energy Review, April 1977, p. 45.)

> Petroleum consumed in transportation was calculated based on Department of Transportation data as follows: Motor gasoline — 100 percent; naphtha jet fuel — 100 percent; kerosine jet fuel — 97 percent; distillate fuel oil — 30.3 percent; residual fuel oil — 11.2 percent; all other products — 4.7 percent. The remainder is distributed to economic sectors using the following percentage shares, derived from 1974 Bureau of Mines data on consumption: Residential and Commercial — 52.3 percent; Industrial — 47.7 percent.

The energy content of the petroleum products consumed is calculated by using the conversion factor 5.4959 × 10^6 Btu/barrel. (The numbers cited above do not necessarily remain invariant from year to year. Those cited are valid for 1974, 1975 and 1976.)

As a result of the above methodology, any failure of residential-commercial petroleum consumption to exactly parallel national petroleum consumption is actually indicative of a change in the distribution of the types of petroleum products consumed.

NOTE 4

Number of Cities Priced for Each Fuel and Definitions of Terms of Sale

Indexes reported here are components of the Consumer Price Index, which measures price changes for commodities and services bought by wage earners and clerical workers in the urban United States. Not all fuels are important in each of the 56 metropolitan areas and smaller cities selected to represent urban places in the index. As of January 1966, electricity prices were collected in all 56 cities, gas prices for use other than residential heating in 55 cities, gas for residential space heating in 51 cities, No. 2 fuel oil in 31 cities, and coal in 9 cities. The metropolitan areas selected for inclusion in this release are 22 SMSAs of over one million population (plus Honolulu) for which consumer price indexes are published. Area coverage includes the urban portion of the corresponding Standard Metropolitan Statistical Area (SMSA), except for New York and Chicago where the more extensive Standard Consolidated Areas are used. Area definitions are those established for the 1960 Census and do not include revisions made since 1960. Average prices for gas other than space heating and for electricity are published monthly for each of the large metropolitan areas in which the fuel is important.

Source: U.S. Department of Labor, Bureau of Labor Statistics, Retail Prices of Fuels and Indices, Washington, D.C., February 1972.

NOTE 5

Two sources of electric utility data are from the Federal Power Commission (FPC) and the Edison Electric Institute (EEI). A combined commercial and industrial category is presented because individual electricity utilities define commercial and industrial users in various ways. Most utility companies classify customers according to the Standard Industrial Classification system or to predominant kilowatt-hour use; other utility companies classify all customers whose demand or annual use exceeds some specified limit as industrial. These limits are generally based on a utility's particular rate schedule. (See Table U.G.5.)

The major difference between the FPC and EEI statistics is the exclusion of Federal projects from the FPC data in Table U.G.5. For example, the table below suggests that the Federal projects and New York state categories comprise 51.6% of total kWhr sales of publicly owned utilities in 1974. Other differences in the data may occur. Beginning with 1961, as a result of a change in the FPC filing procedure, there was a large increase in the number of reporting municipal utilities. The FPC warns against the comparability of pre- and post-1960 data. The EEI data experiences reclassification shifts of the commercial/industrial sector.

Table U.G.5. Kilowatt-Hour Sales of Electricity to the Residential and Commercial/Industrial Sectors (10^6 kWhr)

	Residential		Commercial and industrial[a]		Rural[b]	
	Federal Power Commission[c]	Edison Electric Institute[d]	Federal Power Commission[c]	Edison Electric Institute[d]	Federal Power Commission[c]	Edison Electric Institute[a]
1950	57,059	67,030	171,217	189,510	8,896	7,40[illegible]
1955	100,455	120,524	273,307	329,965	12,495	10,751
1960	156,063	189,911	371,236	453,298	15,208	12,798
1965	244,038	280,970	550,491	635,477		
1966	266,648	306,572	602,837	690,95[illegible]		
1967	287,440	331,525	636,811	728,535		
1968	320,454	367,692	694,310	783,985		
1969	357,068	407,922	749,629	843,906		
1970	391,185	447,795	791,642	885,272		
1971	420,844	479,080	836,666	926,452		
1972	452,581	511,423	907,065	1,001,326		
1973	486,380	554,171	975,530	1,084,138		
1974	485,396	554,960	969,184	1,082,151		
1975	506,677[e]	586,149	959,571[e]	1,079,627		

[a] For a discussion of commercial/industrial reclassification shifts, see W. S. Chern, B. D. Holcomb, and S. B. Caudill, Historical Trends of Electricity Sales by Sector, Region and State: 1951–1974, unpublished document, Oak Ridge National Laboratory, Oak Ridge, Tenn.

[b] Category discontinued after 1960.

[c] FPC data is the sum of the publicly and privately owned utilities. Publicly owned refers to utilities operated by municipalities and Federal power agencies. However, data was not readily available (on a time-series basis) for the Federal projects, so the publicly owned data presented here includes municipalities. Data also excludes the Power Authority of the State of New York, which is not comparable to other utilities because of its limited service to the ultimate consumer.

[d] EEI also includes an "other" category not presented here covering electricity supplied to municipalities or governmental units as the ultimate consumer.

[e] Data computed by author.

Sources: Edison Electric Institute, Statistical Yearbook of the Electric Utility Industry for 1969, New York, September 1970, Table 22s. (Also other years.) Federal Power Commission, Office of Accounting and Finance, Statistics of Publicly Owned Electric Utilities in the United States: 1968, FPC S-200, Washington, D.C., December 1969, Statistics of Privately Owned Electric Utilities in the United States: 1973, FPC S-247, Washington, D.C., December 1974, Table 16. (Also other years.)

Table U.G.6. Electricity Sales of Publicly Owned Utilities as Classified by the Federal Power Commission, 1974
(10^6 kWhr)

	Total	Federal projects	Municipals	
			Power Authority of the State of New York[a]	Other municipals
Residential	69,629	81		69,548
Commercial and industrial	169,729	63,629	5,242	100,858
Other ultimate consumers	15,515	7,639		7,876
Total	254,873	71,349	5,242	178,282
For resale	212,201	144,733	19,568	47,860
Total kWhr sales	467,074	216,122	24,810	226,142

[a] The Power Authority of the State of New York is separated from other municipal utilities because of its limited service to the ultimate consumer.

Source: Federal Power Commission, Office of Accounting and Finance, Statistics of Publicly Owned Electric Utilities in the United States: 1974, Washington, D.C., 1975, Table 1.

NOTE 6

Table U.G.7. Implicit Generating Efficiency

Year	Heat rate[a] (Btu per kWhr)	Implicit generating efficiency[b]
1951	13,641	25%
1952	13,361	26%
1953	12,889	26%
1954	12,180	28%
1955	11,699	29%
1956	11,456	30%
1957	11,365	30%
1958	11,090	31%
1959	10,879	31%
1960	10,701	32%
1961	10,552	32%
1962	10,493	33%
1963	10,438	33%
1964	10,407	33%
1965	10,384	33%
1966	10,3[illegible]	33%
1967	10,396	33%
1968	10,371	33%
1969	10,457	33%
1970	10,508	32%
1971	10,5[illegible]	32%
1972	10,47[illegible]	33%
1973	10,429	33%
1974	10,481	33%
1975	10,383	33%

[a] EEI estimate.

[b] Calculated by author according to the formula $\frac{3413}{\text{heat rate}}$ = generating efficiency.

Note: Generation efficiency remains between 25% and 33% for all years between 1951 and 1975.

Source: Edison Electric Institute, Statistical Yearbook of the Electric Utility Industry 1975, New York, October 1976, Table 41s, p. 49.

Table U.G.8. Implicit Transmission Losses (1959–1975)

Year	Electricity generated by total electric utility industry (10^6 kWhr)	Total electricity sales (10^6 kWhr)	Implicit[a] distribution-transmission efficiency	Implicit distribution-transmission losses
1959	710,006	627,529	88%	12%
1960	753,350	683,987	91%	9%
1961	792,039	721,645	91%	9%
1962	852,314	777,749	91%	9%
1963	916,795	832,796	91%	9%
1964	983,990	894,609	91%	9%
1965	1,055,252	957,113	91%	9%
1966	1,144,350	1,042,158	91%	9%
1967	1,214,365	1,111,373	91%	9%
1968	1,329,443	1,206,606	91%	9%
1969	1,442,182	1,311,008	91%	9%
1970	1,531,609	1,395,568	91%	9%
1971	1,613,936	1,469,955	91%	9%
1972	1,747,323	1,580,466	90%	10%
1973	1,856,216	1,705,773	92%	8%
1974	1,866,436	1,703,495	91%	9%
1975	1,916,578	1,738,107	91%	9%

[a] Calculated by author according to the formula $\frac{\text{sales}}{\text{generation}}$ = distribution-transmission efficiency.

Source: Edison Electric Institute, Statistical Yearbook of the Electric Utility Industry 1975, New York, October 1976, Table 10s, p. 18 and Table 19s, p. 31.

The above calculations indicate that historically the generation-transmission efficiency has ranged from 22% to 30% with the latter figure more representative of the recent years. The Monthly Energy Review uses a combined figure of 32% for generation-distribution-transmission efficiency.*

*Source: Federal Energy Administration, Monthly Energy Review, Washington, D.C., April 1977, p. 45.

Were one to calculate the implicit percentage generation losses from this table, one would find that they range from

$$0.67 = (1 - \frac{3412}{10383}) \text{ to } 0.75 = (1 - \frac{3412}{13641}) .$$

The Monthly Energy Review assumes generation losses of 65% and distribution-transmission losses of an additional 3%.

Direct calculation by the author (based on information published by the Edison Electric Institute) indicates that distribution-transmission losses could well be 9%. In fact, for the year 1975, one finds that the quotient of "electricity sales" divided by "electricity generated" is 0.91.

Private conversations with representatives of EEI indicate that this estimation procedure for distribution-transmission losses is reasonable. The actual equation used is $100 - \frac{\text{total sales}}{\text{total generated}} = \%$ distribution-transmission loss.

NOTE 7 — Room Air Conditioners

As can be seen from Table 3.25, a great deal of information is available concerning the efficiency of individual room air conditioner models. Unfortunately, no disaggregate sales data are available that would allow the aggregation of the individual models into meaningful groups for analysis. The tables presented in Chapter 3 are based on the premise that it is better to present data with known-and-minimized maximum errors than it is to make assumptions and possibly lose track of the potential errors involved.

Principally, the values in Chapter 3 were arrived at in the following manner.

1. The individual model characteristics were aggregaged into groups for which the sales data were known while maintaining the upper and lower bound of the capacity EER, PF, and PF′ ranges.
2. From these groups the data were aggregated to larger groups by weighting resulting in true mean of midpoints.

Under these circumstances it can be shown that

$$e_{mi} = \left(\frac{mi - li}{li}\right) \times 100$$

where e_{mi} = maximum % error to the midpoint of the true mean,

mi = midpoint efficiency of group i,

li = lower efficiency bound of group i, and

$$e_{ei} = \frac{\sum_{i=1}^{n} \frac{B_{mi}}{m_i} - \frac{B_l}{h_i}}{\sum_{i=1}^{n} \frac{B_l}{h_i}}$$

where e_{ei} = % error of true value to calculated value in energy calculation in the nature of $E = \frac{(\text{mean of})\ B_{mi}}{(\text{mean of})\ mi}$,

B_{mi} = midpoint of capacity range i,

B_l = lower range bound of group i,

mi = midpoint efficiency of group i,

h_i = upper efficiency bound of group i.

Definition of Table Headings

Rated capacity — a general capacity range in Btu/hr and by which the manufacturers' shipments are published.

Midpoint of capacity range — the midpoint of the capacity range of the actual units shipped falling within the capacity category outlined above and shown in the tables in Chapter 3.

EER value — the value of the ratio of the rated cooling capacity and the electrical power input during steady state operation at 80°F and 95°F (inside and outside dry bulb temperatures, respectively). It is given in units of Btu/Whr. It should be noted that the EER value will vary with temperature and cycling conditions and is not a measure of the actual seasonal performance of the unit.

EER range — the range of the EER values of the units manufactured within the rated capacity category.

PF – the Performance Factor is a dimensionless ratio of the cooling capacity and the energy input, again at the steady state conditions outlined for the EER value.

$$PF = \frac{\text{cooling energy output}}{\text{energy input to the unit}}$$

PF´ – the Performance Factor adjusted to include a 30% electrical generation and distribution efficiency.

Maximum error of midpoint – the maximum error by which the PF and PF´ range midpoints may differ from the true mean PF or PF´ and is expressed as a percentage of the true value. To convert this to a percentage error of the stated value, the following relation may be used.

$$\%\text{ of error of stated value} = \left(\frac{\%\text{ error of true value}}{100 + \%\text{ error of true value}}\right) \times 100 .$$

Maximum error in energy use – the maximum error that may be generated by utilizing the PF and PF´ in the relation

$$\text{energy used} = \frac{\text{Btu/hr cooling capacity midpoint}}{\text{PF or PF}'}$$

The error is expressed as a percent of the true value.

If the errors for the weighted groups are to stay within the prescribed bounds for the weighted aggregates, care must be taken to apply the aggregated values only to sufficiently large groups to assure a distribution equal to that of the actual production populations.

NOTE 8 - Household Refrigerators, Refrigerator-Freezers, and Freezers

In these three appliance categories the cubic feet capacity and monthly energy use under the specified test conditions are known for each model manufactured. As no sales data by model are available (data that would allow aggregation without introducing error), the procedure outlined below and described in terms of the table headings was used for the three appliance categories. With the exception of the adjusting procedure, this follows the procedure outlined for room air-conditioners in Note 9.

Rated capacity category — a general capacity range by which the manufacturers' shipments are published.

Capacity range of units shipped — the capacity range of actual units shipped that fall within the capacity category outlined above and shown in tables in Chapter 3.

PF, Performance Factor — the cubic foot capacity divided by the electrical energy use per day in kilowatt-hours under the prescribed test conditions. The following factors should be noted concerning the test conditions which may differ from field use.

1. The ambient conditions are maintained at 90°F.
2. The general food compartment of refrigerators and refrigeration-freezers is empty.
3. Doors remain closed.
4. Auxiliaries such as automatic ice machines and butter conditioners are set at the lowest energy use mode.
5. All freezers sections are loaded to 75% capacity.
6. The measured energy use for freezers is multiplied by 0.9 to represent "typical household usage" for freezers based on field tests conducted by AHAM members and the U.S. Department of Commerce.

Also, this performance factor is not identical to the energy factor defined by FEA in Vol. 42, No. 178, 46140-41145, September 14, 1977 of the Federal Register. The FEA allowed the following adjustment factors to the respective compartment volumes to compensate for lower temperatures (a) the volume of freezers multiplied by 1.73, (b) the volume of freezer compartments in refrigerator freezers multiplied by 1.68, (c) the volume of freezer compartments in refrigerators multiplied by 1.44. These adjustments are not included in the PF but represent the only difference so a straightforward conversion is possible.

PF′ — the Performance Factor revised to include a 30% electrical generation and distribution efficiency and converted to cubic feeet per 10^3 Btu per month to give the energy use in terms of prime source energy.

Range of energy use — the energy use (kWhr per month) range of the individual models in the capacity category, as determined by laboratory test procedures.

Maximum error of midpoint(s) — the maximum possible error of the midpoint to the true mean (unknown), expressed as the percent of the true mean, and given by

$$\left(\frac{m - \ell}{\ell}\right) \times 100$$

where m = midpoint
ℓ = lower range bound

Adjusted PF and PF′ ranges and midpoints — in order to reduce the errors in calculations involving two ranges (capacity and PF or PF′), the capacity range was fixed at the midpoint. This necessitates in adjustment to the PF and PF′ ranges so that the known energy use ranges are met. The resultant decrease in the maximum error is documented in the final tables in each section. It should be noted that these adjusted valued do not represent actual efficiencies (for these the unadjusted values should be used) but are derived numbers to be used in determining energy usages in conjunction with the capacity midpoints.

$$\text{energy use} = \frac{\text{midpoint of capacity range}}{\text{adjusted PF or PF}'}$$

Maximum error in energy use — the maximum error to the true value when the adjusted/unadjusted PF and PF′ factors are used in the above equation, expressed as percent of the true value.

If the error as percent of the resultant is desired rather than the error as percent of the true value, the following conversion may be used.

$$\%\ \text{error of resultant value} = \left(\frac{\%\ \text{error of true value}}{100 + \%\ \text{error of true value}}\right) \times 100$$

Sources: U.S. National Archives, Library of Congress, Federal Register, Vol. 42, No. 178, Washington, D.C., September 14, 1977, pp. 46140 through 46144; Association of Home Appliance Manufacturers, Procedural Guide — Refrigerator and Freezer Certification Program, Chicago, Ill., July 1975; Association of Home Appliance Manufacturers, Standard No. HRF-2-ECFT, Chicago, Illinois, July 1975.

NOTE 9 — Heat Pumps

With the exceptions outlined below, the problems, methodologies, and table headings encountered in the section on heat pumps are essentially the same as those outlined in Note 8 for household refrigerators, refrigerator-freezers, and freezers. A sample calculation is carried out in this Note for further amplification of the methodology.

PF, Performance Factor — The dimensionless ratio of the heating or cooling energy output (without auxiliary heating coils) to the total energy input. This is identical to the Coefficient of Performance (COP) for the heating modes.

Range of Power Use — As the amount of use is dependent on location and installation, the power use when energized is given rather than an average energy use per month.

Sample Calculation

The source data from Table 3.33 for heat pumps in the 44,000 to 53,900 Btu/hr category in the cooling mode is utilized in this calculation to exemplify the derivation of the data in Tables 3.34 to 3.39. The midpoint of the manufactured capacity range is given by:

$$\frac{44,000 + 53,000}{2} = 48,500$$

yielding a maximum possible error to the true value of:

$$\left(\frac{48,500 - 44,000}{44,000}\right) \times 100 = 10.2\%$$

Changing the EER values to dimensionless PFs yields unadjusted bounds of

$$\frac{5.6}{3.412} = 1.64 \text{ to } \frac{7.9}{3.412} = 2.32$$

with a midpoint value of

$$\frac{1.64 + 2.32}{2} = 1.98$$

However, when these PFs are used in conjunction with the capacity midpoint values of 48,500 Btu/hr, they yield power uses of

$$\left(\frac{48,500}{1.64}\right)\frac{1}{3.14} = 9,418 \text{ watts and } \left(\frac{48,500}{2.32}\right)\frac{1}{3.14} = 6,658 \text{ watts}$$

respectively which do not coincide with the known power use band of 6,200 to 7,860 watts.

To compensate for this adjusted PFs are calculated specifically for use with the midpoint capacity value yielding

$$\left(\frac{48,500}{6,200}\right)\frac{1}{3.142} = 2.29 \text{ and } \left(\frac{48,500}{7,860}\right)\frac{1}{3.142} = 1.81$$

with a midpoint value of

$$\frac{2.49 + 1.81}{2} = 2.05$$

Including an electrical generation and distribution efficiency of 30% yields a PF′ of:

$$(2.05)\ .3 = 0.615$$

The maximum error which can be guaranteed in equations of the format

$$\text{energy used} = \frac{\text{capacity}}{\text{PF or PF}'}$$

is dependent on which values (adjusted or unadjusted) are used. If the unadjusted ranges and values are used this is given by:

$$\left(\frac{\frac{48,500}{1.98} - \frac{44,000}{2.32}}{\frac{44,000}{2.32}}\right) \times 100 = 29.2\%$$

If the capacity range is assumed fixed at the midpoint and the adjusted PFs are used (which is the same from the energy viewpoint), the maximum error is given by:

$$\left(\frac{\frac{48,500}{2.50} - \frac{48,500}{2.29}}{\frac{48,500}{2.29}}\right) \times 100 = \left(\frac{2.29}{2.05} - 1\right) \times 100 = 11.7\%$$

Appendices

APPENDIX A

STANDARD INDUSTRIAL CLASSIFICATION CODES AND DEFINITIONS

Following is a brief set of "commercial" SIC definitions from the Standard Industrial Classification Manual 1972; the SIC codes are the basis for classification of commercial definition by type. Although the SIC categorizes by division, major group, and industry, only definitions by division or major group are given here. Further explanation is provided in the Manual.

Division A

Agriculture, Forestry, and Fishing

This division includes establishments primarily engaged in agricultural production, forestry, commercial fishing, hunting and trapping, and related services.

The classification of agricultural production covers establishments primarily engaged in the production of crops, plants, vines, or trees (excluding forestry operations); and the keeping, grazing, or feeding of livestock for the sale of livestock or livestock products (including serums), for livestock increase, or for value increase.

Farms are the establishment units generally utilized for the purpose of industrial classification of agricultural production. A farm may consist of a single tract of land, or a number of separate tracts which may be held under different tenures. When a landowner has one or more tenants, renters, croppers, or managers, the land operated by each is considered a farm.

The classification of agricultural services includes establishments primarily engaged in supplying soil preparation services, crop services, landscape and horticultural services, veterinary and other animal services, and farm labor and management services.

The classification of forestry covers establishments primarily engaged in the operation of timber tracts, tree farms, forest nurseries, the gathering of forest products, or in performing forestry services.

The classification of fishing, hunting, and trapping covers establishments primarily engaged in commercial fishing (including shellfish and marine products); operating fish hatcheries, and fish and game preserves; and commercial hunting and trapping.

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Major Group 7--Agricultural Services includes establishments primarily engaged in performing soil preparation services, crop services, veterinary services, other animal services, farm labor and management services, and landscape and horticultural services, for others on a fee or contract basis.

Major Group 8--Forestry includes establishments primarily engaged in the operation of timber tracts, tree farms, forest nurseries, and related activities such as reforestation services and the gathering of gums, barks, balsam needles, maple sap, Spanish moss, and other forest products.

Major Group 9--Fishing, Hunting, and Trapping includes establishments primarily engaged in commercial fishing and the operation of fish hatcheries, fish and game preserves, in commercial hunting and trapping, and in game propagation.

Division C

Construction

This division includes establishments (or kind-of-activity units) primarily engaged in construction. The term "construction" includes new work, additions, alterations, and repairs. If a company has more than one relatively fixed place of business from which it undertakes or manages construction activities and for which separate data on the number of employees, payroll, receipts and other establishment-type records are maintained, each such place of business is considered a separate construction establishment. Each legal entity is considered a separate establishment, even where two or more legal entities carry out construction activities from the same place of business.

Major Group 15--Building Construction-General Contractors and Operative Builders includes general contractors and operative builders primarily engaged in the construction of residential, farm, industrial, commercial, or other buildings. General building contractors who combine a special trade with the contracting are included in this major group.

Major Group 16--Construction Other than Building Construction-General Contractors includes general contractors engaged in heavy construction such as highways and streets, bridges, sewers, railroads, irrigation projects, flood control projects and marine construction, and miscellaneous types of construction work other than buildings. General heavy construction contractors who combine a special trade with the contracting are included in this major group.

Major Group 17--Construction-Special Trade Contractors includes contractors who undertake specialized activities such as plumbing, painting, plastering, carpentering, etc. Also included are establishments primarily engaged in miscellaneous specialized construction activities such as industrial machinery and equipment installation, grave excavation, gas leakage detection and water well drilling. Special trade contractors for the most part perform their work at the site of construction, although they also may have shops where they perform work incidental to the site job.

Division E

Transportation, Communications, Electric, Gas, and Sanitary Services

This division includes establishments providing to the general public or to other business enterprises passenger and freight transportation, communication services, electricity, gas, steam, water or sanitary services, and the U.S. Postal Service.

For many of the industries in this division, the establishments have activities, workers, and physical facilities distributed over an extensive geographic area. For this division, the establishment is represented by a relatively permanent office, shop, station, terminal, warehouse, etc. which is either (1) directly responsible for supervising such activities, or (2) the base from which personnel operate to carry out these activities. Many of the industries are engaged in various related activities.

Those establishments which perform such activities as maintenance and repair of the physical facilities, and repair of railroad cars and engines are classified as Construction or Manufacturing if they serve other companies, but are included here if they do not. Separate industries are included in this division for terminal and maintenance services, where they are important, but otherwise these activities are included with the industries which they serve. Locations engaged in activities such as sales of electric appliances to household consumers, or in manufacturing ice are classified in Retail Trade and Manufacturing, respectively, if separate records are available.

The establishments classified in this division furnish services to the general public or to other business enterprises; establishments which furnish similar services only to other establishments of the same enterprise are classified as auxiliary to the establishments or units of the enterprise which they serve. However, separate establishments primarily engaged in long-distance hauling, stevedoring, water transportation or pipe line transportation are classified according to their activity and not as auxiliaries, even though they serve only establishments of the same company.

Major Group 40--Railroad Transportation includes establishments furnishing transportation by line-haul railroad, as well as REA Express, and switching and terminal establishments.

Major Group 41--Local and Suburban Transit and Interurban Highway Passenger Transportation includes establishments primarily engaged in furnishing local and suburban passenger transportation, and establishments engaged in furnishing transportation to local scenic features. Also included are establishments primarily engaged in furnishing highway passenger transportation and establishments furnishing highway passenger terminal or maintenance facilities. Intercity bus lines are included in this major group.

Major Group 42--Motor Freight Transportation and Warehousing includes establishments furnishing local or long-distance trucking, or transfer services, or those engaged in the storage of farm products, furniture and other household goods, or commercial goods of any nature. The operation of terminal facilities for handling freight, with or without maintenance facilities, is also included.

Major Group 44--Water Transportation includes establishments engaged in freight and passenger transportation on the open seas or inland waters, and establishments furnishing such incidental services as lighterage, towing, and canal operation. This major group also includes excursion boats, sightseeing boats, and water taxis.

Major Group 45--Transportation By Air includes establishments engaged in furnishing domestic and foreign transportation by air and also those operating airports and flying fields and furnishing terminal services. Establishments primarily engaged in performing services which may incidentally use airplanes (crop dusting, aerial photography, etc.) are classified according to the service performed.

Major Group 46--Pipe Lines, Except Natural Gas includes establishments primarily engaged in the pipe line transportation of petroleum and other commodities, except natural gas. Pipe lines operated by petroleum producing or refining companies and separately reported are included.

Major Group 47--Transportation Services includes establishments furnishing services incidental to transportation, such as forwarding and packing services, and the arrangement of passenger and freight transportation.

Major Group 48--Communication includes establishments furnishing point-to-point communication services, whether by wire or radio, and whether intended to be received aurally or visually; and radio and television broadcasting. Services for the exchange or recording of messages are also included.

Major Group 49--Electric, Gas, and Sanitary Services includes establishments engaged in the generation, transmission and/or distribution of electricity, gas, or steam. Such establishments may be combinations of any of the above three services and also include other types of service such as transportation, communication, and refrigeration. Water and irrigation systems, and sanitary systems engaged in the collection and disposal of garbage, sewage, and other wastes by means of destroying or processing materials, are also included.

Division F

Wholesale Trade

This division includes establishments or places of business primarily engaged in selling merchandise to retailers; to industrial, commercial, institutional, farm or professional business users; or to other wholesalers; or acting as agents or brokers in buying merchandise for or selling merchandise to such persons or companies.

The principal types of establishments included are: (1) merchant wholesalers; (2) sales branches and sales offices (but not retail stores) maintained by manufacturing or mining enterprises apart from their plants or mines for the purpose of marketing their products; (3) agents, merchandise or commodity brokers, and commission merchants; (4) petroleum bulk stations; and (5) assemblers, buyers, and associations engaged in the cooperative marketing of farm products. Establishments primarily engaged in the wholesale distribution of used products are classified on the basis of the products sold.

Establishments primarily engaged in selling merchandise to contractors are included in Wholesale Trade, with the exception of lumber yards and paint, glass, and wallpaper stores, which are classified in Retail Trade if they sell to the general public, even if a higher proportion of their sales is made to contractors.

The chief functions of establishments included in Wholesale Trade are selling goods to trading establishments, or to industrial, commercial, institutional, farm, and professional business users; and bringing buyer and seller together.

Major Group 50--Wholesale Trade--Durable Goods includes establishments primarily engaged in the wholesale distribution of durable goods.

Major Group 51--Wholesale Trade--Nondurable Goods includes establishments primarily engaged in the wholesale distribution of nondurable goods.

Division G.

Retail Trade

This division includes establishments engaged in selling merchandise for personal or household consumption, and rendering services incidental to the sale of the goods. In general, retail establishments are classified by kind of business according to the principal lines of commodities sold or the usual trade designation. Some of the important characteristics of retail trade establishments are: the establishment is usually a place of business and is engaged in activities to attract the general public to buy; the establishment may process its products, but such processing is incidental or subordinate to selling; the establishment is considered as retail in the trade; and the establishment sells to customers for personal or household use. Not all of these characteristics need be present and some are modified by trade practice.

For the most part, establishments engaged in retail trade sell merchandise to the general public for personal or household consumption. Exceptions to this general rule are made necessary by trade practices. However, establishments that sell exclusively to business establishments, institutional and industrial users, or contractors are classified in Wholesale Trade.

Establishments engaged in selling to the general public, from displayed merchandise, products such as typewriters, stationery, or gasoline are classified in Retail Trade even though such products may not be used for personal or household consumption. However, establishments that sell these products only to institutional or industrial users and establishments that sell similar merchandise for use exclusively by business establishments are classified in Wholesale Trade.

Buying of goods for resale to the consumer is a characteristic of retail trade establishments that particularly distinguishes them from the agricultural and extractive industries.

Processing incidental or subordinate to selling often is conducted at retail stores. Retail establishments of manufacturing concerns are included in Retail Trade. Chain store warehouses are considered auxiliary to the retail establishment served and are classified on the basis of the activity carried on by such retail stores.

Major Group 52--Building Materials, Hardware, Garden Supply, and Mobil Home Dealers includes retail establishments primarily engaged in selling lumber and other building materials; paint; glass and wallpaper; hardware; nursery stock; lawn and garden supplies; and mobile homes.

It includes lumber and other building materials dealers and paint, glass and wallpaper stores selling to the general public, even if sales to contractors account for a larger proportion of total sales.

Establishments primarily selling plumbing, heating and air conditioning equipment and electrical supplies are classified in Wholesale Trade.

Major Group 53--General Merchandise Stores includes retail stores which sell a number of lines of merchandise, such as dry goods, apparel and accessories, furniture and home furnishings, small wares, hardware, and food. The stores included in this group are known as department stores, variety stores, general merchandise stores, general stores, etc.

Major Group 54--Food Stores includes retail stores primarily engaged in selling food for home preparation and consumption.

Major Group 55--Automotive Dealers and Gasoline Service Stations includes retail dealers selling new and used automobiles, boats, recreational and utility trailers, and motorcycles; those selling new automobile parts and accessories; and gasoline service stations. This group includes establishments dealing in used automobiles exclusively, but not establishments dealing exclusively in used parts. Automobile repair shops maintained by the establishments engaged in the sale of new automobiles are also included.

Major Group 56--Apparel and Accessory Stores includes retail stores primarily engaged in selling new clothing, shoes, hats, underwear, and related articles for personal wear and adornment. Furriers and custom tailors carrying stocks of materials are included in this group.

Major Group 57--Furniture, Home Furnishings, and Equipment Stores includes retail stores selling goods used for furnishing the home, such as furniture, floor coverings, draperies, glass and chinaware, domestic stoves, refrigerators, and other household electrical and gas appliances. Establishments selling electrical and gas appliances are included in this group only if the major part of their sales consist of articles for home use. Stores furnishing interior decorator service are classified according to the merchandise handled.

Major Group 58--Eating and Drinking Places includes retail establishments selling prepared foods and drinks for consumption on the premises, and also lunch counters and refreshment stands selling prepared foods and drinks for immediate consumption. Restaurants, lunch counters, and drinking places operated as a subordinate service facility by other establishments are not included in this industry, unless they are operated as leased departments by outside operators.

Major Group 59--Miscellaneous Retail includes retail establishments not elsewhere classified. These establishments include drug stores, liquor stores, used merchandise stores, nonstore retailers, fuel and ice dealers, miscellaneous shopping goods stores, florists, cigar stores and stands, and miscellaneous retail stores.

Division H

Finance, Insurance, and Real Estate

This division includes establishments operating primarily in the fields of finance, insurance, and real estate. Finance includes banks and trust companies, credit agencies other than banks, holding (but not predominantly operating) companies, other investment companies, brokers and dealers in securities and commodity contracts, and security and commodity exchanges. Insurance covers carriers of all types of insurance, and insurance agents and brokers. Real estate includes owners, lessors, lessees, buyers, sellers, agents, and developers of real estate.

Major Group 60--Banking includes institutions which are engaged in deposit banking or closely related functions, including fiduciary activities.

Major Group 61--Credit Agencies Other Than Banks includes establishments engaged in extending credit in the form of loans but not engaged in deposit banking.

Major Group 62--Security and Commodity Brokers, Dealers, Exchanges, and Services includes establishments engaged in the underwriting, purchase, sale, or brokerage of securities and other financial contracts on their own account or for the account of others; exchanges; exchange clearinghouses and other services allied with the exchange of securities and commodities.

Major Group 63--Insurance includes insurance carriers of all types.

Major Group 64--Insurance Agents, Brokers, and Service includes agents and brokers dealing in insurance, and also organizations offering services to insurance companies and to policyholders.

Major Group 65--Real Estate includes real estate operators; and owners and lessors of real property, as well as buyers, sellers, developers, agents, and brokers.

Major Group 66--Combinations of Real Estate, Insurance, Loans, and Law Offices includes establishments not classifiable on the basis of predominant nature of business, which are regularly engaged in any combination of real estate, insurance, loans, or the practice of law. However, if any one of these activities constitutes the principal business, the establishment should not be classified in this major group, but should be classified in the industry provided for that activity.

Major Group 67--Holding and Other Investment Offices includes investment trusts, investment companies, holding companies, and commodity trading companies.

Division I

Services

This division includes establishments primarily engaged in providing a wide variety of services for individuals, business and government establishments, and other organizations. Hotels and other lodging places; establishments providing personal, business, repair, and amusement services; health, legal, engineering, and other professional services; educational institutions; membership organizations, and other miscellaneous services, are included.

Major Group 70--Hotels, Rooming Houses, Camps, and Other Lodging Places includes commercial and institutional establishments engaged in furnishing lodging, or lodging and meals, and camping space and camping facilities, on a fee basis.

Major Group 72--Personal Services includes establishments primarily engaged in providing services generally involving the care of the person or his apparel, such as laundries, dry cleaning plants, portrait photographic studios, and beauty and barber shops.

Major Group 73--Business Services includes establishments primarily engaged in rendering services, not elsewhere classified, to business establishments on a fee or contract basis, such as advertising, mailing services; building maintenance services; employment service; management and consulting services; protective services; equipment rental and leasing (except finance leasing); commercial research, development and testing; photofinishing; and personnel supply services.

Major Group 75--Automotive Repair, Services, and Garages includes establishments primarily engaged in furnishing automotive repair, rental, leasing, and parking services to the general public. Similar facilities owned and operated by concerns for their own use and not for the general public are treated as auxiliary establishments and are not included in this group.

Major Group 76--Miscellaneous Repair Services includes establishments engaged in miscellaneous repair services. It does not include such repair services as automotive repair, clothing repair, and shoe repair.

Major Group 78--Motion Pictures includes establishments producing and distributing motion pictures, exhibiting motion pictures in commercially operated theaters, and furnishing services to the motion picture industry. The term "motion pictures" includes similar productions for television or other media using film, tape, or other means.

Major Group 79--Amusement and Recreation Services, Except Motion Pictures includes establishments engaged in providing amusement or entertainment on payment of a fee or admission charge, except motion picture theaters.

Major Group 80--Health Services includes establishments primarily engaged in furnishing medical, surgical, and other health service to persons. Associations or groups primarily engaged in providing medical or other health services to members are included.

Major Group 81--Legal Services includes establishments engaged in offering legal advice or legal services the head or heads of which are members of the bar.

Major Group 82--Educational Services includes establishments furnishing formal academic or technical courses, correspondence schools, commercial and trade schools, and libraries.

Major Group 83--Social Services includes establishments providing social services and rehabilitation services to those persons with social or personal problems requiring special services and to the handicapped and the disadvantaged. Also included are organizations soliciting funds to be used directly for these and related services.

Major Group 84--Museums, Art Galleries, Botanical and Zoological Gardens includes museums, art galleries, and botanical and zoological gardens which are not operated commercially. Receipts or funding of these establishments are not primarily from admission charges. These establishments are of historical, educational, or cultural interest.

Major Group 86--Membership Organizations includes organizations operating on a membership basis for the promotion of the interests of the members. Included are such as trade associations; professional membership organizations; labor unions and similar labor organizations; and political and religious organizations. This major group does not include business establishments operated by membership organizations.

Major Group 89--Miscellaneous Services includes establishments engaged in performing services, not elsewhere classified, such as those rendered by engineers, architects, accountants, artists, lecturers, and writers. This major group also includes noncommercial establishments primarily engaged in educational, scientific, and research activities.

Division J

Public Administration

This division includes the legislative, judicial, administrative, and regulatory activities of Federal, State, local, and international governments. Government-owned and operated business establishments are classified in Major Groups 01-89 according to the activity in which they are engaged.

Major Group 91--Executive, Legislative, and General Government, Except Finance includes offices of executives, legislative bodies, and general government offices, not elsewhere classified.

Major Group 92--Justice, Public Order, and Safety includes government establishments engaged in justice, public order, and safety.

Major Group 93--Public Finance, Taxation, and Monetary Policy includes establishments engaged in public finance, taxation, and monetary policy.

Major Group 94--Administration or Human Resources Programs includes government establishments engaged in the administration of human resources programs.

Major Group 95--Administration of Environmental Quality and Housing Programs includes government establishments engaged in the administration of environmental quality and housing programs.

Major Group 96--Administration of Economic Programs includes government establishments engaged in the administration of economic programs.

Major Group 97--National Security and International Affairs includes government establishments engaged in national security and international affairs.

Division K

Nonclassifiable Establishments

Major Group 99--Nonclassifiable Establishments includes establishments which cannot be classified in any other industry. Establishments which can be classified in a division should be classified in the most appropriate industry within that division.

Source: Executive Office of the President, Office of Management and Budget, Statistical Policy Division, Standard Industrial Classification Manual 1972, Washington, D.C., 1972.

APPENDIX B

STANDARD METROPOLITAN STATISTICAL AREAS

Several tables in the Facts and Trends Book include geographic divisions by Standard Metropolitan Statistical Area (SMSA). The SMSA is a statistical standard used by federal agencies to compile information on metropolitan areas. It is important to understand the definitions and limitations of SMSA data.

The basic criteria for the establishment of an SMSA are extensive. It is based on population within cities (generally 50,000), population density, and certain combinations of contiguous areas. Those definitions are outlined in Standard Metropolitan Statistical Areas 1975*, including loss of designation and special provisions for the New England area.

Data by SMSA is limited when used in time-series. The area of an SMSA is continually changing. There are also changes in the number of SMSAs over time. For example, from 1950 to October of 1975, there were 246 changes made in SMSA, those changes being either additions, deletions, or combinations. As of June 1977, there were 281 designated SMSAs in the United States.

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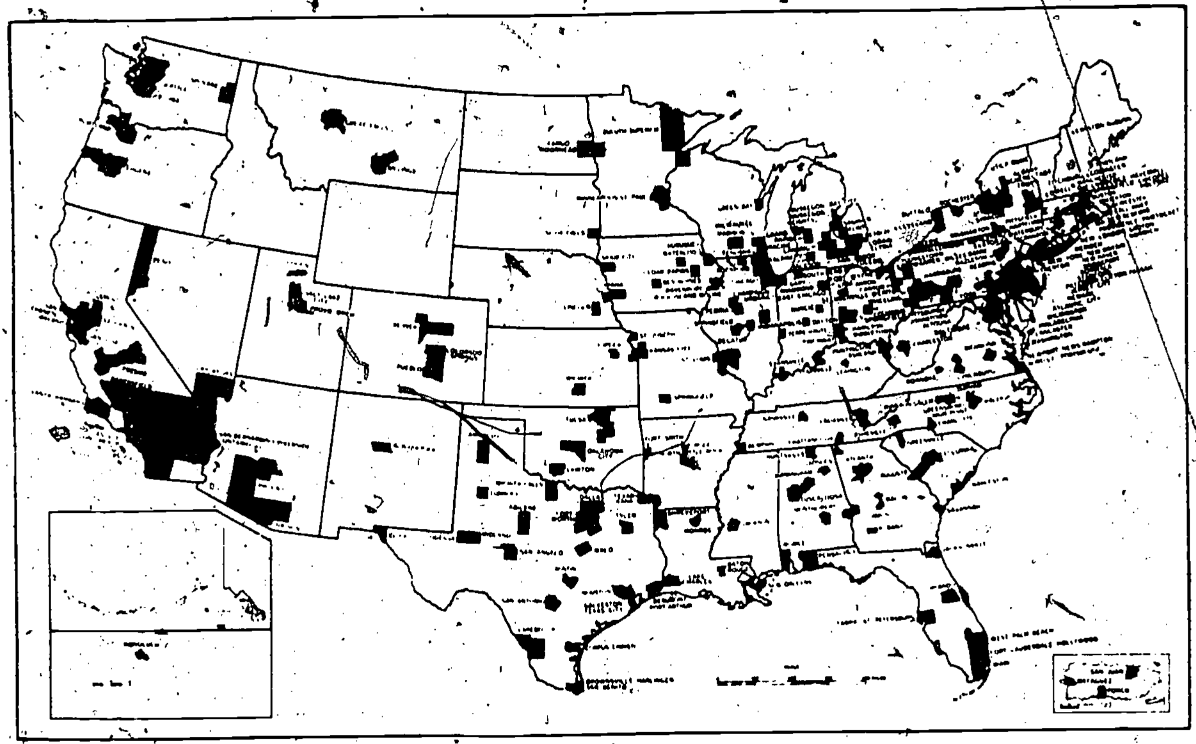
*Source: Executive Office of the President, Office of Management and Budget, Statistical Policy Division, Standard Metropolitan Statistical Areas 1975, Washington, D.C., 1975.

Percent Change in Population of Ten Fastest-Growing SMSAs: 1960 to 1970

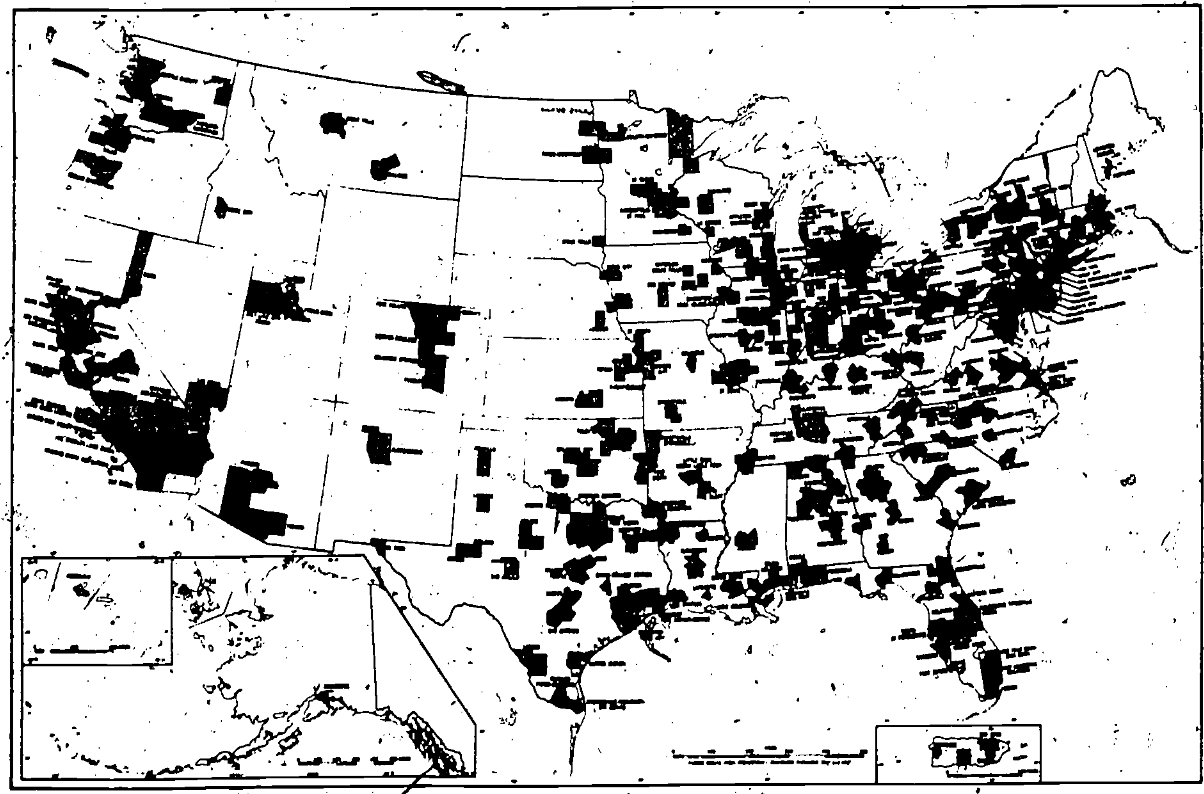
	SMSA	Percent change
1.	Las Vegas, Nev.	115.2
2.	Anaheim-Santa Ana-Garden Grove, Calif.	101.8
3.	Oxnard-Ventura, Calif.	89.0
4.	Fort Lauderdale-Hollywood, Fla.	85.7
5.	San Jose, Calif.	65.8
6.	Colorado Springs, Colo.	64.2
7.	Santa Barbara, Calif.	56.4
8.	West Palm Beach, Fla.	52.9
9.	Huntsville, Ala.	48.3
10.	Nashua, N.H.	47.8

Source: U.S. Department of Commerce, Bureau of the Census, 1970 Census of Population and Housing, United States Summary, PHC(2)-1, Washington, D.C., October 1971, Table D.

Standard Metropolitan Statistical Areas



Areas Defined in 1960



Areas Defined as of June, 1977

Source: Maps prepared by the Geography Division of the Bureau of the Census.

APPENDIX C

CENSUS REGIONS AND DIVISIONS OF THE UNITED STATES

NORTHEAST REGION

New England

Connecticut
Maine
Massachusetts
New Hampshire
Rhode Island
Vermont

Middle Atlantic

New Jersey
New York
Pennsylvania

NORTH CENTRAL REGION

East North Central

Illinois
Indiana
Michigan
Ohio
Wisconsin

West North Central

Iowa
Kansas
Minnesota
Missouri
Nebraska
North Dakota
South Dakota

SOUTH REGION

South Atlantic

Delaware
District of Columbia
Florida
Georgia
Maryland
North Carolina
South Carolina
Virginia
West Virginia

East South Central

Alabama
Kentucky
Mississippi
Tennessee

West South Central

Arkansas
Louisiana
Oklahoma
Texas

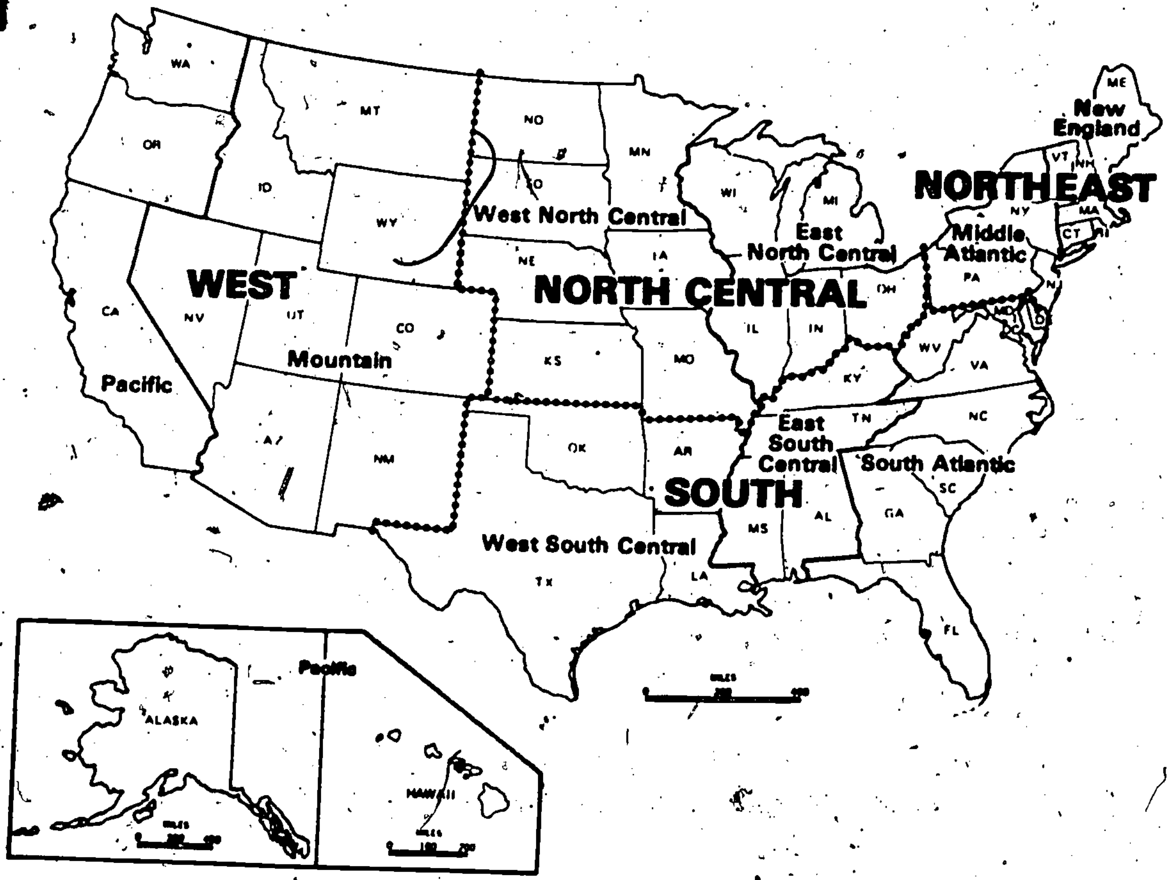
WEST REGION

Mountain

Arizona
Colorado
Idaho
Montana
Nevada
New Mexico
Utah
Wyoming

Pacific

Alaska
California
Hawaii
Oregon
Washington



Source: U.S. Department of Commerce, Bureau of the Census, Annual Housing Survey: 1975, United States and Regions, Part A-General Housing Characteristics, Washington, D.C., April 1977, p. VIII.

APPENDIX D

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Glossary

ABSORPTION RATE: Refers to the amount of time or rate at which units in multifamily buildings are rented.

AIR CONDITIONER, REMOTE CONDENSER: System characterized by a condenser in a separate location and for which each part may be manufactured separately.

AIR CONDITIONER, SINGLE-PACKAGE: Entire system is manufactured as a single unit.

AIR CONDITIONER, SPLIT-SYSTEM: Consists of two or more separate units incorporating different functions.

AIR CONDITIONER, YEAR-ROUND SYSTEM: Capable of both heating and cooling functions.

AIR CONDITIONING: The cooling of air by a refrigeration unit; excluded are evaporative coolers, fans, or blowers that are not connected to a refrigeration unit.

ANTHRACITE: A hard coal containing little volatile matter, low ash and generally having a heating value of 12,000—15,000 Btu/lb.

ATTIC OR ROOF INSULATION: Includes roll or blanket insulation encased in a paper covering, fiberglass batting, and loose insulation which is poured or blown between the attic floor joists.

BITUMINOUS COAL: Ranking of soft coal generally having a heating value of 11,000—14,000 Btu/lb, high in volatile matter and ash.

BOTTLED, TANK OR LP GAS: Gas that is stored in tanks that are refilled or exchanged when empty.

BRITISH THERMAL UNIT (Btu): The amount of heat required to raise the temperature of one pound of water one degree Fahrenheit under stated conditions of pressure and temperature.

BUILT-IN ELECTRIC UNIT: Refers to a space heating system permanently installed in floors, walls, ceilings, or baseboards.

CENTRAL AIR CONDITIONER: A consumer appliance rated below 65,000 Btu/hour that is powered by single-phase electric current. It consists of a compressor and an air cooled condenser assembly and an evaporator or cooling coil, designed to provide air cooling, dehumidifying, circulating, and air cleaning.

CIVILIAN LABOR FORCE: All persons employed or unemployed, excluding members of the Armed Forces.

COAL: All coal including anthracite, bituminous, and lignite.

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COAL GAS: Manufactured gas made by distillation or carbonization of coal in a closed coal gas retort, coke oven, or other vessel.

COMMERCIAL SECTOR (as defined by E. Hirst and J. Jackson, Historical Patterns of Residential and Commercial Energy Uses, Oak Ridge National Laboratory, Oak Ridge, Tenn., September 1976): Those structures in the commercial sector (e.g. office buildings, schools, hospitals, stores) that house the service sector of our economy (e.g. retail and wholesale trade, government enterprises, health services). Included in this category are all nonenergy consumer and government services.

COMMERCIAL SERVICE (as defined by the American Gas Association): Service to customers primarily engaged in wholesale or retail trade, agriculture, forestry, fisheries, transportation, communication, sanitary services, finance, insurance, real estate, personal services (clubs, hotels, rooming houses, five or more households served as a single customer, auto repair, etc.), government, and service that does not directly come in one of the other classifications of service. See Standard Industrial Classification Manual (also Appendix A).

(a) The size of the customer or volume of use is not a criterion for determining Commercial Service. The nature of the customer's primary business or economic activity at the location served determines the customer classification. If a particular load to a manufacturing or processing plant represents the cafeteria of the plant, or a heating load, with or without any processing load, whether or not separately metered, the account is classified as Industrial Service.

(b) Gas supplied to commercial customers for air conditioning or space heating is included under Commercial Service, whether or not supplied under a separate rate contract.

(c) For statistical purposes, Commercial Air Conditioning Service (including any other commercial use under the same rate classification) should be tabulated separately to distinguish this from other types of commercial use. This also applies to gas sold under interruptible or off-peak rates or contracts.

COMMERCIAL AND INDUSTRIAL (as defined by the Edison Electric Institute): A customer, sales, and revenue classification covering energy supplied for commercial and industrial purposes, except that supplied under special contracts or agreements or service classification applicable only to municipalities or divisions or agencies of federal or state governments or to railroads and railways. Usually subdivided into Commercial and Industrial or into Small Light and Power and Large Light and Power. Most companies classify such customers as Commercial or Industrial using the Standard Industrial Classification or predominant kWhr use as yardsticks; others still classify as Industrial all customers whose demands or annual use exceeds some specified limit. These limits are generally based on a utility's rate schedules.

CONSTANT DOLLARS: Computed values that eliminate the effect of price changes. They are computed by dividing current-dollar figures by the corresponding price indexes based on a year specified as 100.

CONSUMER PRICE INDEX (BLS): Issued by the U.S. Department of Labor, Bureau of Labor Statistics, as a measure of average change in the retail prices of goods and services usually bought by the families of wage earners and clerical workers living in cities. It was formerly entitled "Customer's Price Index for Moderate-Income Families in Large Cities Combined."

The national index is the U.S. city average, currently based on 56 areas and separate indexes are available for certain large cities. The index numbers are the mathematically weighted cost of a standard shopping list of goods and services, expressed in percentage of the corresponding average cost of such list in a stated base period. The present indexes are each based on their 1957—1959 average = 100.

CONVENTIONAL FUELS: The fossil fuels: coal, petroleum products, or natural gas.

COOLING DEGREE-DAYS: A measure of the warmness of the weather experienced, based on the extent to which the daily mean temperature rises above a reference temperature, usually 24°C (75°F). For example, on a day when the mean outdoor dry-bulb temperature is 35°C (95°F), there would be 20 degree-days experienced.

CURRENT DOLLARS: Represent dollars in terms of the level of prices prevailing for the specified year.

DAILY MEAN TEMPERATURE: Generally the sum of the high and low temperature readings divided by two.

DEMAND RATES (as defined by the Edison Electric Institute): Any method of charge for electric service that is based upon, or is a function of, the rate of use, or size, of the customer's installation or maximum demand during a given period of time. Different types of demand rates are flat, Hopkinson method, and three part Wright demand. (Additional definitions available in Glossary of Electric Utility Terms, Edison Electric Institute, p. 67.)

DISPOSABLE PERSONAL INCOME: Includes personal income less personal tax and nontax payments.

DISTILLATE FUEL OIL: The lighter fuel oils distilled during the refining process. Included are products shown as ASTM grades Nos. 1 and 2 heating oils, diesel fuels, and No. 4 fuel oil.

ELECTRICAL ENERGY LOSS DISTRIBUTED: The allocation of electricity losses to the final end-use sectors in proportion to their direct kilowatt-hour usage. In generating electricity with nuclear or fossil fuels, approximately 65% of the energy is lost in the form of heat. Transmisssion and distribution losses use an additional 3% or more of the energy inputs of the utility industry. Electrical energy losses are allocated in order to fully account for all energy used both directly and indirectly.

ELECTRICITY DISTRIBUTED: Electricity generated by power plants and transmitted to each sector was distributed on the basis of electricity sales as reported by the Edison Electric Institute. The data were adjusted to the total net generation and net imports of utility electricity production in the United States.

ELECTRICITY AT POINT OF ENTRY: Electric energy calculated at 3412 Btu/kWhr.

END USE ENERGY EFFICIENCY: The efficiency associated with the final use of the energy excluding any distribution, transmission, refining, and other losses incurred in the energy cycle.

ESTABLISHMENT: A single physical location where business is conducted or where services or industrial operations are performed.

EXPANDABLE MOBILE HOME: See MOBILE HOME, EXPANDABLE.

EXTERIOR WALL MATERIAL: The principal type of material covering the exterior wall; the material covering more than half of the exterior wall is considered the principal type.

FAMILY: Consists of the head of household and all other persons living in the same household who are related to the head by blood, marriage, or adoption.

FLOOR, WALL, OR PIPELESS UNIT: Refers to a space heating system which delivers warm air to the room right above the furnace or to the room(s) on one or both sides of the wall in which the furnace is installed.

FOSSIL FUELS: Coal, oil, or natural gas.

FREEZER: A cabinet designed as a unit for the storage of food at temperatures of −18°C (0°F) or below having the ability to freeze food.

FUEL OIL, KEROSINE, ETC.: Includes fuel oil, kerosine, gasoline, alcohol, and other combustible liquids.

FURNACE: A device designed to be the principal heating source for the living space of a residence and having a heat input rate less than 400,000 Btu/hr.

GANG-METERED (MASS METERED): A term used to identify several ultimate customers whose energy use is metered by a single meter.

GAS LIQUIDS: Those liquid hydrocarbon mixtures which are gaseous at reservoir temperatures and pressures, but are recoverable by condensation or absorption. Natural gasoline and liquefied petroleum gases fall into this category.

GOVERNMENTAL UNITS: A government is an organized entity which, in addition to having governmental character, has sufficient discretion in the management of its own affairs to distinguish it as separate from the administrative structure of any other governmental unit. To be counted as a government, any entity must possess all three of the attributes reflected in the foregoing definition: existence as an organized entity, governmental character, and substantial autonomy.

GROSS NATIONAL PRODUCT (GNP): Total value at market prices of all goods and services produced by the nation's economy. As calculated quarterly by the Department of Commerce, gross national product is the broadest available measure of the level of economic activity.

HEAD OF HOUSEHOLD: The household head is the person reported as the head by members of the group, except that married women are not classified as heads if their husbands are living with them at the time of enumeration. One person in each household, family, or subfamily is designated as the "head."

HEATING DEGREE-DAY: A measure of the coldness of the weather experienced, based on the extent to which the daily mean temperature falls below a reference temperature, usually 18°C (65°F). For example, on a day when the mean outdoor dry-bulb temperature is 2°C (35°F), there would be 30 degree-days experienced. A daily mean temperature usually represents the sum of the high and low readings divided by two.

HEAT PUMP: A year-round air conditioning system employing refrigeration equipment in a manner that enables usable heat to be supplied to a space during the winter period and, by reversing the operation cycle, to abstract heat from the same space during the summer period. When operating as a heating system, heat is absorbed from an outside medium (either air, water, or the earth) and this heat, together with the heat equivalent of the work of compression, is supplied to the space to be heated. When operating on the cooling cycle, heat is absorbed from the space to be cooled and this heat, together with the heat equivalent of the work of compression, is rejected to the outside medium.

HEAT RATE: A measure of generating station thermal efficiency, generally expressed in Btu per net of kilowatt-hour. It is computed by dividing the total Btu content of fuel burned for electric generation by the resulting net kilowatt-hour generation.

HEAVY OIL: Heavy, thick, and viscous, usually refinery residuals commonly specified as grades 5, 6 and Bunker C.

HOME HEATING EQUIPMENT NOT INCLUDING FURNACES: Vented home-heating equipment and unvented home-heating equipment.

HOUSEHOLD: Consists of all the persons who occupy a housing unit; includes the related family members and all unrelated persons, if any, who share the housing unit.

HOUSING UNIT, ONE-UNIT ATTACHED: Housing unit with one or more walls extending from ground to roof separating it from adjoining units.

HOUSING UNIT, ONE-UNIT DETACHED: Structure is detached from any other housing unit, that is, with open space on all four sides. Such units are considered detached even if they have an adjoining private garage or contain a business unit.

HOUSING UNIT, SINGLE-FAMILY: Includes both one-family attached and one-family detached structures.

HOUSING UNIT, TWO OR MORE: A structure containing two or more housing units.

HOUSING UNITS: A house, an apartment, a group of rooms, or a single room occupied or intended for occupancy as separate living quarters. Separate living quarters are those in which the occupants do not live and eat with any other persons in the structure and which have either (1) direct access from the outside of the building or through a common hall which is used or intended to be used by the occupants of another unit or by the general public, or (2) complete kitchen facilities for the exclusive use of the occupants. The occupants may be a single family, one person living alone, two or more families living together, or any other group of related or unrelated persons who share living arrangements.

HYDROELECTRIC: A type of generating station or power or energy output in which the prime mover is driven by water power.

IMPLICIT PRICE DEFLATOR: The ratio of a particular economic indicator (e.g., GNP) in current dollars to constant dollars.

INDUSTRIAL SERVICE (as defined by the American Gas Association): Service to customers engaged primarily in a process which creates or changes raw or unfinished materials into another form or product. This includes establishments in mining and manufacturing. See Standard Industrial Classification Manual.

1. The size of the customer or volume of use is not a criterion for determining Industrial Service. The nature of the company's primary business or economic activity at the location served determines the classification used. If a manufacturing corporation has only a sales office (no plant) at a particular location, this is classified as Commercial Service on the basis of primary activity. If, however, the sales office is part of a manufacturing plant, this is classified as Industrial Service.

2. Gas supplied to these customers for air conditioning or for space heating is included under Industrial Service, whether or not supplied under a separate rate contract.

3. For statistical purposes, Industrial Air Conditioning Service (including any other industrial use under the same rate classification) should be tabulated separately to distinguish this from other types of industrial use. This also applies to gas sold under interruptible or off-peak rates or contracts.

INTERNAL COMBUSTION ENGINE: A prime mover in which energy released from rapid burning of a fuel-air mixture is converted into mechanical energy. Diesel, gasoline, and gas engines are the principal types in this category.

KEROSINE: A petroleum distillate in the 149°C (300°F) to 288°C (550°F) boiling range and generally having a flash point higher than 38°C (100°F) by ASTM Method D 56, a gravity ranging from 40° to 46° API, and a burning point in the range of 66° (150°F) to 79°C (175°F).

LARGE LIGHT AND POWER: See COMMERICAL AND INDUSTRIAL.

LIGHT OIL: Generally, all oils lighter than residual fuel oils No. 5 and No. 6. Oils that have a low specific gravity, usually products of controlled distillation of crude oil but also including by-product benzol and toluol.

LIQUEFIED GAS (LNG): Natural gas that has been liquefied by reducing its temperature to —127°C (260°F) at atmospheric pressure. It remains a liquid at 47°C (116°F) and 637 PSIG. In volume it occupies 1/600 of the gas in the vapor state.

LIQUEFIED PETROLEUM GAS: A gas containing certain specific hydrocarbons which are gaseous under normal atmospheric conditions but can be liquefied under moderate pressure at normal temperatures. Propane and butane are the principal examples.

METER RATES: Any method of charge for electric service based solely upon quantity, such as kilowatt hours used. Different types of meter rates are as follows:

BLOCK — A certain specified price per unit is charged for all or any part of a block of such units, and reduced prices per unit are charged for all or any part of succeeding blocks of such units, each such reduced price per unit applying only to a particular block or portion thereof.

STEP — A certain specified price per unit is charged for the entire consumption, the rate or price depending on the particular step within which the total consumption falls.

STRAIGHT LINE — The price charged per unit is constant, i.e., does not vary on account of an increase or decrease in the number of units consumed.

METROPOLITAN POPULATION: Population living within Standard Metropolitan Statistical Areas. (See Appendix B)

MIDDLE DISTILLATES: The Energy Information Administration's Mandatory Petroleum Allocation Regulations define middle distillates in Section 211.51 as:

> "any derivatives of petroleum, including kerosene, home heating oil, range oil, stove oil, and diesel fuel, which have a fifty percent boiling point in the ASTM D86 standard distillation test falling between 371°F and 700°F. Products specifically excluded from this definition are kerosene-base and naphtha-base jet fuel, heavy fuel oils as defined in VV-F-815C or ASTM D-396, grades #4, 5 and 6, intermediate fuel oils (which are blends containing #6 oil), and all specialty items such as solvents, lubricants, waxes and process oil."

The definition of middle distillates in Section 212.31 of the Mandatory Petroleum Price Regulations reads as follows:

> "Nos. 1 and 2 heating oils, Nos. 1-D, 2-D, and 4-D diesel fuels, No. 4 fuel oil, and kerosene and aviation fuels."

MOBILE HOME AND TRAILER: A movable housing unit to which a permanent foundation, porch and/or shed may be affixed; if one or more rooms have been added, the mobile home or trailer becomes classified as a single-family house.

MOBILE HOME, EXPANDABLE: Single-wide mobile home that has an additional room added when the mobile home is put on its site. The room is shipped with the mobile home unit.

MULTIFAMILY BUILDING: A structure containing two or more housing units.

MUNICIPALITY: Defined by the Federal Power Act as a city, county, irrigation district, drainage district, or other political subdivision or agency of a state competent under the laws thereof to carry on the business of developing, transmitting, utilizing, or distributing power.

NAPHTHA: Any of various volatile often flammable liquid hydrocarbon mixtures used chiefly as solvents and dilutents and as raw materials for conversion to gasoline and substitute natural gas (SNG).

NATIONAL INCOME: The aggregate earnings of labor and property which arise in the current production of goods and services by the nation's economy.

NATURAL GAS: A naturally occurring mixture of hydrocarbon and non-hydrocarbon gases found in porous geologic formations beneath the earth's surface, often in association with petroleum. The principal constituent is methane.

NATURAL GAS LIQUIDS: Products obtained from natural gasoline plants, cycling plants, and fractionators after processing the natural gas. Included are ethane, liquefied petroleum (LG) gases (propane, butane, and propane-butane mixtures), natural gasoline, plant condensate, and minor quantities of finished products such as gasoline, special naphthas, jet fuel, kerosene, and distillate fuel oil.

NATURAL INCREASE: The excess of births over deaths per 1,000 of the population.

NET GROWTH RATE: Natural increase rate (births minus deaths) plus the net legal immigration rate.

NET IMMIGRATION: Total U.S. in-migration minus out-migration.

NET NATIONAL PRODUCT: Includes gross national product less capital consumption allowances.

NONMETROPOLITAN POPULATION: Population living outside Standard Metropolitan Statistical Areas.

OIL GAS: A gas resulting from the thermal decomposition of petroleum oils, composed mainly of volatile hydrocarbons and hydrogen. The true heating value of oil gas may vary between 800 and 1600 Btu/ft^3 depending on the operating conditions and feedstock properties.

ONE-FAMILY ATTACHED: See HOUSING UNIT, ONE-UNIT ATTACHED.

ONE-FAMILY DETACHED: See HOUSING UNIT, ONE-UNIT DETACHED.

ONE-UNIT ATTACHED HOUSING UNIT: See HOUSING UNIT, ONE-UNIT ATTACHED.

ONE-UNIT DETACHED HOUSING UNIT: See HOUSING UNIT, ONE-UNIT DETACHED.

OTHER FUEL: Includes any other fuel such as briquettes made of pitch and sawdust, or coal dust, corncobs, or purchased steam.

OTHER PUBLIC AUTHORITIES: A customer, sales, and revenue classification covering electric energy supplied to municipalities or divisions or agencies of federal or state governments (as ultimate customers) under special contracts or agreements or service classifications applicable only to public authorities, except such items as are includable in the classifications Public Street and Highway Lighting, Sales to Railroads and Railways, and Sales for Resale.

OTHER SERVICES: Service to municipalities or divisions (agencies) of state or federal governments under special contracts or agreements or service classifications, which are applicable only to public authorities using gas for general or institutional purposes. (Excludes sales such as manufacturing arsenals or publicly owned power systems.) Also includes sales by the gas department to other departments of a combination company.

PERMIT-ISSUING PLACE: Local building permit office.

PERSONAL INCOME: The current income received by persons from all sources net of contributions for social insurance.

PETROELUM: Defined by the Federal Energy Administration and the Bureau of Mines as including the following:

- Gasoline
  - Motor gasoline
  - Aviation gasoline
- Jet fuel, total
  - Naphtha-type
  - Kerosine-type
- Ethane (including ethylene)
- Liquefied gases
- Kerosine
- Distillate fuel oil
- Residual fuel oil
- Petrochemical feedstocks
- Special nathphas
- Lubricants
- Wax
- Coke
- Asphalt
- Road oil
- Still gas
- Miscellaneous products
- Plant condensate

PRICE ELASTICITY OF DEMAND: The ratio of percent change in demand to percent change in price $\left(\frac{\partial d}{\partial p} \cdot \frac{p}{d}\right)$.

PRIMARY ELECTRIC ENERGY: Energy required to generate, transmit, and distribute a given amount of electricity.

PRIME MOVER: The engine, turbine, water wheel, or similar machine that drives an electric generator.

PRIME SOURCE ENERGY EFFICIENCY: The efficiency of a unit including generation, distribution, and transmission losses.

PRIVATE HOUSING: Units built by private developers.

PROPANE (C_3H_8): A gaseous member of the paraffin series of hydrocarbons which, when liquefied under pressure, is one of the components of LPG. Contains approximately 2,500 Btu/ft^3 [at 16°C (60°F) and 30" mercury] or equivalently 91,740 Btu per gallon.

PROVISIONAL: A preliminary estimate: The preferable estimate, when available, is the revised estimate.

PUBLIC HOUSING: Generally refers to public housing by various federal, state, and local agencies for particular housing and construction programs.

PUBLICLY OWNED ELECTRIC UTILITY: Defined by the Federal Power Commission as electric utilities operated by municipalities (as defined by the Federal Power Act) and federal power agencies.

Defined by the Edison Electric Institute to indicate class of ownership. It includes municipally owned electric systems and federal and state public power projects. Cooperatives are not included in this grouping.

"R" FACTOR: A measure of a material's resistance to heat flow in units of Fahrenheit degrees per Btu/(hour)(square foot).

$$\left[\frac{\text{Fahrenheit hr ft}^2}{\text{Btu}}\right]$$

RATE SCHEDULE: The accepted forms of electric rates may be divided into two main classes, and each of these classes into several different types of rates, as follows:

Demand Rates	Meter Rates
Flat Demand	Block
Hopkinson Demand	Step
Three Part	Straight-Line or Flat kWhr
Wright Demand	

See also DEMAND RATES AND METER RATES.

REFRIGERATION UNIT: Unit used for lowering the thermal energy content of a given medium.

REFRIGERATOR: A cabinet designed for the refrigerated storage of food above 0°C (32°F). A compartment for storage at temperatures below 0°C (32°F) but above –13°C (8°F) may be included. A refrigerator has only one exterior door but interior doors and compartments may be available.

REFRIGERATOR-FREEZER: A cabinet that consists of two or more compartments with at least one of the compartments designed for the refrigerated storage of foods at temperatures above 0°C (32°F) and with at least one of the compartments designed for the freezing of and the storage of frozen foods at temperatures of –13°C (8°F) or below.

REMOTE CONDENSER AIR CONDITIONER: See AIR CONDITIONER, REMOTE CONDENSER.

RESIDENTIAL (as defined by the Edison Electric Institute): A customer, sales, and revenue classification covering electric energy supplied for residential (household) purposes. The classification of an individual customer's account where the use is both residential and commercial is based on principal use.

RESIDENTIAL SECTOR (as defined by E. Hirst and J. Jackson, Historical Patterns of Residential and Commercial Energy Uses, Oak Ridge National Laboratory, Oak Ridge, Tenn., September 1976): Those structures (single-family units, apartments, trailers) occupied by households.

RESIDENTIAL SERVICE (as defined by the American Gas Association):

1. Without Space Heating

Service to customers supplied for residential purposes (cooking, water heating, kitchen heating, where another fuel is the principal heat for premises, etc.) by individual meter in a single family dwelling or building, or in an individual flat or apartment, or to not over four households served by a single meter (one customer) in a multiple family dwelling, or portion thereof. Service for residential purposes supplied to five or more households served as a single customer (one meter) under one rate classification contract is considered as commercial and is counted as only one customer.

Residential premises also used regularly for professional or business purposes (such as a doctor's office in a home, or where a small store is integral with the living space) are considered as residential where the residential use is half or more of the total gas volume; otherwise, these are commercial.

Dormitories, hotels, religious and eleemosynary institutions (such as orphan homes), boarding and rooming houses, motor courts, camps, etc., are considered as commercial customers for statistical purposes even though they are supplied by the company on a residential rate contract.

2. With Space Heating

Service to customers using natural gas to supply the principal space heating requirements of a dwelling; other residential uses are included herein if supplied under the same rate classification.

3. Air Conditioning Service

Service to customers using gas to supply the principal air cooling requirements of a dwelling; other residential uses (cooking, water heating, etc.) are included in this classification if supplied under the same rate classification. These customers will be included under items (1) or (2) above, as appropriate so that the sum of (1) and (2) will be Total Residential Service. However, for statistical purposes, "Residential Air Conditioning Service" (including any other residential use) should also be tabulated separately to distinguish this from other types of residential service.

RESIDENTIAL/COMMERCIAL SECTOR: Defined by the Energy Information Administration and Bureau of Mines as consisting of housing units, nonmanufacturing business establishments (e.g. wholesale and retail businesses) health and educational institutions, and government office buildings.

RESIDUAL FUEL OIL: The heavier oils that remain after the distillate fuel oils and ligher hydrocarbons are boiled off in refinery operations. Included are products known as ASTM grades Nos. 5 and 6 oil, heavy diesel oil, Navy Special Oil, Bunker C oil, and acid sludge and pitch used as refinery fuels. Residual fuel oil is used for the production of electric power, for heating, and for various industrial purposes.

ROOM AIR CONDITIONER: An encased assembly designed as a unit for mounting in a window or through the wall for the purpose of providing delivery of conditioned air to an enclosed space. It includes a prime source of refrigeration and may include a means for ventilating and heating.

ROOM HEATERS WITH FLUE: Include circulating heaters, convectors, radiant gas heaters, and other nonportable heaters that burn gas, oil, kerosine, or other liquid fuels, and which are connected to a flue, vent, or chimney to remove smoke and fumes.

ROOM HEATERS WITHOUT FLUE: Include any room heater (not portable) that burns gas, oil, or kerosine and which is not connected to a flue, vent or chimney.

SATURATION, APPLIANCE OR CUSTOMER: The number of specified appliances, or users, divided by the basic units or total potential of the universe involved, i.e., Gas Heating Saturation related to customers is the total number of customers with space heating divided by the total number of customers.

SERVICE TO OTHER UTILITIES — SALES FOR RESALE (Uniform System of Accounts): Service to other utility companies, governmental agencies (municipal, county, state or federal), rural cooperatives, etc., for distribution and resale to ultimate customers. Service to other utilities for use by them and not for distribution and resale, is to be classified as residential, commercial, or industrial, depending upon the primary business or economic activity.

SIC: Standard Industrial Classification (see Appendix A).

SINGLE-FAMILY HOUSING UNIT: See HOUSING UNIT, SINGLE-FAMILY.

SINGLE-PACKAGE AIR CONDITIONER: See AIR CONDITIONER, SINGLE-PACKAGE.

SPLIT-SYSTEM AIR CONDITIONER: See AIR CONDITIONER, SPLIT-SYSTEM.

SMALL LIGHT AND POWER: See COMMERCIAL AND INDUSTRIAL.

STEAM OR HOT WATER: Refers to a central heating system in which heat from steam or hot water is delivered through radiators or other outlets.

STORM DOOR: An additional door placed outside an ordinary outside door for protection against severe weather or to serve as an insulating factor for conservation.

STORM WINDOWS OR OTHER PROTECTIVE WINDOW COVERING: A sash placed outside an ordinary window as a protection against severe weather or to serve as an insulating factor for conservation. Included in this category are protective window coverings such as double-glazed glass, closeable shutters, or plastic.

SUBBITUMINOUS COAL: Ranking of soft coal generally having a heating value of 8,300—13,000 Btu/lb, high volatile matter and ash.

SUBSTITUTE NATURAL GAS (SNG): A gas manufactured from carbonaceous material whose characteristics are substantially interchangeable with natural gas. The resultant gas is composed primarily of methane. At this writing, SNG feedstocks are the light hydrocarbons, propane, butane and the naphthas. Development is underway of processes for production from heavier feedstocks and from coal.

TENURE: A term used by the Bureau of the Census to denote type of occupancy. A housing unit may be either "owner occupied" (if the owner or co-owner lives in the unit) or "renter occupied" (if the unit is rented for cash rent or occupied without payment of cash rent).

THERMAL RESISTANCE: See "R" FACTOR.

TONNAGE (as relevant to refrigeration): One ton is equivalent to 12,000 Btu/hour. This measure is the heat content of one ton of ice.

TOTAL FERTILITY RATE: The sum of the age-specific birth rates over all ages of the childbearing period.

TWO OR MORE HOUSING UNITS: See HOUSING UNIT, TWO OR MORE.

UNITARY AIR CONDITIONER: Consists of one or more factory-made assemblies that normally include an evaporator or cooling coil, a compressor and condenser combination, and may include a heating function as well. Where such equipment is provided in more than one assembly, the separated assemblies are to be designed to be used together.

UNITS ADDED BY NEW CONSTRUCTION (as defined in the Annual Housing Survey): A housing unit built in April 1970 or later. Vacant units under construction at the time of enumeration were enumerated only if construction had proceeded to a point that all exterior windows and doors were installed and final usable floors were in place. Housing units built during this period but removed from the housing inventory before enumeration are not reflected.

UNITS LOST THROUGH DEMOLITION OR DISASTER: A housing unit in a structure that existed in April 1970 and was torn down on the initiative of a public agency or as a result of action on the part of the owner is classified as a unit lost through demolition. Structures destroyed by fire, flood, or other causes are classified as units lost through disaster. A housing unit is counted as a demolition or disaster loss when the whole structure in which it was located was lost from the inventory.

UNITS LOST THROUGH OTHER MEANS: Any housing unit that existed in April 1970 and the entire structure in which it was located was lost to the housing inventory through means other than demolition or disaster. This component includes the following types of losses:

1. Units lost by change to group quarters.
2. Units lost from the inventory because they are vacant and unfit for human habitation. A unit is unfit for human habitation if the roof, walls, doors, and windows no longer protect the interior from the elements.
3. Vacant units lost from the inventory because there is positive evidence (sign, notice, mark on the house or block) that the units are scheduled for demolition or rehabilitation or that they are condemned for reasons of health or safety so that further occupancy is prohibited.
4. Units lost by change to nonresidential use.

5. Units moved from site since April 1970. Such moves in the same area do not necessarily result in a net loss from the total inventory since they presumably represent units added in the place to which they were moved.

UNVENTED HOME HEATING EQUIPMENT: A class of home heating equipment, not including furnaces, used for the purpose of furnishing heat to a space proximate to such heater directly from the heater and without duct connections and includes electric heaters and unvented gas heaters.

URBAN AREAS: Includes people directly within a central city and those living in adjacent cities of 25,000 population and above.

UTILITY GAS: Gas that is piped through underground pipes from a central system and serves a neighborhood.

VACANT HOUSING UNITS (as defined in the Annual Housing Survey): A housing unit in which no one is living at the time of enumeration, unless its occupants are only temporarily absent. In addition, a vacant unit may be one which is occupied entirely by persons who have a usual residence elsewhere.

VENTED HOME HEATING EQUIPMENT: A class of home heating equipment, not including furances, designed to furnish warmed air to the living space of a residence, directly from the device without duct connections (except that boots not to exceed 10 inches beyond the casing may be permitted).

WARM-AIR FURNACE: Refers to a central system which provides warm air through ducts leading to various rooms.

WATER HEATER: An automatically controlled thermally insulated vessel designed for heating water and storing heated water which utilizes either oil, natural gas, or electricity as the fuel or energy source for heating the water, which is designed to produce hot water at a temperature of less than 82°C (180°F). For the purpose of the Energy Conservation Program for Appliances, the following size and power bounds apply.

Electric water heaters:	energy input rate	≤ 12 kW
	voltage	≤ 250 V
	storage capacity	20 ≤ C ≤ 120
Gas water heaters:	energy input rate	≤ 75,000 Btu/hr
	storage capacity	20 ≤ C ≤ 100
Oil water heaters:	energy input rate	≤ 103,875 Btu/hr
	storage capacity	≤ 50

YEAR-ROUND AIR CONDITIONLNG SYSTEM: See AIR CONDITIONER, YEAR-ROUND SYSTEM.

YEAR-ROUND HOUSING UNITS: All occupied units plus vacant units which are intended for year-round use.

Permuted Title Index

Notations:

- # indicates the beginning of the title
- * indicates the end of the title

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Keyword Index

Bibliography

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Abrahamsson, D.E. (ed.); Essinga, S. (ed.); Saulter, K.J.; Lawrence, C.W.; Achenbach, P.R.; Rauenhorst, G.; Stein, R.G.; Dubin, F.S.
Minnesota Univ., All-University Council on Environmental Quality; Minnesota Univ., School of Public Affairs
Address: 967 Social Sciences Building, Minneapolis, MN 55455
Energy Conservation: Implications For Building Design and Operation

Proceedings of a Conference held in Bloomington, Minnesota, May 23, 1973, 156 p.
1973
Sponsor: Minnesota Univ.; Upper Midwest Council; Minnesota Society of Architects
Abstract: The conference opened with a discussion of energy supply and demand, with some comments on future availability and prices of energy, by Mr. Kenneth J. Saulter, Staff Economist with the Ford Foundation's Energy Policy Project. Mr. Charles W. Lawrence, Public Utilities Specialist, Office of the Mayor, New York City, described the results of a study of energy consumption in existing commercial buildings in New York City. He also described means to affect the energy use in existing buildings. The next speaker, Mr. Paul Achenbach, Chief, Building Environment Division of the National Bureau of Standards discussed the several projects involving energy use and building design and operation currently underway in the National Bureau of Standards and in agencies and groups with which the National Bureau of Standards is closely working. Mr. Achenbach emphasized means and methods to influence energy consumption, and means to determine, and minimize, the energy use of buildings over their lifetimes. The luncheon speaker was Mr. Gerald Rauenhorst, President, the Rauenhorst Corporation, Minneapolis, Minnesota, a very successful developer. Mr. Rauenhorst discussed, in a candid and forthright manner, the way in which he evaluates the energy use implications of the various decisions faced by a developer. The afternoon speakers were Mr. Richard G. Stein, FAIA, and Mr. Fred Dubin, PE. Mr. Stein, of Richard G. Stein and Associates, New York City, presented the options available to the architect to influence energy use. Mr. Dubin, President, Dubin-Mindell-Bloome Associates of New York City, presented the range of options and implications which face the engineer. The discussion sessions which followed the speakers were recorded and are included in these proceedings. (Auth, from Introduction)
Availability: University of Minnesota $5.00

Achenbach, P.R.
U.S. Dept. of Commerce, National Bureau of Standards
Address: Washington, DC 20234
NBS Research in Support of Energy Conservation Standards for Buildings

Published in Proceedings of the 10th Intersociety Energy Conversion Engineering Conference, held in Newark, Delaware, August 17, 1975, 57 p.
Jun 1975
Abstract: Initiation of an energy conservation program for buildings revealed that, until very recently, buildings and the mechanical and electrical equipment installed therein have been designed for low first cost, with little attention given to energy cost. Current efforts to draft energy conservation standards for buildings showed that neither the energy conservation potential nor the life-cycle costs of many well-known energy conservation techniques are established. The research program of the National Bureau of Standards on energy conservation in buildings is presented in overview, and selected projects are discussed in some detail to show the types of information being developed in the laboratory, and in full-scale field studies of new and existing buildings. Additional research needs for energy standards purposes are identified. (8 references) (auth)
Availability: Center for Building Technology, National Bureau of Standards; whole conference: Institute of Electrical and Electronic Engineers, Inc., 345 E. 47th St., New York, NY 10017 $50.00

Achenbach, P.R.
U.S. Dept. of Commerce, National Bureau of Standards, Institute for Applied Technology, Center for Building Technology
Address: Washington, DC 20234
Effective Energy Utilization in Buildings

Paper presented at the Third Urban Technology Conference, Boston, MA, 18 p.
Sep 1973
Abstract: Local shortages of gas, oil, and electrical energy have occurred for brief periods of time in the last year or two. Steps must be taken to prevent a worsening of this situation in the near future. Design engineers believe that the energy use in new residential and commercial buildings could be reduced by 50% without increasing life-cycle costs and without reduction in standard of living if known concepts for energy conservation in the design, construction, and operation of buildings were put into effect. Significant savings could also be attained in existing buildings by retrofitting. A major program on energy conservation technology has been undertaken at the National Bureau of Standards covering laboratory and field studies, analysis of occupant needs and practices, measurement techniques, economic analysis of energy conservation concepts, and the mechanisms for implementation of cost-effective building practices. The NBS program is described briefly, together with additional opportunities for energy conservation. The probable effects of energy conservation on building and urban design are suggested. (16 references) (auth)

Ackerman, A.D.; Hogarth, P.T.; Burke, B.J.; Stone, R.F.
ABT Associates Inc.
Address: 55 Wheeler Street, Cambridge, MA 02138
Cost-Effective Methods to Reduce the Heating and Cooling Energy Requirements of Existing Single-Family Residences

Report No. PB-241919, AAI-75-19, v.p.
Feb 1975
Sponsor: U.S. Dept. of Housing and Urban Development, Office of Policy Development and Research, Division of Building Technology and Safety
Abstract: This publication has three main purposes: (1) to be a quick reference guide for professionals engaged in the renovation of existing single-family residential structures; (2) to permit the building professional to determine the cost effectiveness of different energy-conserving retrofit measures as applied to particular houses in particular locations; and (3) to establish in the building professional a high level of awareness about the economic facts of energy-conserving retrofit. (From Note to the Building Professional)
Availability: NTIS

Acton, J.P.; Graubard, M.H.; Weinschrott, D.J.
Rand Corp.
Address: Santa Monica, CA 90406
Electricity Conservation Measures in the Commercial Sector: The Los Angeles Experience

Report No. R-1592-FEA, 66 p.
Sep 1974
Sponsor: Federal Energy Administration, Office of Energy Conservation and Environment
Abstract: The impact of the energy situation of the winter of 1973-74 on commercial establishments in Los Angeles is analyzed. A city ordinance was passed to curtail residential use by as much as 12% and commercial use by as much as 33% with a penalty of a 50% surcharge on the entire bill for excess use. [illegible]uctions in use were greater than tha[illegible]anded by the ordinance. The reasons for the adjustments in electricity consumption as well as specific measures taken to reduce consumption are reported. Some general comments are made concerning the applicability of the findings of this study to other areas. (BLM)

AIA Research Corp.; Robert G. Werden & Associates Inc.; Burt, Hill & Associates
Address: AIA, 1735 New York Ave. NW, Washington, DC 20036
Energy Conservation Design Guidelines for New Office Buildings. Second Edition

310 p.
1975
Sponsor: General Services Administration, Public Buildings Service
Abstract: Revised guidelines for including energy conservation factors in the design of office buildings add two new concepts: computer software programs for analyzing energy conservation and available solar energy technology. Intended for architects and engineers, this reference book covers methods of setting energy goals, setting design criteria, working with the climate and site, and includes detailed notes on design and construction for efficient energy use. Checklists of conservation opportunities and suggestions for setting priorities cover site selection, construction, lighting, power, heating, ventilating, air conditioning, domestic water, vertical transportation, solid waste, and operation and maintenance. (149 references) (DCK)
Availability: Public Buildings Service, General Services Administration, Washington, DC 20405
$2.00

American Gas Association
Address: 1515 Wilson Boulevard, Arlington, VA 22209
American National Standard for Gas Water Heaters. Volume I, Automatic Storage Type Water Heaters with Inputs of 75,000 Btu Per Hour or Less

ANSI Z21.10.1-1974, 66 p.: with Addenda ANSI Z21.10.1a-1975, 11 p.
1974
Sponsor: American National Standards Institute Inc.
Abstract: In this publication a basic standard is provided for safe operation, substantial and durable construction, and acceptable performance of automatic storage type gas water heaters with inputs of 75,000 Btu per hour or less. This standard refers to water heaters for use with natural gas, manufactured gas, mixed gas, liquefied petroleum gases, or LP gas-air mixtures, and for installation in mobile homes or recreational vehicles. (BYB)

American Gas Association, Dept. of Statistics
Address: 1515 Wilson Blvd., Arlington, VA 22209
Gas Facts, a Statistical Record of the Gas Utility Industry

Annual publication, v.p.
Abstract: These publications contain both current and historical information and related data about the gas utility industry. The gas utility industry includes all regulated distribution and transmission companies and excludes producers. Statistics for the given year and summary data for earlier years are shown. Five year summary data from 1945 are also included for comparative analysis. These issues of Gas Facts are comprised of at least twelve sections and a glossary of terms relative to the gas industry. The sections are arranged to follow the standard sequence of the industry's operations. The first section serves as an overall review of the year and those events affecting the gas industry most importantly. The subsequent sections detail current and historical data pertinent to the industry and encompasses reserves, production, transmission and distribution, storage, customers, sales and revenues. The remaining sections pertain to financial information, construction, labor, prices, and appliance data trends. All data are relevant to the operations of a segment of the gas utility industry as it existed during any year in question. Accordingly, time series analysis is not completely valid for comparison with individual company statistics over a period of years. The number and size of companies included in a given segment of the industry has varied from one year to another, according to A.G.A. definitions as explained in the Glossary. (from Introduction)
Availability: American Gas Association, Catalog No. F10175 for 1975 data

American Gas Association, Dept. of Statistics
Address: 1515 Wilson Blvd., Arlington, VA 22209
Historical Statistics of the Gas Utility Industry, 1966 - 1975

209 p.
1977
Abstract: This publication contains historical statistics of the gas utility industry and includes sections on: energy reserves, production, underground storage, transmission and distribution, energy consumption, customers, sales, revenues, prices, appliance data, finance, and personnel data. Data presented in the individual Gas Facts for the years 1966 through 1975 are provided in this document, along with summary data for the period 1950 through 1975. (BYB)

American Institute of Architects
Address: 1735 New York Avenue NW, Washington, DC 20006
A Nation of Energy Efficient Buildings by 1990

20 p.
Abstract: In this report a national program is proposed by the American Institute of Architects (AIA) to achieve energy savings from constructing energy efficient buildings and retrofitting existing buildings to be energy efficient. It is shown how the proposed program is economically, financially, and administratively feasible. The capital investment required to make current and new buildings energy efficient will result in both energy and dollar savings. Key recommendations are as follows:

(1) the U.S. should begin an intensive program to make the nation's buildings efficient by 1990; (2) operational plans should be made to conduct at least six national demonstrations on energy efficient buildings; (3) the AIA will offer coordinative leadership; and (4) support for this program is called for from other building design professions and associations, the President of the U.S., Federal departments and agencies, governors and state governments, and the private sector. (BYB)
Availability: AIA Free

American National Standards Institute Inc.
Address: 1430 Broadway, New York, NY 10018
American National Standard for Household Automatic Electric Storage-Type Water Heaters

ANSI C72.1-1972 (Revision of C72.1-[illegible]9), 11 p.
1972
Abstract: The purpose of this standard is to provide users and manufacturers with a reference standard for the best use and production of household automatic electric storage-type water heaters, that have 1) a rated volumetric capacity of not less than 30 nor more than 120 gallons, 2) a rated input of 12,000 watts or less, and 3) a rated voltage of 250 V ac or less. Covered in this standard are definitions, methods of test, performance, function, durability, safety, rating, nameplate marking, informative labeling, and installation practices. (BYB)

American Society of Heating, Refrigerating and Air-Conditioning Engineers Inc.
Address: 345 East 47th St., New York, NY 10017
ASHRAE Handbook of Fundamentals

688 p.
1972
Abstract: This handbook contains fundamental theory and basic data pertaining to heating, refrigerating, air conditioning, and ventilating. The handbook consists of seven sections with the following titles: Theory, General Engineering Data, Basic Materials, Load Circulations, Duct and Pipe Sizing, General (Terminology, Abbreviations and Symbols, Units and Conversion Factors), and Basic Tables (Physical Properties of Materials, Refrigerant Tables and Charts, Psychrometric Tables, Weather Data and Design Conditions). (MPG)
Availability: ASHRAE

American Society of Heating, Refrigerating and Air-Conditioning Engineers Inc.
Address: 345 East 47th St., New York, NY 10017
ASHRAE Guide and Data Book, Applications, 1971

825 p.
1971
Abstract: This handbook presents information on the use of various components, units, and systems to provide specific conditions for a particular building or as required for a process, such as food refrigeration. The handbook consists of six sections with the following titles: Air-Conditioning and Heating Applications - Comfort; Air-Conditioning and Heating Applications - Special and Process; Food Refrigeration; Distribution [illegible] Chilled and Frozen Food; Low Temperature Applications; and Industrial Applications of Refrigeration. (MPG)
Availability: ASHRAE

American Society of Heating, Refrigerating and Air-Conditioning Engineers Inc.
Address: 345 East 47th St., New York, NY 10017
ASHRAE Standard: Energy Conservation in New Building Design

ASHRAE Standard No. 90-75, 53 p.
1975
Abstract: This Standard sets forth design requirements which will improve the efficiency of energy use in buildings. Sections are included on the exterior envelope of buildings; the heating, ventilation, and air conditioning (HVAC) systems; HVAC equipment; service water heating; electrical distribution systems; lighting power budget determination procedure; energy requirements for building designs based on systems analysis; and requirements for buildings utilizing solar, wind, or other non-depleting energy sources. (35 references) (BYB)
Availability: ASHRAE Circulation Sales Dept., 345 E. 47th St., New York, NY 10017 $20.25

American Society of Heating, Refrigerating and Air-Conditioning Engineers Inc.
Address: 345 East 47th Street, New York, NY 10017
ASHRAE Handbook and Product Directory: 1975 Equipment

v.p.
1975
Abstract: The 1975 Equipment volume, which is one of four volumes of the ASHRAE Handbook and Product Directory (formerly ASHRAE Guide and Data Book), is a comprehensive, up-to-date source of reference data on air conditioning, heating, ventilating, and refrigerating. The Technical Data section will be revised every four years. Information is provided on available types and capacities; principles of operation, construction, performance, testing, and rating; selection considerations; and other data on components and assemblies used to perform a specific function. The document is organized into these sections: I, Air Handling Equipment; II, Refrigeration Equipment; III, Heating Equipment; IV, General Components; V, Unitary Equipment; and VI, General. The Product Directory section, which will be updated annually, lists addresses for approximately 5000 manufacturers and product categories (over 1300) under which the various manufacturers are listed. A section on Branch Offices and Representatives of Advertisers and a comprehensive list of Engineering Societies and Trade Associations are included. The Catalog Data section (to be revised each year) illustrates products of leading manufacturers and contains essential information on modern equipment. Also included in this volume are a complete index to all current volumes of the Handbook series, and the 1972 ASHRAE Handbook of Fundamentals. (BYB)
Availability: $42.00

American Society of Heating, Refrigerating and Air-Conditioning Engineers Inc., Subcommittee for Heating and Cooling Loads
Address: 345 E 47th St., New York, NY 10017
Procedure for Determining Heating and Cooling Loads for Computerizing Energy Calculations: Algorithms for Building Heat Transfer Subroutines

Energy Calculations 1. 185 p.
Feb 1975
Abstract: Fundamentals of heating and cooling load calculation procedures are described in relation to detailed heat transfer equations

among interior surfaces and air in the building. The discussion includes several simplified and approximate procedures such as the Carrier storage load factor method, ASHRAE time averaging technique and weighting factor method. Step-by step calculation procedures to determine essential elements of heating and cooling loads, such as conduction heat transfer, air infiltration, solar heat gain, heat storage, psychrometric properties of air, and sunlit area of the exterior surfaces, are given in view toward assisting an engineer to write his own computer programs. (auth)
Availability: $10.00

Anderson, K.P.
Rand Corp.
Address: Santa Monica, CA 90406
Residential Energy Use: An Econometric Analysis

Report No. R-1297-NSF, 80 p.
Oct 1973
Sponsor: National Science Foundation, RANN Program
Abstract: Recent studies of residential gas and electricity demands have a number of persistent weaknesses: (1) The interdependencies between household demand for one type of energy source and that for competing energy sources have not been adequately accounted for in the specification of the models and in the estimation procedures. (2) The list of competing energy price variables included in a given energy demand equation is usually restricted to a single energy type, despite the possible importance of other such prices. (3) The price elasticity estimates obtained leave one in doubt as to the nature of responses to price and, in particular, to the role of inter-fuel substitution compared with the role of alterations in usage rates or the size, efficiency, and features of new and renovated equipment. ... Since the solution to this problem bears both upon the methodology of energy demand estimation and upon the evaluation of policies affecting energy price, this report seeks to provide some helpful clues. A second and equally important goal is to provide a more comprehensive statistical picture of residential energy demand behavior than has been available in the past. ... The equations estimated for this report fall into two classes: those for predicting stocks of energy-using equipment and those for predicting energy consumption. The equations for equipment stocks provide information about the relative importance of fuel choice in the overall responsiveness of residential energy consumption to price. (from Introduction)

Anderson, K.P.
Rand Corp.
Address: Santa Monica, CA 90406
The Price Elasticity of Residential Energy Use

Paper No. P-5180, 21 p.
Feb 1974
Abstract: The long-run elasticity of household energy consumption with respect to price can be expressed as the sum of a usage-level and a fuel-choice elasticity. Using 50-state data for 1960 and 1970, this study describes procedures for estimating mean values for both total elasticity and its two components. The procedures involve the estimation of equations for predicting stocks of energy-using equipment by energy type as well as equations for predicting energy consumption. For "own-prices," the resulting estimates suggest a mean usage-level elasticity of about one-third for electricity and (less certainly) utility gas and a mean fuel-choice elasticity of about 0.8 for electricity and 1.7 for gas. Mean cross-price elasticities vary depending on the energy type and price considered. (13 references) (auth)

Applied Nucleonics Company Inc., Energy Division
Address: 1701 Colorado Avenue, Santa Monica, CA 90404
Guide to Energy Conservation Literature

Vol. III, No. 1, v.p.
Apr 1977
Abstract: The Guide consists of a bibliography on fuel conservation and efficient use of energy. The documents cited include technical and scientific journal articles, popular and trade journal articles, newspaper articles, bibliographic publications, published and unpublished reports and symposia papers, symposia proceedings, monographs, public documents, and books. Each citation lists the title, author, publication description, institution or corporate author, and category and key words, which describe the document's subject matter. These indexes are provided: Category, Key Word, Author, and Institution/Corporate Indexes. Definitions of the key words as they are used in this bibliography are given. (600 references) (EYB)
Availability: $25.00

Associated Universities Inc.
Address: Upton, NY 11973
Reference Energy Systems and Resource Data for Use in the Assessment of Energy Technologies

Report No. AET-8, 135 p.
Apr 1972
Sponsor: Executive Office of the President, Office of Science and Technology
Abstract: The Office of Science and Technology is directing an extensive assessment of new energy technologies in order to identify the most promising set of R&D options. This report presents a reference set of data related to the energy system and a framework for carrying out the assessment. The demand for energy has been projected in twenty-seven end-use categories. Conservative assumptions are made regarding the implementation of new technologies and Reference Energy Systems have been constructed for the years 1969, 1977, 1985, 2000, and 2020. These reference systems show the energy flows through the system, the efficiencies involved, and the consumption of resources. Summaries are presented of energy resources and the first-order environmental impacts of energy use. When applied to the Reference Energy Systems, these data indicate the total resource and environmental impact of energy use in the future. A new energy technology can be evaluated by substituting that technology for appropriate elements of the reference systems and calculating the net change in resource and environmental impacts. This combination of information thus serves as a means of evaluating the potential benefits to be gained by research in various energy technologies. (82 references) (auth)

Association of Home Appliance Manufacturers
Address: 20 North Wacker Drive, Chicago, IL 60606
AHAM Standards

Abstract: These standards, which are adopted voluntarily by AHAM's members, are designed to eliminate misunderstanding between manufacturers and consumers and to help the consumer in purchasing home appliances. These Standards are published: Dehumidifiers, Self-Contained, Electrically Operated, Mechanically Refrigerated (DH-1, American National Standard B149.1-1972); Household Electric Ranges (ER-1, ANS C71.1-1972); Household Electric Ranges with Glass/Ceramic Cooking Tops (ER-2, ANS C71.1a-1975); Cleaning Performance of Household Electric Ranges with One or More Pyrolytic Self-Cleaning Ovens (ER-3, ANS C71.1b-1975); Test Method for Measuring Energy Consumption of Household Tumble Type Clothes Dryers (HLD-2EC); Performance Evaluation Procedure for Household Washers (HLW-1, ANS Z224.1-1971); Test Method for Measuring Energy Consumption of Household Clothes Washers (HLW-2EC); Test Procedure to Determine the Freezer Temperature and Energy Consumption of Household Refrigerators, Combination Refrigerator-Freezers, and Household Freezers (HRF-Z-ECPT); Household Electric Dishwashers (DW-1, ANS A197.5-1975); Appliance Humidifier Standard (HU-1, ANS Z235.1-1972); Humidifier Application Standard (HU-1A); Room Air Conditioner Standard (RAC-1, ANS Z234.1-1972); Room Air Conditioner Sound Rating Standard (RAC-2SR); Plumbing Requirements for Home Laundry Equipment (HLW-2PR, ANS A197.2-1973); Plumbing Requirements for Household Dishwashers (DW-2PR, ANS A197.1-1973); Plumbing Requirements for Household Food Waste Disposer Units (FWD-2PR, ANS A197.3-1973); Standard Methods of Measuring Household Food Waste Disposer Performance (FWD-1, ANS A197.4-1974); and Performance Evaluation Procedure for Household Trash Compactors (TC-1, ANS A197.7-1976). (BYB)

Availability: All Standards are $1.00 each for the first 3 copies of the same Standard; additional copies are $0.35 each

---

Association of Physical Plant Administrators of Universities and Colleges, Energy Project Office

A Feasibility Study on the Impact of Agencies and Codes on University and College Energy Use. Volume I: Executive Summary. Volume II: Source Data

Report No. TID-27629-P1P1, 27 p. for Volume I; Report No. TID-27629-P1P2, 155 p. for Volume II

Mar 1977

Sponsor: Energy Research and Development Administration, Division of Buildings and Community Systems

Abstract: This feasibility study was conducted to determine the impact of agencies and organizations which review and apply codes and standards to new construction and major renovation projects affecting colleges' and universities' ability to use and conserve energy. ... A questionnaire was prepared, setting forth two theoretical models (Major Building exceeding $2,000,000, and a Major Renovation exceeding $100,000), and was used as a basis for information gathering. The program involved a survey of four representative states: (1) California--moderate climate, West Coast; (2) Maryland--moderate climate, East Coast; (3) Michigan--cold climate/heating region, North; and (4) Texas--warm climate/cooling region, South. Within each state, four institutions were analyzed, one from each of the following types: (1) two year public community or junior college; (2) four year public college; (3) public university; and (4) four year private college/university. The recommendations and conclusions of the survey are contained in the Executive Summary, Volume I. The Source Data are set forth in Volume II. (16 references) (from Program Objective)

Availability: NTIS

Atelsek, F.J.; Gomberg, I.L.
American Council on Education
Address: One Dupont Circle, Washington, DC 20036

Energy Costs and Energy Conservation Programs in Colleges and Universities: 1972-73, 1974-75

Higher Education Panel Reports, No. 31, 47 p.

Apr 1977

Sponsor: National Science Foundation; U.S. Dept. of Health, Education, and Welfare, Office of Education; U.S. Dept. Of Health, Education, and Welfare, National Institutes of Health; Energy Task Force

Abstract: Based on a survey in which 533 colleges and universities responded, increases in energy costs in these institutions between academic year 1972-1973 and academic year 1974-1975 are detailed, and energy conservation programs are described. Between these two years, total energy costs rose 70%, from $555 million to $944 million, but total energy consumption decreased 6%, from 4.25 billion therms to 4.01 billion therms. During this period the largest increase in per-unit cost occurred for oil (163%), followed by coal (126%), gas (64%), and electricity (57%). In both academic years natural gas accounted for 45% of the total energy consumed; electricity and oil about 20%; and coal approximately 10%. Colleges and universities in the East and South suffered the greatest increases in total energy costs (94% and 84%, respectively). The Midwest and West experienced smaller increases (48% and 40%, respectively). The energy costs per student rose 57%, from $79 to $124. Three types of conservation programs are defined: "quick fix," involving obvious measures that provide significant energy savings at little cost; "refit," involving engineering analysis and moderate amounts of capital investment; and "systems convert," involving major changes in systems and design and substantial capital investment. Most of the institutions surveyed have implemented quick fix measures which could be put into effect by the physical plant manager, but have not implemented quick fix practices that require the cooperation of the institutional community. Although most respondents felt that refit measures should be implemented further, few reported significant progress in this area. Only one in five institutions has upgraded its boiler/chiller plants by converting to alternate fuel sources. About 50% of the respondents reported holding interruptible gas contracts; 44% of these experienced some curtailment during 1974-1975. (BYB)

Availability: Higher Education Panel, American Council on Education, One Dupont Circle, Washington, DC 20036

Austin, A.L.; Winter, S.D.
Lawrence Livermore Laboratory
Address: Livermore, CA 94550

U.S. Energy Flow Charts for 1950, 1960, 1970, 1980, 1985, and 1990

Report No. UCRL-51487, 18 p.

16 Nov 1973

Sponsor: U.S. Atomic Energy Commission

Abstract: Energy flow charts for the U.S., showing the origin and disposition of energy for the years 1950, 1960, 1970, 1980, 1985, and 1990, are presented along with a discussion of their development and the implications of the data they represent. An appendix describes the construction of one chart in detail, serving as an example of the method. (Auth)

Availability: NTIS

Balachandran, S.
Illinois Univ., Library
Address: Urbana, IL 61801
Energy Statistics: A Guide to Sources

Council of Planning Librarians Exchange
Bibliography No. 1065, 51 p.
Jun 1976
Abstract: Books and periodical publications providing statistical data on energy have in recent years mushroomed tremendously, in response, no doubt, to the increasing demand from people involved in research on various aspects of energy. This publication is an attempt to compile a selected and annotated guide to 169 national and international sources of statistics covering all forms of energy such as coal, electricity, natural gas, nuclear power, petroleum, solar and other miscellaneous types. While each of these forms are dealt with separately and in considerable detail, the first section covers composite sources, i.e. sources whose coverage extends to all forms of energy. Within each section, the arrangement is strictly alphabetical. Other useful features of this guide are a subject index and directory of publishers. (from Introduction)
Availability: Council of Planning Librarians,
P.O. Box 229, Monticello, IL 61856 $5.00

Balachandran, S.
Illinois Univ., Library
Address: Urbana, IL 61801
Energy Statistics: An Update to Bibliography No. 1065

Council of Planning Librarians Exchange
Bibliography No. 1247, 22 p.
Mar 1977
Abstract: Citations to 80 publications containing energy data are presented in this bibliography. The types of statistics covered in each source are described. A subject Index is provided. (BYE)
Availability: Council of Planning Librarians,
P.O. Box 229, Monticello, IL 61856 $2.00

Ball, S.J.
Oak Ridge National Laboratory, Instrumentation and Controls Division
Address: Oak Ridge, TN 37830
Experimental Investigation of Retrofit Options for Mobile Homes

Report No. ORNL/CON-9, 34 p.
Mar 1977
Sponsor: Energy Research and Development Administration, Division of Buildings and Industry; Federal Energy Administration
Abstract: A mobile home located in Oak Ridge, Tennessee, was tested to determine its energy-use characteristics for both space heating and cooling. The main objective was to determine the energy savings that can be achieved by the addition of retrofit items such as storm windows, skirting, and extra insulation and how these savings vary with weather conditions. Analyses of space heating data show that energy savings approaching 50% can be achieved, but analyses of space cooling data were inconclusive. (2 references) (auth)
Availability: NTIS

Basile, P.S. (ed.); Wilson, C.L.
Energy Demand Studies: Major Consuming Countries. Analyses of 1972 Demand and Projections of 1985 Demand

First Technical Report of the Workshop on Alternative Energy Strategies held October 1974, MIT Press, Cambridge, MA, ISBN 0-262-23076-3, 567 p.
1976
Sponsor: National Science Foundation
Abstract: The Workshop on Alternative Energy Strategies (WAES), which first convened in October 1974, is an ad hoc, international project with over 75 participants from 15 countries. This first technical report of WAES presents projections of energy demand to the year 1985 and detailed 1972 energy demand data for 13 countries (Canada, Denmark, Finland, France, German Federal Republic, Italy, Japan, Mexico, the Netherlands, Norway, Sweden, the United Kingdom, and the U.S.). Energy demand projections are made under five different scenarios based on a number of factors, including economic growth, energy prices, and national energy policy. Part I of this volume contains an Introduction and Overview, the Workshop Methodology, and a Summary of the National Demand Studies. In Part II each chapter covers one country and includes an overview section; a methodology section; an analysis section; and a section containing summary tables and detailed worksheets with economic, efficiency, and energy-use data for all sectors (transportation, industry, commercial, public, and residential). (BYB)
Availability: MIT Press

Batey, J.; Gazerro, V.; Salzano, F.J.; Berlad, A.L.
Brookhaven National Laboratory
Address: Upton, NY 11973
Energy Management in Residential and Small Commercial Buildings. Annual Report, Fiscal Year 1976

Report No. BNL 50576, 60 p.
Jul 1976
Sponsor: Energy Research and Development Administration
Abstract: The goal of the present program is to develop the technical basis for efficient energy use in space heating of residential and small commercial buildings. Part One of the report describes efficiency measurements performed on conventional residential oil-fired hot water heating equipment, including both steady state and cyclic (part load) efficiency determinations. A list of preliminary recommendations for retrofit actions to improve efficiency is provided at the end of Part One. A summary of work carried out in the areas of thermal storage media, fenestration, and building thermal dynamics is presented in Part II. (9 references) (auth)
Availability: NTIS

Baughman, M.L.; Joskow, P.L.
Massachusetts Institute of Technology, Energy Laboratory
Address: Cambridge, MA
Progress Report on Energy System Modeling - Interfuel Competition

Report No. PB-239292, 24 p.
Feb 1974
Sponsor: National Science Foundation, RANN Program
Abstract: The Energy System Modeling program is addressing issues of interfuel substitution on the national and state level. This is being done via the construction of policy planning tools that can be used for analysis and evaluation of policies that impinge upon the economics and investment strategies of suppliers and/or consumers of various energy producing and consuming subsectors. The steps involved in such a process include 1. the development of conceptual models; 2. the

identification of data needs and estimation of the models; 3. an assessment of the model validity; 4. testing and using the model for prediction and policy analysis to see that it actually has the desired capabilities, and finally, 5. implementation of the model use and results. This paper discusses the approach (Section II), the progress to date (Section III), and the future direction of the effort (Section IV) in this program. (auth, from Introduction)
Availability: NTIS

Baughman, M.L.; Joskow, P.L.
Massachusetts Institute of Technology
Address: Cambridge, MA
The Effects of Fuel Prices on Residential Appliance Choice in the United States

Land Economics, 51(1), pp. 41-49 (Feb. 1975)
Feb 1975
Abstract: The effect of fuel prices on fuel choice decisions made by residential consumers is estimated for space heating, water heating, cooking, and clothes drying. These energy usage categories account for about 80% of the energy consumed in the residential sector of the U.S. A model is developed to analyze the appliance alternatives. It is concluded that fuel prices are an important factor in appliance choices. These results imply that possibilities for fuel switching in the residential and commercial sectors should not be overlooked when formulating energy policy. (13 references) (BYB)

Baughman, M.L.; Joskow, P.L.
Massachusetts Institute of Technology, Energy Library
Energy Consumption and Fuel Choice by Residential and Commercial Consumers in the United States

Report No. MIT-EL 75-024, 31 p.; a paper with the same title was presented at the Conference on Energy Modeling and Forecasting, Berkeley, CA, June 28, 1974
20 May 1975
Abstract: The authors specify and estimate a model of total energy consumption in the residential and commercial sectors in the United States, and the distribution of energy consumption among the three energy sources used extensively there: gas, oil, and electricity. In their conceptualization of the fuel-choice decision, the consumer decision-making process is composed of two steps: (1) the consumer decides on a level of energy using services that he desires based on the price of energy, the prices of other goods and services, and household income (this decision defines the expected level of energy that will be consumed); and (2) the consumer then seeks to find a combination of fuels that will provide these sources most cheaply. Obviously, this two-step procedure is not completely recursive in reality, but has strong simultaneities associated with it. ... The first section of the paper sets up the basic model that is used for estimation. ... Section Two presents estimates of the parameters of this model based on time series-cross section data for 49 states for 1965--1972. The third section uses these estimated relationships to make projections of total energy consumption and fuel usage for the residential and commercial sector based on five possible scenarios of the future of individual fuel prices. Changing relative energy prices (relative to the prices of other goods and services and relative to each other) has profound effects on the level of energy consumption and its distribution among fuels. (20 references) (from Introduction)

Baughman, M.L.; Joskow, P.L.; Zerhoot, F.S.
Massachusetts Institute of Technology, Energy Laboratory
Address: Cambridge, MA 02139
Interfuel Substitution in the Consumption of Energy in the United States. Part I: Residential and Commercial Sector

Report No. MIT-EL 74-002, 90 p.
25 May 1974
Sponsor: National Science Foundation, RANN Program
Abstract: Results for the determinants of energy consumption in the residential and commercial sector in the United States are presented. First, a discussion of the conceptual model used for fuel choice decisions is presented. Then, empirical results are given for appliance choices in the residential sector for four selected appliances and for the "fuel-split" of aggregate energy consumption among the three fuels used in the residential and commercial sector. The own-price and cross-price elasticities are estimated and discussed. Next, the paper discusses the determinants of total energy demand in the residential and commercial sector and presents empirical results for a simple flow adjustment model. The long run price elasticity of total demand in this sector is estimated to be about 0.5, while the short run (one year) value is -0.15. Finally, the estimated relationships are used to make projections to 1980 for alternative price scenarios. These results show that significant consumption responses to changing fuel prices can be expected and, further, that some states are much more dramatically impacted than others. (10 references) (auth)
Availability: NTIS

Beausoliel, R.W.; Beese, W.J.; Yonemura, G.
U.S. Dept. of Commerce, National Bureau of Standards, Institute for Applied Technology, Center for Building Technology
Address: Washington, DC 20234
Modification of Fluorescent Luminaires for Energy Conservation

Report No. COM-75-11365, NBS TN-886, 18 p.
Oct 1975
Sponsor: Federal Energy Administration
Abstract: Reducing energy consumption in existing buildings by reducing the number of lamps presents technical problems when more than one fluorescent lamp operates from a single ballast. A preliminary investigation was made whereby capacitors were substituted for one fluorescent lamp in a two-lamp luminaire which operated with a single ballast. Under optimum conditions, lighting efficiency (foot-candles per watt) was nearly as high at reduced power input as it was with two lamps operating normally. No failures in lighting equipment or capacitors occurred and no fire hazards, other safety hazards, or other unsatisfactory occurrences were observed. A more thorough investigation involving a number of parameters is needed to ascertain the feasibility of this modification. (auth)
Availability: NTIS; also available from GPO $0.65, SD Cat. No. C13.46:886

Beller, M. (ed.)
Brookhaven National Laboratory
Address: Upton, NY 11973
Sourcebook for Energy Assessment

Report No. BNL-50483, 204 p.

Dec 1975
Sponsor: Energy Research and Development
Administration, Office of the Assistant
Administrator for Planning and Analysis
Abstract: An analytical approach is presented which is broadly applicable to the assessment of energy technologies and policies. Use of the Reference Energy System approach permits the examination of the economic, environmental, and resource implications resulting from the substitution of one fuel or technology for another. Included as tools for such analyses are the necessary data and methodology, as well as a set of Reference Energy Systems (i.e., network representations of the major components of the energy system for given years specifying resource consumption, fuel transportation, conversion processes, and end uses) covering the 1972-2020 period to serve as baselines for the perturbation analyses of interest. (71 references) (auth, abstract modified)
Availability: NTIS

Berg, C.A.
U.S. Dept. of Commerce, National Bureau of
Standards, Institute for Applied Technology
Address: Washington, DC 20234
Conservation via Effective Use of Energy at the
Point of Consumption

Report No. NSF/BA/N-73-180, paper presented at NSF Conferency "Energy: Demand, Conservation, and Institutional Problems," held at Massachusetts Institute of Technology, February 12-14, 1973, published in proceedings, Macrakis, M.S. (ed.), pp. 467-482
1974
Sponsor: National Science Foundation, RANN Program
Abstract: Methods of conserving energy at the point of consumption are explored. Some examples of opportunities for improving effectiveness of energy consumption in buildings are discussed under three general areas: design (including insulation, fenestration, selection of heating and ventilating equipment, etc.): construction practices in implementing design; and occupant practices in using buildings. Industrial energy consumption has not been studied thoroughly. Many fairly simple measures, such as plugging leaks in air and steam lines and furnishing steam at the required temperatures and pressures, could result in considerable energy conservation. Data are cited to support the belief that the practices and equipment used in various industries could be substantially improved to conserve energy, and—in many cases the improvements would be economically justified. Additional information on ways to conserve energy coupled with more effective technology of materials and machinery should result in substantial energy savings in both the residential and industrial sectors. (16 references) (BLM)
Availability: MIT Press, Cambridge, MA $25.00
for entire proceedings

Berlad, A.L.; Lin, H.C.; Batey, J.; Salzano,
F.J.; Yu, W.S.; Hoppe, B.J.; Allen, T.
Brookhaven National Laboratory, Dept. of Applied
Science; State Univ. of New York, College of
Engineering and Applied Sciences
Address: BNL, Upton, NY 11973; SUNY, Stony
Brook, NY 11794
Seasonal Performance and Energy Costs of Oil or
Gas-Fired Boilers and Furnaces

Report No. BNL 50647, 63 p.
Mar 1977
Sponsor: Energy Research and Development
Administration
Abstract: The seasonal operating cost of a small oil or gas-fired boiler or furnace depends upon the intrinsic merits of the device itself, the appropriateness of its capacity and cycle characteristics to the imposed load conditions, the weather characteristics and heat loss characteristics of the building being heated, and the control philosophy employed. The current study provides the bases for comparing quantitatively the seasonal operating costs of various specific space heating and/or domestic hot water systems, as influenced by the device specifics and device interaction with the space conditioned system that it serves. The resulting formalism is applied to various space heating systems. Quantitative cost comparisons are presented. (6 references) (auth)
Availability: NTIS

Berman, M.B.; Graubard, M.H.
Rand Corp.
Address: Santa Monica, CA 90406
A Model of Residential Electricity Consumption

Paper No. P-5063, paper presented at the Operations Research Society's National Meeting in San Diego, November 12-14, 1973, 41 p.
Jul 1973
Sponsor: National Science Foundation, RANN
Program; California State Assembly
Abstract: This paper examines the impact of price increases of electricity on different income classes of consumers in the residential sector. Residential electricity consumption in Los Angeles in 1970-1971 is analyzed to provide estimates of electricity use by income class. Future consumption of electricity in the residential sector of Los Angeles is estimated, with and without electricity price increases. Several ways to mitigate the effects of the price increases on low-income groups are discussed. (27 references) (MEG)

Berry, S.A. (ed.)
U.S. Dept. of Commerce, National Bureau of
Standards, Institute for Applied Technology,
Center for Building Technology, Office of
Building Standards and Code Services:
National Conference of States on Building
Codes and Standards
Address: DOC, Washington, DC 20234
Emergency Workshop on Energy Conservation in
Buildings. National Conference of States on
Building Codes and Standards and National
Bureau of Standards Joint Emergency Workshop
on Energy Conservation in Buildings Held at
the U.S. Department of Commerce, Washington,
DC, on June 19, 1973

Report No. COM-75-10766, NBS-TN-789-1, 31 p.
Jul 1975
Abstract: This report contains the non-technical presentations given at the National Conference of States on Building Codes and Standards/National Bureau of Standards Joint Emergency Workshop on Energy Conservation in Buildings. Presentations included in this document are those of other Federal Agencies, States, technical societies and industry organizations. This document is a companion document to NBS Technical Note 789, "Technical Options for Energy Conservation in Buildings." (GBA)
Availability: NTIS; also available from GPO, SD
Catalog No. C13.46:789-1

Bhagat, N.; Jones, H.G.M.
Brookhaven National Laboratory, Dept. of Applied
Science, Energy Policy Analysis Group
Address: Upton, NY 11973
Simulation of Residential Energy Use and Its
Dependence on Land Use and Economic Parameters

Report No. BNL-19307, Paper presented at the meeting of the Operations Research Society of America/The Institute of Management Science in San Juan, Puerto Rico, October 16-18, 1974, 32 p.
1974
Sponsor: National Science Foundation, RANN Program
Abstract: The present energy crisis has introduced a new dimension to land use planning. To be feasible, a land use plan must be developed with energy supply and associated environmental effects included as constraints. This paper discusses the simulation of residential energy consumption and its dependence on land use planning variables like housing type, size of house, and family income. (11 references) (auth)
Availability: NTIS

Booz, Allen & Hamilton Inc.
Address: 4733 Bethesda Ave., Bethesda, MD 20014
An Evaluation of the Economics and Efficiencies
of Heat Pump and Gas Furnace Space
Conditioning Systems Using Coal as a Primary
Source of Fuel

v.p.
Aug 1976
Sponsor: Energy Research and Development Administration, Division of Buildings and Industry Conservation
Abstract: The cost and efficiency of three alternative space conditioning systems are evaluated and compared. The systems under study are: (1) a gas heat pump fueled by a substitute natural gas (SNG) derived from coal; (2) an electric heat pump with electricity supplied through coal-fired power generation; and (3) a conventional gas furnace fueled by SNG. A mathematical model representing the costs of each system is developed to determine cost and efficiency of alternative systems. A sensitivity analysis considers the variability that could occur in important factors for each system and determines the impact of this variability on costs and efficiencies. No one system is found to have a clear economic or efficiency advantage in all locations or under all operating conditions. This document is organized into four chapters: Overview and Summary of Findings; Methodology for Evaluation of Alternative Space Conditioning Systems; Sample Application of the Methodology to a Specific Climatic Region; and Sensitivity of Results to Changes in Key Parameters (e.g., Region, Fuel Costs). Appendices are included on heat pumps (definition and operation), environmental impacts associated with the conversion of coal to SNG and to electricity, comparison of alternative end-use device financing strategies, and input variables used in illustrative applications of the model. (38 references) (BYB)

Booz, Allen Applied Research, a Division of Booz, Allen & Hamilton Inc.
Address: 4733 Bethesda Ave., Bethesda, MD 20014
Comparison of the Assumptions, Methodologies and
Conclusions of Three Residential Space
Conditioning System Studies

v.p.
Nov 1976
Sponsor: Energy Research and Development Administration, Office of Conservation, Division of Buildings and Community Systems
Abstract: This report compares the results, assumptions, and methodologies of three studies which analyze the relative costs and energy efficiencies of electric and gas residential space conditioning systems. The studies are: "An Evaluation of the Economics and Efficiencies of Heat Pump and Gas Furnace Space Conditioning Systems Using Coal as a Primary Source of Fuel," by Booz, Allen & Hamilton Inc., August 1976; "Comparative Space Heating Costs for Gas and Electricity," by Northern Natural Gas Company (NNG), March 1976; and "A Fossil Fuel Choice--To Manufacture Gas or Generate Electricity," by Pacific Gas and Electric Company (PG&E), February 23, 1976. Each of these studies has differing conclusions. This document tries to explain why there are differences and also pinpoints the important factors that should be taken into consideration in studying alternative space conditioning systems. It is noted that a large number of important data assumptions and detailed statements of methodologies used in the NNG and PG&E studies were not contained in the report documents available for use in this analysis. (BYB)

Brainard, J.; Davitian, H.; Goettle, R., IV;
Palmedo, P.F.
Brookhaven National Laboratory, National Center
for Analysis of Energy Systems, Policy
Analysis Division
Address: Upton, NY 11973
A Perspective on the Energy Future of the
Northeast United States

Report No. BNL 50550, 220 p.
Jun 1976
Sponsor: Energy Research and Development Administration, Division of Biomedical and Environmental Research
Abstract: The past and present energy supply and demand patterns for the United States and the Northeast region are reviewed. On the basis of detailed analyses of present and possible future supply and demand activities, scenarios for the years 1985 and 2000 are constructed and compared. Economic and environmental consequences are also discussed. The principal findings are: (1) conservation measures can reduce fuel and resource requirements in the Northeast by over 30%; (2) oil imports are likely to continue to be a major energy resource for the Northeast; (3) a shift to coal and other alternate energy supplies, coupled with increased conservation, could compensate for a curtailment in the use of nuclear power in the region; (4) new resource technologies are capable of supplying up to 20% of the region's energy requirements in 2000; and (5) no single supply technology or single conservation strategy taken alone can reduce the region's increasing dependence on foreign oil. Rather, the creation of an acceptable energy system for the region will require efforts in many directions in terms both of reducing demand and developing reliable, diversified supplies. (44 references) (auth, abstract modified)
Availability: NTIS

Brookhaven National Laboratory
Address: Upton, NY 11973
Balanced Program Plan: Analysis for Biomedical
and Environmental Research. Volume 7.
Conservation and Energy Efficiency

Report No. ERDA-116(Vol. 7), Pt. I and II,
BNL-21823, 209 p.
Jul 1975
Sponsor: Energy Research and Development

Administration, Division of Biomedical and Environmental Research

Abstract: Energy conservation technologies encompass the entire spectrum of human activities: electrical supply; industry, commercial and residential buildings, transportation and various overlapping combinations of these. This report is concerned with those conservation technologies which appear to be most important in the near and intermediate terms. Many of the specific R & D programs are contained in the preliminary "Conservation Program Plan" of the ERDA Assistant Administrator for Conservation. However, some projects are included which are supported by other Federal agencies and private industry. Section 1 contains a brief description of each conservation technology and an enumeration of health/safety/environmental impacts, both beneficial and adverse, which are expected to accrue from the new technology. Section 2 contains a brief discussion of problems, priorities and programs. Section 3 contains "Problem Definitions" and "Program Units" which are recommended to become a part of the "BER Balanced Program Plan." The need for assessments which will permit a cost/benefit analysis of each ERDA-sponsored R & D project is emphasized. Most conservation technologies will have net beneficial environmental impact. Often the decision whether or not to support a particular R & D proposal will depend on a detailed cost/benefit evaluation. (30 references) (from Summary)

Availability: NTIS

Brundrett, G.W.
Electricity Council Research Centre
Address: Capenhurst, Cheshire, UK
Some Effects of Thermal Insulation on Design

Applied Energy, 1(1), pp. 7-30 (Jan. 1975)
Jan 1975

Abstract: An understanding of insulation standards will encourage customers to accelerate conservation through thermal insulation and increase personal comfort at the same time. Comparison of insulation indexes shows that design day heat loss based on floor area is the best index for both the designer and client. Individual room temperature control with insulation between rooms will increase efficiency. Double glazing of windows offers moisture control and increased comfort. Insulation and weather stripping decrease heat loss by ventilation leaks, but a major loss is sustained when windows are opened in mild weather. Incidental sources of heat (appliances, solar heat through windows, water heaters, and body heat) are all enhanced by insulation. The demand for heating energy and the length of the heating season can both be decreased with good insulation. (13 references) (DCK)

Bullard, C.W.; Herendeen, R.A.
Illinois Univ., Center for Advanced Computation
Address: Urbana, IL 61801
Energy Use in the Commercial and Industrial Sectors of the U.S. Economy, 1963

Report No. PB-235487, UIUC-CAC-DN-73-105, 266 p.
Nov 1973

Sponsor: National Science Foundation, RANN Program

Abstract: This report presents detailed analyses of energy use in the 366 commercial and industrial sectors of the U.S. economy in 1963, and of intersector dependence in energy terms. Besides direct use, full attention is paid to the flow of non-energy goods and the energy thereby implied. The approach, which is based on energy Input-Output analysis, is described. Results: In Section 2, sectors are ranked according to several energy-use criteria: 1) direct energy use, 2) energy intensity of the sector's output, and 3) energy required in the actual economy to provide the sector's total deliveries to final demand. In Section 3, a detailed energy accounting of all inputs is given for each sector. (Auth)

Availability: NTIS

Cahners Publishing Co.
Address: 270 St. Paul St., Denver, CO 80206
1977-1978 Annual Directory of the Appliance Industry

Annual report, Appliance Manufacturer, 25(8), pp. 5-176+ (June 1977)
Jun 1977

Abstract: The Directory provides a Technical Literature File, with listings by category, of selected reference or product literature now available; an Appliance Index of Manufacturers and Private-Brand Merchandisers; a Suppliers' Product Index; and a Supplier Locator. The Technical Literature File is organized into these categories: Materials; Mechanical Components and Fabricated Parts; Controls; Electrical/Electronic Parts, Subassemblies; Fasteners, Adhesives, and Assembly Equipment; Finishes, Chemicals, and Equipment; and Production Equipment and Supplies. The Appliance Index of Manufacturers and Private-Brand Merchandisers includes information on: Major Household Appliances; Electric or Gas-Fired Housewares; Environmental Comfort Appliances; Consumer or Laboratory Appliances; and Vending or Coin-Operated Appliances. For each of these categories, an alphabetical listing of products and the companies that make and/or sell them under private brands are provided. The Supplier's Product Index consists of an alphabetial listing of suppliers products, identifying suppliers that sell each product to the appliance industry. The suppliers' addresses and phone numbers are listed in the alphabetized Supplier Locator. (BYB)

Availability: U.S. Subscription $20

Carnahan, W.; Ford, K.W.; Prosperetti, A.; Rochlin, G.I.; Rosenfeld, A.H.; Ross, M.H.; Rothberg, J.E.; Seidel, G.M.; Socolow, R.H.
Efficient Use of Energy: A Physics Perspective. A Report of the Summer Study on Technical Aspects of Efficient Energy Utilization

Report No. PB-242773, Summer Study held in Princeton, NJ, July 1974, 264 p.
Jan 1975

Sponsor: American Physical Society; National Science Foundation; Federal Energy Administration; Electric Power Research Institute

Abstract: Research opportunities in physics related to efficient energy utilization are identified. Stress is given to the conceptual framework of thermodynamics, especially as a tool for assessing the efficiency of the management of low quality heat. Elementary quantitative models of energy flows in the house and the car are developed. The report emphasizes the importance of new systems concepts and new materials for the management of heat and of new diagnostic instrumentation. Further technologies reviewed include the automobile tire and suspension, hot water heaters, HVAC systems, the fuel cell as a combined system for electricity and heat, electrochemical processes, and processes involving separative

work. (GRA)
Availability: NTIS

Carroll, T.O.; Nathans, R.; Palmedo, P.F.; Stern, R.
Brookhaven National Laboratory, National Center for Analysis of Energy Systems, Policy Analysis Division; State Univ. of New York, Institute for Energy Research
Address: BNL, Upton, NY 11973; SUNY, Stony Brook, NY 11790
The Planner's Energy Workshop: A Manual for Exploring Relationships Between Land Use and Energy Utilization

Report No. BNL 50633, 132 p.
Jun 1977
Sponsor: Federal Energy Administration, Office of Energy Conservation and Environment
Abstract: Recently, problems of energy supply and greatly increased energy prices have introduced a major new concern into planning and policy making at all levels of government. In particular, it has been clear that the magnitude and character of a region's energy requirements are intimately related to the spatial configuration and mix of land use activities. To the degree to which they can shape the future configurations of residential, commercial, industrial, and transportation activities, local governments and their planners must give serious consideration to the energy implications of those configurations in the light of future social goals and requirements. This Planner's Energy Workbook describes a set of procedures that can be used by local planners to carry out their own community and regional energy analyses. The choice of land use activity parameters and their relation to energy use characteristics are associated with the normal planning concepts of land use density, type of residential development, commercial floorspace, industrial sales and employment, and shopping and work trip lengths. At the same time these energy-related intensity coefficients are expressed in a form that permits the analysis of short-term conservation strategies such as the retrofit of insulation and the introduction of new technologies such as solar energy. An integrating framework is provided to construct total community or area energy consumption profiles and future needs; to examine compatibility between area requirements and the energy supply-distribution system serving the area; and to evaluate the implications for energy use of the physical configuration of urban, suburban and rural areas including such elements as growth policy, density, transportation systems, community service areas, and the design and siting of buildings and communities. Two cases illustrate the application of the Planner's Energy Workbook. The Long Island area is representative of major suburban regions throughout the U.S. which have undergone major growth and development. A community redevelopment design in Tucson, Arizona is typical of rapid and major land use development within the environs of an existing city. Using modest and accepted community design considerations, energy savings in area development of up to 40% are estimated. These savings indicate both the range of potential savings and the need to explore opportunities for energy-saving community designs. (68 references) (auth, abstract modified)
Availability: NTIS

Carter, J.E.
Executive Office of the President, Office of the White House Press Secretary
Address: Washington, DC 20500
Text of the President's Address to the American People on the Energy Problem

White House Press Release, (April 18, 1977), 5 p.
18 Apr 1977
Abstract: The President presented the energy problem as a "challenge" to the American people. He stated that the U.S. energy problem is worse than it was in 1973, because more waste had occurred and more time had passed without planning for the future. Unless drastic changes are made to lower oil consumption, he stated that early in the 1980's the world will be demanding more oil than it can produce. He outlined a policy of strict conservation and expanded use of coal and renewable energy sources, like solar energy. If the U.S. does not adopt such an energy policy, it may "face an economic, social, and political crisis that will threaten our free institutions." The proposed national energy plan is based on ten proposals: (1) the government must take responsibility for energy policy and the people must understand the seriousness of the situation; (2) healthy economic growth must continue; (3) the environment must be protected; (4) the U.S. must reduce its vulnerability to potentially devastating embargoes; (5) the energy policy must be fair, asking equal sacrifices from every region, class of people, and interest group; (6) energy demand must be reduced through conservation (the "cornerstone" of the proposed policy); (7) prices should generally reflect the true replacement cost of energy; (8) government policies must be predictable and certain; (9) the U.S. must conserve the fuels that are scarcest and make the most of those that are abundant; and (10) new, unconventional sources of energy must be developed now. The President set these goals for 1985: reduce the annual growth rate in energy demand to less than 2%; cut oil imports by one-half; establish a strategic petroleum reserve of 1 billion barrels; increase coal production to more than 1 billion tons per year; insulate 90% of U.S. homes and all new buildings; and use solar energy in more than 2 1/2 million houses. (BYB)
Availability: White House, Press Release Office, Washington, DC 20500

Carter, J.E.
Executive Office of the President, Office of the White House Press Secretary
Address: Washington, DC 20500
Detailed Fact Sheet: The President's Energy Program

White House Press Release, (April 20, 1977), 26 p.
20 Apr 1977
Abstract: The President addressed a Joint Session of Congress and outlined a national energy plan with the following objectives: in the short term, to reduce dependence on foreign oil and to limit supply disruptions; in the medium term, to weather the eventual decline in the availability of world oil supplies; and in the long term, to develop renewable energy sources. The major strategies for achieving these objectives are: implementation of an effective conservation program for all sectors; the conversion of industries and utilities using oil and natural gas to coal and other more abundant fuels; an R & D program on renewable energy resources. It is projected that the President's energy plan could save approximately 4.6 million barrels of oil per day over the amount of oil otherwise consumed by 1985. The energy program is forecasted to have small but basically positive economic impacts. The elements of the program are

described, including those dealing with: conservation, with programs on transportation, buildings, appliances, industrial conservation, cogeneration of electricity and process steam, district heating, utility rate reform, and taxes on oil and natural gas; management information systems; industry competition; state and local government participation; assistance for low income persons; oil and natural gas, coal, nuclear power, hydroelectric power, and non-conventional energy sources; RD&D of decentralized systems; and a transportation study to reassess the nation's energy transportation system. Conservation measures proposed for the transportation sector include: a gas guzzler tax and rebate, auto efficiency standards, a 55 mph speed limit, a standby gasoline tax, expanded use of Highway Trust Fund, efficiency standards for light duty trucks, removal of the 10% excise tax on intercity buses, a tax on aviation and marine fuel, and a Federal Energy Management Program. In the buildings sector, the plan provides for: a national residential energy conservation program for existing buildings, mandatory efficiency standards for new buildings, and programs for Federal buildings. (BYB)

Availability: White House, Press Release Office,
Washington, DC 20500

Carter, J.E.
Executive Office of the President, Office of the White House Press Secretary
Address: Washington, DC 20500
Text of an Address by the President to a Joint Session of Congress on Energy

White House Press Release, (April 20, 1977), 7 p.
20 Apr 1977

Abstract: In his message to a Joint Session of Congress, the President outlined a national energy plan. Energy conservation goals to be reached by 1985 are presented. The first goal of the plan is conservation, the cheapest, most practical means to meet energy needs while reducing dependence on foreign oil. The U.S. wastes most of its energy in transportation and in its heating and cooling systems. For the transportation sector, the President proposes: a graduated excise tax on new gas guzzlers; rebates on cars that are efficient; and a standby tax on gasoline. His proposed conservation plan for buildings includes: strict conservation goals for both new and old Federal buildings; a tax credit for those who weatherize buildings; a weatherization service offered by all regulated utility companies; direct Federal help for low-income residents; an additional 10% tax credit for business investments; Federal matching grants to non-profit schools and hospitals; and public works money for weatherizing state and local government buildings. Other conservation measures are outlined, including: legislation that would impose strict efficiency standards for household appliances by 1980; changes in utility rate structure; and cogeneration projects by industries and utilities. The second major strategy of the plan involves production and rational energy pricing. The price of newly found oil will be allowed to rise, over a three-year period, to the 1977 world market price. In order to eliminate artificial distortions in gas prices in different regions of the country, the President proposes that the price limit for all new gas sold anywhere in the U.S. be set at the price of the equivalent energy value of domestic crude oil, beginning in 1978. The third strategy is conversion from scarce fuels to coal. This strategy will be implemented through a sliding scale tax on large industrial users of oil and gas. Nuclear energy will be needed to close the gap between energy needs and the energy that can be produced and imported. The President discusses reforming the nuclear licensing procedures. The fourth strategy is to develop permanent and reliable new energy sources, particularly solar energy. A gradually decreasing tax credit is proposed for people purchasing solar heating equipment. An independent information system is called for to provide reliable data about energy reserves and production, emergency capabilities, and financial data from the energy producers. It is emphasized that the guiding principle in developing this national energy plan was that it must be fair. (BYB)

Availability: White House, Press Release Office,
Washington, DC 20500

Carter, J.E.
Executive Office of the President, Office of the White House Press Secretary
Address: Washington, DC 20500
Message to Congress from the President; Fact Sheet on Energy Reorganization Legislation

White House Press Release, (March 1, 1977), v.p.
1 Mar 1977

Abstract: The President sent to Congress proposed legislation to reorganize the Federal government's energy agencies and programs. This bill would establish a new Cabinet-level Department of Energy by combining the functions of the three major Federal energy agencies along with energy-related functions of six other executive and independent regulatory agencies. This new Department would provide the organizational base and the programmatic authorities needed to develop and implement overall Federal energy policies. Among the major responsibilities of the Department will be: conservation; regulation, research and development, resource development and production, and data management. Each of these functions is critical to establishing and implementing a national energy policy which serves both the near and long term needs of the country. The proposal was advanced in the President's Message on Energy Reorganization of the Executive Branch. Legislation to establish the Department of Energy accompanies the Message to Congress. (from Fact Sheet)

Availability: White House, Press Release Office,
Washington, DC 20500

Carter, J.E.
Executive Office of the President
Address: Washington, DC 20500
The Organization of Federal Energy Functions. A Report from the President to the Congress

88 p.
Jan 1977

Abstract: A Department of Energy is proposed to provide a more effective and efficient management structure for conducting national energy affairs. This report details the study, findings, analyses, and conclusions which support this proposal. Part A describes the study background and methodology; Energy Background, Part B, discusses the national and international energy outlook. The present organizational structure is reviewed in Part [illegible] Federal energy functions are now divided among several agencies, including the Federal Energy Administration, ERDA, the Department of the Interior, the Federal Power Commission, and the Nuclear Regulatory Commission. Seven alternative organizational structures are identified and evaluated in Part D, and the three most promising are selected for further evaluation: (1) a multipurpose Department of Energy and Natural

Resources; (2) a special-purpose Department of Energy (DOE); and (3) the current structure for energy functions, with some effort to improve coordination and resolve unclear jurisdictions. To facilitate the selection of an alternative, a series of special analyses was performed (Part E), including studies on: energy policy formulation and coordination; data collection and analysis; energy resource development; energy conservation; research, development and demonstration; energy use of Federally managed natural resources; energy regulation; and nuclear weapons development and production. The DOE (which would include functions of FEA, ERDA, FPC, Bureau of Mines, the power marketing functions of the Department of the Interior, and the Rural Electrification Administration) is proposed as the best organization plan (Part F). The proposed DOE would have approximately 22,860 employees and a budget of $7185 million. Part G describes a proposed internal management structure of DOE and proposes the Executive Level positions and basic staff units needed. A bill to establish the DOE is provided in Part H. (BYE)

Availability: GPC $1.45, Stock No.
041-001-00141-

Chern, W.S.; Holcomb, B.D.; Caudill, S.B.
Oak Ridge National Laboratory, Energy Division
Address: Oak Ridge, TN 37830
Historical Trends of Electricity Sales by Sector, Region and State: 1951-1974

75 p.
Sep 1976
Sponsor: Energy Research and Development Administration; U.S. Nuclear Regulatory Commission

Abstract: This report presents the graphs and analysis of the historical trends of electricity sales by sector, region and state for 1951-1974. Data on electricity sales are obtained from Edison Electric Institute's Statistical Yearbook of the Electric Utility Industry for the years 1951 through 1974. The commercial sector refers to the class of "Small Light and Power" while the industrial sector corresponds to the class of "Large Light and Power" as categorized by EEI. These classifications are by no means consistent throughout the study period. In fact, there are a number of apparent changes in these classifications observed in several years in several states. Consequently, a drastic shift in the trends of commercial and industrial sales of electricity occurs in several states. The total sales include the sales of the residential, commercial, and industrial sectors as well as other miscellaneous categories. ... The discussion and graphs of the historical trends for the U.S. are first presented. A similar presentation is then followed for each region. The graphs of individual states are grouped by region and are presented following their regional summary. The identification of regions and states is shown. (auth, abstract modified)

Clark, S.H.; MacDonald, R.E.; Levison, L.;
Morris, W.V.; Rose, K.; Walker, F.; Warner, J.
Stanford Research Institute
Address: Menlo Park, CA 94025
Patterns of Energy Consumption in the United States

SRI Project ECU-8819, prepared for the Energy Policy Staff, Office of Science & Technology, Office of the President, Washington, D.C., 220 p.
1971, November

Abstract: The Energy Policy Staff of the President's Office of Science and Technology has retained Stanford Research Institute to delineate the trends in energy consumption that have prevailed since 1960, in the important specific end uses in the residential, commercial, and industrial sectors of the U.S. economy. The objectives of the study are to determine: (1) What significant purposes (end uses) have fuels been used for in the United States?; (2) What portion of the nation's energy requirements for the various end uses have been met by each fuel?; (3) What has been the rate of growth of consumption in the major end uses of each fuel?; (4) What technical efficiency can be expected when each fuel is used for those end uses for which it is suitable? While the emphasis of the study has been on the residential, commercial, and industrial sectors, the use of electric power has also been incorporated, along with the transportation sector, in order to arrive at a total energy balance. It should be emphasized that the study deals only with energy consumption in the recent past; there are no projections of energy demand, nor are there observations as to the significance of the results to the future or to policy considerations. This report is strictly a factual document; its purpose is to provide the most detailed information practicable on how the nation uses its energy. (Auth).

Availability: GPC ($2.25) Stock No. 4106-0034

Coble, J.A. (Chairman)
National Petroleum Council, Committee on U.S. Energy Outlook
U.S. Energy Outlook, An Initial Appraisal by the Energy Demand Task Group 1971-1985

Interim report, 63 p.
1972

Abstract: The estimated growth rate for total U.S. energy consumption during the period 1970-1985 is 4.2 percent per year. At this rate, demand will about double over the next 15 years. Although all major markets for energy will participate in this expansion, the electric utility market will outpace all others, greatly increasing its relative share. ---- In addition to a detailed analysis of market share by consuming sector, this chapter examines the growth rate in demand by geographic area. An area analysis of total energy demand indicates that growth is likely to be more rapid in the southern and western parts of the United States. (Auth)

Cohen, A.S.; Fishelson, G.; Gardner, J.L.
Argonne National Laboratory, Energy and Environmental Systems Division; Chicago Univ., Center for Urban Studies
Address: ANL, 9700 S. Cass Ave., Argonne, IL 60439; CU, Chicago, IL 60637
Environmental Regulations and Energy for Home Heating

Report No. PB-240699, 10 p.
1975
Sponsor: National Science Foundation, RANN Program

Abstract: A cost/benefit study of environmental policies supports banning coal as an urban fuel. In an analysis of the Chicago area a coal ban resulted in costs exceeding benefits in only 16 of 172 square miles. In 54 areas benefits were double costs. Benefits include improved air quality, health, and savings on cleaning supplies, and showed no income or racial preferences. As coal use declines, natural gas and oil will increase in demand and price. Two methods for increasing natural gas price would be Federal

deregulation of wellhead gas and a fuel policy allowing price increases in response to local shortages. (DCK)
Availability: NTIS

Ccben, J.C.; White, R.H.
Environmental Law Institute; Citizens for Clean Air Inc.
Address: ELI, 1346 Connecticut Ave., NW, Washington, DC 20036; CFCA, 25 Broad St., New York, NY 10004
Energy Conservation in Buildings: The New York Metropolitan Region

ELI Occasional Paper Series 1, 65 p.
1975
Sponsor: National Science Foundation; Paigel Leah Foundation Inc.
Abstract: This report describes and analyzes the energy, economic, and regulatory implications of increasing the use of thermal insulation in residential construction and reducing overall energy consumption in new commercial construction in the New York Metropolitan Region, a 31-county tri-state area including and surrounding New York City. The first chapter summarizes major findings of the study and technical terms used in the building energy design field. The second chapter describes standards and programs designed to reduce energy consumption in existing and new construction. The third chapter is a technical description, based on local data, of the energy and economic impacts of three conservation policy options: (i) the increased use of thermal insulation in all new residential construction, (ii) retro-fitting existing single family homes to reduce energy consumption, and (iii) utilizing a broad range of techniques to reduce energy consumption in new commercial construction. The fourth chapter combines energy impact estimates developed in Chapter III with census and floorspace projections to establish overall annual energy savings that could be expected in the 31-county Region by 1985 if the three policy options were adopted immediately. (auth)
Availability: Environmental Law Institute, 1346 Connecticut Ave., NW, Washington, DC 20036 $3.00; also available from Citizens for Clean Air Inc.

Construction Industry Conference Centre Limited
Address: P.O. Box 31, Welwyn, England
Energy Conservation and Energy Management in Buildings

Conference held November 13-14, 1975, at the Westminster Theatre, London SW1, 260 p.
1976
Sponsor: Institution of Heating and Ventilating Engineers; Illuminating Engineering Society; Institute of Fuel; United Kingdom Dept. of Energy
Abstract: The purpose of the conference was to determine what can be accomplished and is being accomplished to minimize and economize on energy consumption in England's existing buildings and how new buildings can be designed to conserve energy. Speakers included building services engineers, architects, lighting engineers, fuel technologists, managers, equipment manufacturers, and others concerned about energy conservation. These papers were presented: "Energy Policy and Buildings"; "Legislation and Energy Conservation"; "Spending Money to Save Energy"; "Energy Conservation Measures in the NES Laboratory Complex"; "Swiss Examples of Energy Saving in Existing Buildings"; "Energy Economy in Government Buildings"; "Energy Conservation Studies for New and Existing Buildings Produce Guidelines and Standards--Tools for Decision Making"; "Economic Aspects of Energy Conservation"; "Policies for Lighting Provision"; "Insulation of the Housing Stock--A National Problem"; "Energy Saving in Industrial Buildings"; "Built Form and Energy Needs"; "Building Services--An Energy Demand Review"; and "Energy Prospects--A Framework for Energy in Buildings." (BYB)

Cooke, P.W.; Zelenka, L.P.; Tejuja, H.K.
U.S. Dept. of Commerce, National Bureau of Standards, Institute for Applied Technology, Center for Building Technology
Address: Washington, DC 20234
Mobile Home Construction Standards Adopted by State Regulatory [illegible]--An Analysis

Report No. NBSIR 75-680, 107 p.
Mar 1975
Abstract: This study examines the extent to which the nationally recognized standard for the construction of mobile homes (i.e., ANSI Standard A119.1/NFPA 501B) has been adopted and amended by the individual States that have implemented enforcement programs for the regulation of mobile homes. Summary data are presented on the existing status of the various versions of the standard adopted in each State. State-adopted amendments to the technical requirements in the national standard are compiled by State and construction discipline for comparative analysis. (auth)
Availability: NTIS

Crump, L.H.
U.S. Dept. of Interior, Bureau of Mines, Division of Interfuels Studies
Address: Washington, DC
Fuels and Energy Data: United States by States and Census Divisions, 1974

Annual report, Report No. BM-IC 8739, 163 p.
1977
Abstract: Salient statistics on reserves, production, and consumption of fuels and energy by state and region are presented in this preliminary report. Tables display reserve and production data for each of the fossil fuels (anthracite, bituminous coal and lignite, crude oil, natural gas liquids, and natural gas) and for uranium and thorium. Consumption information is broken down by sector (household-commercial, industrial, transportation, electric power, and miscellaneous) and by source (anthracite, bituminous coal and lignite, petroleum product, natural gas, and hydropower). Total U.S. energy consumption in 197[illegible] is compared with the consumption during 1973 and 1975. Petroleum consumption by major product (gasoline, jet fuel, kerosine, distillate fuel oil, residual fuel oil, liquefied petroleum gases, and asphalt for each sector in each state is covered in an appendix. (BYB)
Availability: GPO, Stock No. 024-004-01910-7, Supt. of Documents Catalog No. I28.27:8739

Cuba, J.F.; Crall, G.C.P.
American Society of Heating, Refrigerating and Air-Conditioning Engineers Inc.; Battelle Columbus Laboratories
Address: ASHRAE, 345 East 47th St., New York, NY 10017; BCL, Columbus OH 43201
Bibliography on Available Computer Programs in the General Area of Heating, Refrigerating, Air-Conditioning and Ventilating

Report No. NSF-RA-760002, ASHRAE Research Project GRP-153, v.p.

Oct 1975
Sponsor: National Science Foundation, RANN Program
Abstract: Approximately 90 computer programs, which were written to improve and facilitate design calculations involved in heating, refrigeration, air conditioning, and ventilation equipment and systems, are described in this report. Sources of information used to compile this bibliography included machine and hand searches of literature and contacts with manufacturers, researchers, and consulting engineers working in this area. The bibliography informs potential program users of the available programs, what the programs do, and whom to contact for further information. Each program description includes (when available) the code name, purpose, key words, a description, input requirements, program outputs, cost, program language, system compatibility, program limitations, developer, data and status, organization that maintains program, documentation, and availability. The report is organized by subject area: Heating and/or Cooling Load Calculation Programs, Energy Analysis Programs, Duct Design Programs, Piping Design Programs, Equipment Selection Programs, Solar Programs, and Miscellaneous Programs. A Key Word Index, a Code Name Index and an Author/Developer Index are provided. It is anticipated that periodic updates of this bibliography will be issued. (EYB)
Availability: American Society of Heating, Refrigerating and Air-Conditioning Engineers

Daifuku, R.
Brookhaven National Laboratory, Economic Analysis Division, National Center for Analysis of Energy Systems
Address: Upton, NY 11973
Residential Space Heating and Cooling in New England 1972-2000

Report No. BNL 50614, 109 p.
Dec 1976
Sponsor: Energy Research and Development Administration, Division of Buildings and Community Systems
Abstract: The object of this report on residential space heating and air conditioning in New England is to develop a model for predicting energy demand from this sector and for assessing energy conservation policy options. To this end, the housing stock is disaggregated by type and insulation levels. This allows the definition of targets for potential insulation retrofit program, and as a result of the dynamic nature of the model, older, poorly insulated housing is allowed to be replaced over time by new units of higher thermal integrity. Under a set of assumptions, including those pertaining to system efficiencies, electric heat pump penetration, and likely energy conservation decisions, energy use in this sector demonstrates a slight decrease at the end use level between the years 1972 and 2000. This document has provided the methodology for a computerized simulation model of residential space heating and cooling being developed for the New England Energy Management Information System (NEMIS) at the Massachusetts Institute of Technology with a data base specific to each of the six New England States. (23 references) (auth)
Availability: NTIS

Davis, A.J.; Schubert, R.P.
Passive Energy Systems
Address: P.O. Box 499, Blacksburg, VA 24060
Alternative Natural Energy Sources in Building Design

252 p.
1974
Abstract: Information needed to design a building using alternative natural energy sources is presented in this book. In the first chapter the energy consumed in buildings is studied, considering current technological solutions to energy problems, and practical alternatives to present technology. Chapter Two examines the effect of climate on building design. Chapter Three, "Energy Conservation," covers these topics: life cycle costs; conservation through the use of materials; the exclusion or inclusion of natural environment; windows; the collection, distribution, and utilization of waste heat; lighting systems; and heat transmission coefficients. Natural methods of cooling and ventilation are reviewed in Chapter Four. Chapters Five through E[illegible]scuss the use of these alternative e[illegible]urces: water power, wind power, sola[illegible], and organic fuels. Integrated syste[illegible]sing more than one alternative energy source, are described in Chapter Nine. (171 references) (EYB)
Availability: Passive Energy Systems $6.00

Dawson, J.
U.S. Dept. of Health, Education, and Welfare, Office of Consumer Affairs; Federal Energy Administration, Energy Resource Development
Address: Washington, DC
Buying Solar

Report No. FEA/G-76/154, 79 p.
Jun 1976
Abstract: The purpose of this publication is to help individual consumers determine whether installation of solar space heating and cooling and domestic water heating systems would be economically practical for them. This decision is dependent on several factors--location, type of home, quality of insulation in home, current energy costs, and type of solar system. This book also describes the main operating components of solar systems, such as the collector and storage subsystems. A procedure is explained to calculate annual fuel savings from switching to solar heating systems. The economics of standard heating, hot water heating, and cooling systems are compared to solar systems by regions. (EYB)
Availability: GPO $1.85, Stock No. 041-018-00120-4

DeGolyer and MacNaughton
Address: One Energy Square, Dallas, TX 75206
Twentieth Century Petroleum Statistics

Annual publication, approximately 115 p.
Abstract: Over 100 tables, accompanied by graphs, present statistics on production, reserves, transportation, imports, exploration, and consumption of crude oil, petroleum products, and natural gas. This handbook utilizes information published by the American Petroleum Institute, U.S. Bureau of Mines, and other government agencies as well as data in "The Oil and Gas Journal" and "World Oil." (EYB)

Delene, J.G.
Oak Ridge National Labor[illegible]tor Division
Address: P.O. Box X, Oak [illegible] 37830
A Regional Comparison of [illegible]source Use and Cost to Consumer of [illegible]esidential [illegible]ystems

Re[illegible]L-TM-4689, 37 [illegible]
Nov [illegible]

Sponsor: U.S. Atomic Energy Commission
Abstract: The energy use and cost of heating a reference model home in various cities in the United States were calculated for various methods of residential heating. The costs include capital and maintenance costs as well as the energy costs reflected in the consumers' utility bills. Heating systems considered include heat pump, electric furnace, gas furnace, oil furnace, and either electric baseboard or ceiling heat. This report is intended to provide basic data which can be used in future studies aimed at evaluating the potential effect of energy saving strategies and future shifts in residential heating patterns. (14 references) (auth)
Availability: NTIS

Delene, J.G.; Gaston, J.B.
Oak Ridge National Laboratory, Reactor Division
Address: Oak Ridge, TN 37830
A Regional Comparison of Savings from Various Residential Energy Conservation Strategies

Report No. ORNL/TM-5146, 69 p.
Feb 1976
Sponsor: Energy Research and Development Administration
Abstract: The energy use and cost of providing space conditioning to a reference model home in various cities in the United States were calculated for alternate space conditioning systems and for various residential energy conservation strategies. The benefits and costs of increasing the thermal insulation in new and in older homes were estimated, as well as the value of the revised HUD minimum insulation standards compared to their predecessor. The benefits of thermostat setback and improved gas furnace efficiency were estimated from both a resource savings and consumer economic standpoint. The economic analysis included capital and maintenance, as well as costs reflected in the consumer's utility bill. Heating systems considered include heat pump, electric furnace, gas and oil furnaces, and either electric baseboard or ceiling heat. This report is intended to provide basic data for future studies. Such studies include evaluations of the potential effect of energy saving strategies and future shifts in residential heating patterns. (auth)
Availability: NTIS

Denton, J.C.; Lorsch, H.G.
Pennsylvania Univ., National Center for Energy Management and Power
Address: Philadelphia, PA 19174
Energy Conservation and Electric Load Leveling Through Thermal Energy Storage in Air Conditioning

Paper presented at the Conference on Improving Efficiency in HVAC Equipment and Components for Residential and Small Commercial Buildings held October 7-8, 1974 at Purdue University, pp. 107-116
1974
Sponsor: National Science Foundation, RANN Program
Abstract: As a part of a larger program in energy conservation, off-peak air conditioning systems were investigated which would generate coolness during nighttime hours, maintain it in thermal energy storage, and use it during subsequent peak demand periods for space conditioning. A number of such systems were conceived, and their technical and economic performances were evaluated. The two most promising designs were then selected for prototype demonstration. One of these units, designated the Recondenser system, operates by initially evaporating the refrigerant at 59 degrees Fahrenheit, recondensing it through the use of thermal energy storage and evaporating it a second time at 40 degrees Fahrenheit. The conditioned air is precooled in the first evaporator, and dehumidified and fully cooled in the second evaporator. Thermal energy storage is achieved by lowering the temperature of water in a storage tank. The second unit, designated the Air-Loop system, employs a salt hydrate as the thermal energy storage medium. The material is alternately frozen and thawed. The conditioned air is precooled by passing through the storage unit, and dehumidified and fully cooled in a conventional evaporator... Performance and cost data are presented; energy savings and cost savings are detailed. It is concluded that these systems can significantly reduce peak power demands and that they are economically advantageous for buildings on electric demand metering. (11 references) (from summary)

DePinto, D.; Segeler, C.G.
Sage (David) Inc.
Address: 200 Park Avenue, New York, NY 10017
Energy Use Patterns and Conservation Potentials for Existing High-Rise Housing in the City of New York

105 p.
1975
Sponsor: Citizens for Clean Air Inc.
Abstract: A compilation and analysis are presented of energy consumption data from large apartment projects in New York City. This report provides the initial step in a program to identify and test economically feasible methods of reducing energy consumption in existing elevator apartment houses. Energy consumption data for over 80,000 apartments are categorized by use - heating, domestic hot water, and public light and power. Data have also been related to floor area, population, project age, and other factors. Space heating represents the largest use of energy. Space heating and domestic hot water consume 62.5% of all energy ased in public housing and 55% in the private sector. The second largest energy use is electric consumption for tenant use and public light and power (31.8% in the public sector and 38.1% in the private sector). Gas for cooking constitutes only 5.7% and 6.9% of energy consumed in public and private sectors respectively. (BYB)
Availability: Citizens for Clean Air, Inc., 25 Broad Street, New York, NY 10004 $5.00

Deshpande, A.S.
Ontario Research Foundation
Address: Ontario, Canada
Energy Conservation Through Utilization of Domestic Wastes as Fuel in Housing

Paper presented at Institute of Environmental Sciences 21st Annual [illegible]nical Meeting, Energy and the Environment, held in Anaheim, California April 14-16, 1975, pp. 235-240
1975
Abstract: Due to limited energy supplies, increasing waste generation, and tighter pollution controls, the utilization of wastes as fuel is considered. An integrated utility system, the CANWEL (Canadian Water Energy Loop) System, which manages domestic refuse, garbage, sludge and liquid wastes, is described. The philosophy of this concept includes: 1) the use of domestic waste as fuel for heating; 2) minimization of waste haulage by treating wastes at the point of origin; 3) renovation of waste waters to potable quality water; 4) the processing of

all domestic wastes to reusable water, clean cool exhaust gases and sterile ash; and therefore, 5) a system causing no health hazard, nor pollution. Technical and economic considerations are discussed. (9 references) (BYB)

Development Sciences Inc.
Address: East Sandwich, MA
Using Net Energy Methodology for Energy Planning: Tradeoffs of Supply vs. End-Use Technologies. Volumes I and II, Final Report

Report No. FE-77-2443/1, 38 p. for Volume I: Report No. FE-77-2443 2, pp. 36-364 for Volume II
15 Apr 1977
Sponsor: Energy Research and Development Administration, Office of Program Planning and Analysis, Fossil Energy
Abstract: This study examines the usefulness of net energy analysis in addressing energy research and development alternatives. New England space and water heating are selected as examples, and new supply and end-use technologies are quantified according to their energy resource requirements. The results of the analysis are used to draw three conclusions concerning the conduct of energy-related programs. (1) Efforts should be directed toward evaluating complete energy systems, consisting of both supply and end use, rather than evaluating either supply or end use alone. Similarly, energy research planning should consider not only single technologies but also the mix of technologies. Thus attention should be paid to the best use of natural resources to satisfy needs for space heat, lighting, refrigeration, etc., rather than to the means of providing or saving intermediate energy forms (such as refined oil). (2) Regional characteristics strongly affect the performance and practicality of new energy options. Consequently, programs must be designed to address energy problems at the regional level. (3) Energy analysis provides a narrower and deeper examination of energy resource effects than does an economic analysis and should be used to identify the energy resource implications of technological alternatives. (32 references) (auth)
Availability: NTIS

Dole, S.H.
Rand Corp.
Address: Santa Monica, CA 90406
Energy Use and Conservation in the Residential Sector: A Regional Analysis

Report No. R-1641-NSF, 190 p.
Jun 1975
Sponsor: National Science Foundation
Abstract: This study estimates consumption of all forms of energy in the residential sector, broken down by the major end uses, for each of the nine census regions of the United States for the base year 1970. A forecasting methodology based in part on econometrics then makes projections to the year 2000. Various conservation measures are then considered for application in future years and, finally, alternative sets of policy actions are postulated. The region-by-region effects of these policy actions in producing reductions in energy consumption are estimated. The objective of this study was been to evaluate various residential energy conservation policies for their effectiveness in producing energy savings. A regional approach was adopted to account for the possibility of significant differences among climatic regions. (56 references) (from Summary)

Donovan, J.J.; Fischer, W.P.
Massachusetts Institute of Technology, Sloan School Center for Information Systems Research; Massachusetts Institute of Technology, Energy Laboratory
Address: Cambridge, MA 02139
Factors Affecting Residential Heating Energy Consumption

Report No. MIT-EL-76-004WP, 67 p.
Apr 1976
Sponsor: New England Regional Commission
Abstract: This paper reports on an effort to ascertain the major factors affecting the consumption of home heating oil in New England. Three general classes of factors are analyzed: (1) physical and occupant characteristics (number of rooms, number of occupants, number of stories, amount of insulation, income level, etc.); (2) external (price, shortage awareness, weather); and (3) behavioral and physical changes (change in temperature settings, change in insulation, change in oil burner, etc.). The study is based on four data series: (1) actual monthly home heating oil consumption data on 8000 suburban homeowners in suburban Boston; (2) questionnaire responses from 2000 homeowners on their homes' physical and occupant characteristics, as well as changes in physical and occupant behavioral characteristics between 1972 and 1975; (3) monthly weather data; and (4) heating oil price data. The data are associated with the years from 1972 through 1975. ... Three models are central to the study: Model I, a cross-sectional model that depicts consumption per degree-day as a function of physical and occupant characteristics of a home; Model II, a time series regression model that establishes consumption per degree-day as a function of price and consumer awareness of an energy shortage; and Model III, a cross-sectional regression model that attempts to explain change in consumption per degree-day from one year to the next as a function of specific conservation actions. (34 references) (auth, abstract modified)
Availability: Energy Laboratory, Headquarters, Room E40-139, MIT, Cambridge, MA 02139. $2.65

Drysdale, F.R.; Calef, C.E.
Brookhaven National Laboratory, National Center for Analysis of Energy Systems, Biomedical and Environmental Assessment Division
Address: Upton, NY 11973
The Energetics of the United States of America: An Atlas

Report No. BNL 50501, 444 p.
Sep 1976
Sponsor: Energy Research and Development Administration
Abstract: A description of the United States energy system is presented in the form of thirty-one maps and eight major tables. The county has been chosen as the basic unit for reporting estimations of many energy, demographic and economic variables. The variables include production of all fuels (including hydroelectricity), uses of fuels and electricity broken down by sector and end-use, existing and planned electricity generation capacity, refinery capacities, and emissions of air pollutants from fuel use. Calculations and assumptions used to make county-level energy estimates are described in detail. (21 references) (auth)
Availability: NTIS

Dubin, F.S.
Dubin-Mindell-Bloome Associates
Address: 42 West 39th St., New York, NY 10018
Energy Conservation Through Building Design and a Wiser Use of Electricity

Paper presented at the Annual Conference of the American Public Power Association, San Francisco, CA, 18 p.
26 Jun 1972
Abstract: The author recommends the following methods of conserving energy in buildings: reduce environmental requirements, such as levels of illumination, glazed areas, decorative lighting; select building sites and design structures to minimize energy consumption, e.g. sites with existing trees, building shapes, insulation, buildings with greater densities (multi-family dwellings); refine design calculations to avoid oversizing equipment; use energy conservation systems, such as use of waste heat, and select systems and equipment which use less energy, such as heat pumps in place of resistance heating; use building materials which require less energy to produce, e.g. steel instead of aluminum; improve maintenance practices to reduce deterioration and improve operating efficiencies; and make better utilization of buildings, combine facilities and systems to take advantage of diversity. Demonstration buildings are needed to provide information on the relative benefits of alternate energy conservation methods. (MPG)

Dubin, F.S.
Dubin-Mindell-Bloome Associates
Address: 42 West 39th St., New York, NY 10018
Energy for Architects

Architecture Plus (July 1973), reprinted in Energy Conservation and S.2176, Congressional Committee Print Serial No. 93-7 (92-42), Part 2, p. 950-[illegible]
1973
Abstract: Energy conservation measures that do not sacrifice needed services or important amenities can save 15 to 25% of the energy consumed in exiting buildings and 35 to 50% in new structures. Methods of achieving these savings are discussed, including: location of the building site and orientation of the building on the site; improved methods of heating, ventilating, and air conditioning, such as heat pumps, total energy systems, and solar energy systems; new waste management techniques; improved design of windows and lighting systems; interior landscape planning; and modular integrated utility systems. Conservation checklists to make existing and new buildings more efficient are presented. (MPG)

Dugas, D.J.; Dole, S.H.; Peterson, R.E.; Riegel, X.W.
Rand Corp.
Address: Santa Monica, CA 90406
A Preliminary Assessment of Energy Conservation in Lighting

Report No. WN-8666-FEO, 49 p.
May 1974
Sponsor: Federal Energy Office
Abstract: The amount of energy consumed in the U.S. for lighting purposes was estimated by means of lamp manufacturing statistics to be 323 billion kWh in 1972, or about 19 percent of total electricity consumption. The discussion includes several lighting conservation measures, most of which could be put into practice within a short time and would require little or no investment. This report makes no prediction of the likelihood that these measures will be implemented on a nationwide basis; however, it is estimated that the potential energy savings could be up to 8 percent of total electricity consumption. Over half of the potential savings results from reducing illumination levels and turning off unused lights in commercial buildings, which in turn reduces the load on air conditioning equipment. Other measures that were considered include: reducing waste in the residential sector, replacing incandescent lamps with fluorescent or high-intensity discharge lamps where practical, and eliminating decorative and advertising lighting. In general, considerable energy can be saved without sacrificing visual performance through the following practices: (a) turning off lights when not in use; (b) using the most efficient lamps compatible with the visual task; (c) designing the lighting system so that the lumen output is used as efficiently as possible; and (d) making maximal use of daylighting. Some areas that require further research are mentioned. (34 references) (Summary)

Dunning, R.L.
Westinghouse Electric Corp., Power Systems Planning Dept., Energy Utilization Project
Address: East Pittsburgh, PA 15112
Furnace-Efficiency Variations Explained

Electrical World, 181(3), pp. 50-62 (Feb. 1, 1974)
1 Feb 1974
Abstract: A more sophisticated analysis of the methods used to calculate efficiencies of various kinds of home heating systems reveals flaws in these methods. This can explain the wide variation in published values. Using a computer code and a more elaborate method to calculate efficiency, a gas furnace in a typical Pittsburgh home gave 47% efficiency. An identical situation with a 2.5 ton heat pump gave efficiencies from 119% to 203%, depending on the design of the pump. (JMC)

Dunning, R.L.
Westinghouse Electric Corp., Power Systems Planning Dept., Energy Utilization Project
Address: East Pittsburgh, PA
Efficiency and Cost of Various Residential Heating Systems

Paper presented at the Conference on Improving Efficiency in HVAC Equipment and Components for Residential and Small Commercial Buildings held October 7-8, 1974 at Purdue University, published in Addendum to Proceedings, 7 p.
1974
Abstract: Efficiencies and costs of gas, oil, and electric heating are determined and compared. With the efficiencies for gas and oil furnaces at 40 to 50% and 35 to 45%, respectively, electric heating is considered competitive in energy efficiency. It is stated that the energy shortage is actually a shortage of two sources of energy -- oil and gas. Therefore, an energy policy which promotes the use of electricity generated by coal or uranium, as a substitute for oil and gas, is suggested. (10 references) (BYB)

Dupree, W.; Enzer, H.; Miller, S.; Hillier, D.
U.S. Dept. of Interior, Office of the Secretary, Office of the Assistant Secretary for Energy and Minerals
Energy Perspectives 2

230 p.

Jun 1976
Abstract: "Energy Perspectives" was first published in February 1975. With new and revised energy data available, this revised study was prepared to describe the basic parameters influencing the U.S. energy situation and to present additional data for statistical, econometric, and other analysis. Material presented in the first Energy Perspectives study (e.g., capital requirements, U.S. energy R & D funding, and energy and environmental data) have been omitted from this revised publication. This second study includes additional projections, data on the world energy situation, on prices and costs, U.S. regional data, and energy relationships expressed in both physical terms and in Btu. The document includes a section on world energy resources, consumption, production, trade, and projections as well as a section on the U.S. energy situation. (BYB)
Availability: GPO $5.40, Stock No. C24-000-00826-6

Dupree, W.G., Jr.; Corsentino, J.S. 7
U.S. Dept. of Interior, Bureau of Mines
Address: Washington, DC
United States Energy Through the Year 2000 (Revised)

72 p.
1975
Abstract: Earlier energy consumption and supply forecasts of the Bureau of Mines are updated in this report, which is based mainly on evaluation of Bureau of Mines fuels data. Net energy consumption is expected to increase from 59,855 trillion Btu in 1974 to 110,230 trillion Btu in 2000. The present trend toward increased use of secondary energy sources will continue. Conversion losses in the electrical, synthetic gas, and synthetic liquids sectors will increase as will the total gross energy inputs. Both net and gross energy inputs per capita are forecast to rise. The difference between net and gross energy inputs will increase over time due to increased dependence on secondary energy sources. In 1974 the energy consumed by the electrical sector represented 26.7% of total gross consumption of energy. By 2000 this sector is expected to consume 48.1% of total gross energy inputs. It is anticipated that the U.S. will continue to rely on conventional fossil fuels (i.e., coal, petroleum and natural gas). Coal resources appear adequate through 2000. However, domestic natural gas and petroleum will have to be supplemented by synthetic fuels and imports. (BYB)
Availability: Bureau of Mines, Publications Distribution Branch, 4800 Forbes Ave. Pittsburgh, PA 15213

Ebasco Services Inc.
Address: Two Rector St., New York, NY 10006
1976 Business and Economic Charts

Annual publication, 42 p.
1976
Abstract: Business and economic data for 1976 are displayed in graphical form. The report is organized into five sections: (1) General Economics, including data on population and households, labor force, GNP, inflation indicators, and new houses and type of heating fuel used; (2) Energy and Electricity, with charts on energy consumption, energy sources for electric utility power generation, electric utility capacity and generation, residential electricity, nuclear power reactors, transmission lines, gas turbine capacity, and growth of the gas industry; (3) Electric Utility Economics (e.g., revenue, operating expenses, taxes, fuel costs, and rate actions); (4) Financial, with information on electric companies' construction expenditures, new money financing, yields on public utility bonds, new offering bond yields and new money bond financing, offering yields and new money preferred stock financing, earnings-price ratios and dividend yields, new money common stock financing, pollution control revenue bonds; and (5) Public Affairs, containing data on research and development, expenditures for pollution control, net public and private debt, Rural Electrification Administration, electric power capacity, world comparative statistics, and per capita world statistics. (BYB)

Edison Electric Institute
Address: 90 Park Ave., New York, NY 10016
Statistical Year Book of the Electric Utility Industry for 1975

Annual publication, EEI Publication No. 76-51, No. 43, 76 p.
Oct 1976
Abstract: Tables of statistical data are presented under the following headings: Generating Capacity, Electric Power and Energy Resources, Generation, Energy Sales, Customers, Revenues, Operating Data and Ratios, Financial, and Economic-Miscellaneous. The data were compiled from annual statistical reports from the Investor-Owned Electric Utilities and other agencies. (MPG)
Availability: Edison Electric Institute $11.00 for 1975 Yearbook

Edison Electric Institute
Address: 90 Park Avenue, New York, NY 10016
Electric Output

Weekly publication, 2 p.
Abstract: These periodic publications report on the net amount of electrical energy distributed by the electric utility industry for each week. Included are the following tables: Weekly Electric Output by Geographic Division; Weekly Electric Output in Previous Weeks; Weekly Electric Output Index; Generation by Months: Installed Capacity--Thousands of KW--Name Plate Rating; Number of Customers; Total Sales to Ultimate Customers; and Sales of Major Classes (Residential, Small Light and Power, and Large Light and Power). (BYB)

Edison Electric Institute
Address: 90 Park Ave., New York, NY 10016
Electric Perspectives (Formerly EEI Bulletin)

Bi-monthly publication
Abstract: As the Edison Electric Institute's magazine for management, this publication focuses on such topics as the energy situation, government policies, financing problems, nuclear energy, rate structure, and waste disposal as they relate to investor-owned electric utility companies. (BYB)
Availability: $10.00/yr. to EEI member companies and affiliates; $15.00/yr. to non-members; $2.50 for single copies

Edison Electric Institute, Conservation and Energy Management Division

Address: 90 Park Avenue, New York, NY 10016
Residential Electric Space Heating Survey

Annual report, v.p.
Abstract: These annual surveys, which provide information on a two-year period, are conducted to obtain data on the performance of the U.S. electric space heating market (excluding Alaska and Hawaii). Part I--Dwelling Units Added, by Types--reports on electrically heated dwelling units added, total electric heat customers, and saturation percentage. Part II--Equipment (Systems) Added, by Types--is a compilation of Part I with additional data on types of space heating equipment. Part I provides tables with the following data: total number of residential electric customers served by each company; total number of electrically heated dwelling units in each company's service area; the approximate saturation of electrically heated dwelling units, in percent; electrically heated dwelling units, in apartment buildings, added each year; electrically heated new homes added in each year; existing homes converted to electric heat; electrically heated mobile home units added; and total additions for each year. Part II presents tables with data on: total customers at year end; number of electrically heated dwelling units added during year; total in state at year end, listed by utility category; dwelling units added, by types; and equipment installed by types. (BYB)

Edison Electric Institute, Conservation and Energy Management Division
Address: 90 Park Avenue, New York, NY 10016
Heating-Cooling Statistics of Marketing Interest on New Housing 1966-1975

Compiled from U.S. Government Construction Reports: Characteristics of New Housing 1966-1975 (Series C25-75-13), 14 p.
Dec 1976
Abstract: Data on space heating and air conditioning systems in new residential buildings from 1966 through 1975 are presented. The report is organized into these sections: New One-Family Completions 1966-1975 (by purpose of construction, by type of heating fuel, and by use of central air conditioning); Regional Data on Types of Heating Fuel and Air Conditioning (One Family); New Multi-Family Completions 1971-1975 (by total units and by heating fuel and central air conditioning); and Regional Data on Types of Heating Fuel and Air Conditioning (Multi-Family). The combined market saturation of new one-family and multi-family housing in 1975 was 52% for electric heating sytems, 37% for gas, and 9% for oil. In 1975, 58% of the new multi-family buildings installed electric heating systems, 40% installed gas systems, and 2%, oil. Nationally, electric heat saturation did not maintain its historical growth. Declines in regional electric heat saturation occurred in the Northeast and the South, but the North Central region increased slightly and the West continued high growth rates. Gas heating systems declined in all regions except the South. (BYB)

Edison Electric Institute, Economics and Statistics Dept.
Address: 90 Park Avenue, New York, NY 10016
Total Electric Utility Industry in the United States Including Alaska and Hawaii

Monthly publication, v.p.
Abstract: Included in this periodic report are monthly and yearly data on the source and disposal of electricity and classification of sales. Tables present information on net generation; net energy for distribution; sales to ultimate customers; number of customers by customer group (residential, commercial and industrial, street and highway lighting, other public authorities, railroads and railways, and interdepartmental); energy sales to each customer group; revenue from each customer group; and residential service (average customer data). (BYB)

Egan, M.D.
Clemson Univ.
Address: Clemson, SC
Concepts in Thermal Comfort

Prentice-Hall, Inc., Englewood Cliffs, NJ, ISBN 0-13-166447-6, 216 p.
1975
Abstract: This practical approach to the basics of human thermal comfort uses graphical displays to illustrate the interactions of weather, construction materials, and mechanical systems in architecture. Contents include chapters devoted to basic theory, climate and shelter considerations, building materials, building heat loss and heat gain, mechanical systems, and mechanical system noise and vibrations. Among its many features, the book: presents very extensive tabulations of useful engineering data for solving many actual building problems; illustrates the fundamental principles of thermal comfort and the many related factors that must be considered in effectively heating and cooling a building; includes a chapter on the control of mechanical system noise and vibrations; and provides valuable checklists of design principles and energy conservation techniques for buildings, an appendix of more than 30 useful formulas, metric system conversion factors, and references to related publications. (18 references) (from publisher's description)
Availability: Prentice-Hall, Inc., Englewood Cliffs, NJ $11.95

Eisenhard, R.M.
U.S. Dept. of Commerce, National Bureau of Standards, Institute for Applied Technology, Center for Building Technology, Office of Building Standards and Codes Services
Address: Washington, DC 20234
Building Energy Authority and Regulations Surv[illegible] State Activity

Report No. NBSIR 76-986, 51 p.
Mar 1976
Sponsor: Energy Research and Development Administration, Division of Buildings and Industry
Abstract: This report provides the status of State authority to regulate energy use in new buildings and the status of bills creating such authority that were pending in the 1975 legislative session. Regulations that have been developed are identified and described. Legislation relating to solar energy, retrofitting, insulation and other building energy matters, is identified and the status indicated. (auth)
Availability: NTIS

Electric Energy Association, Technical Services Division
Address: 90 Park Ave., New York, NY 10016
Commercial & Industrial Electric Space Heating Survey: 1973

30 p.
May 1974

Abstract: The purpose of this survey was to determine the performance of utility systems in the 48 contiguous states in adding electric space heating load to commercial and industrial customer properties in 1973. Forecasts for 1974 were also included. Data for 123 utility systems indicated that 3,200,000 kw were added in 1973 with 3,574,000 kw forecast for 1974. Approximations were also made of the percentages of each type of equipment installed. (BLM)

Electrical World, McGraw-Hill Inc.
Heat-Pump Prospects Show Sharp Gain

Electrical World, 180(4), pp. 80-82 (Aug. 15, 1973)
Aug 1973
Abstract: A detailed comparison of the costs of the use of a domestic electric heat pump with electric baseboard and with gas furnace is given for different parts of the country. The conclusion is that if the house is air-conditioned, the total cost of a heat pump is comparable to a gas furnace with electric air conditioners. If the relative price increase of gas rises faster than electricity, the advantage will be more pronounced. (JMC)

Elrick and Lavidge Inc.
Address: 10 South Riverside Plaza, Chicago, IL
Manufactured Housing Institute 1976 Data Book

Annual Report, 25 p.
Apr 1977
Sponsor: Manufactured Housing Institute
Abstract: The purpose of the Data Book is to provide Manufactured Housing Institute (MHI) members with a reference guide to marketing statistics on the manufactured housing industry. Data in this publication are based on an annual census of mobile home production in which the number of mobile homes built is determined by surveying mobile home builders. The first section of the Data Book presents information on manufacturers' shipments of mobile homes and includes tables on: mobile home growth in the past decade; single family private housing starts, 1967-1976; mobile home shipments, 1947-1976; retail value of shipments in 1975 and 1976; mobile home trends by types and sizes; quarterly shipments by types and sizes, 1976; shipments to regions in 1976; shipments to states; shipments by prices and sizes, 1976; seasonally adjusted shipments and seasonal factors, 1974-1976; and mobile home consensus forecast for 1977. Section II, Production of Mobile Homes, consists of these tables: Production, 1975-1976; Production in the Ten Largest Producing States, 1976; Production in States, 1975-1976; Mobile Home Producing Plants, 1975-1976; and Production in States by Types and Widths, 1976. Other MHI Market Information Reports that are available are described. (BYB)
Availability: Manufactured Housing Institute, P.O. Box 201, Chantilly, VA 22021

Energy and Environmental Analysis Inc.
Address: 1701 North Fort Myer Drive, Suite 1213, Arlington, VA 22209
Energy Consumption Data Base. Volumes I, II, and III

Three volumes bound in 16 documents, v.p.
1977
Sponsor: Federal Energy Administration
Abstract: The structure and contents of the Federal Energy Administration's Energy Consumption Data Base (ECDB) are described in this report. ECDB describes and documents domestic energy consumption during 1967, 1971, and 1974, and contains data on eight energy consumption sectors: agriculture, mining, construction, manufacturing, transportation, commercial, household, and electric utilities. For each sector, the quantity of energy consumed and the amount spent on this energy is recorded by state and Census region, fuel type, class of user, and the use for 1967, 1971, and 1974. Volume I, a summary document, provides an overview of energy consumption, the types of energy used, the sectors of the economy it is used in, its end uses, and the geographical distribution of its use. This cross-sectional analysis covers 1974 only, because 1974 is the only year for which data are available for all sectors. Volume I also summarizes data for each consuming sector, covering all three years (except for the commercial sector). The second volume is a user's manual, describing ECDB and the means to update and access its computer files. Volume III, which is bound in 14 separate documents (chapters), contains complete documentation for the ECDB and presents some of its state-by-state data. The introductory chapter to Volume III explains how to interpret the data base output and provides a glossary of terms used in energy analysis. The remaining chapters of Volume III describe these sectoral studies: Agriculture, Mining, Construction, Manufacturing, Small Industries, Paper, Chemicals, Petroleum, Primary Metals, Transportation, Commercial, Household, and Electric Utilities. Each of these documents describes the major energy consumption characteristics of the economic sector, details state-by-state excerpts of data installed in ECDB, and documents this data. Documentation consists of a general methodology as well as a detailed step-by-step methodology, including computer progra[illegible]nd data files used. Net U.S. energ[illegible]umption during 1974 was appro[illegible]y 70 quadrillion Btu's (quads). Petroleum products provided about 46% of the total amount of energy used; natural gas contributed about 29%; coal accounted for about 18%; and hydro and nuclear sources provided about 3%. The industrial sector used 36% of all the energy consumed in 1974; the agriculture sector consumed 2%; mining sector used [illegible]; construction used 2 1/2%; manufacturing accounted for 28%; transportation used almost 25%; the commercial sector used about 8%; the residential sector consumed about 16%; and the electric utilities sector used 16%. (BYB)

Energy Research and Development Administration
Address: Washington, D.C.
A National Plan for Energy Research, Development & Demonstration: Creating Energy Choices for the Future--1976: Volume 2: Program Implementation

Report No. ERDA 76-1, 433 p.
1976
Abstract: As a companion to Volume 1 (The Plan), Volume 2 describes programs now in progress which are supported by the Federal government, including Federally funded research done by industries and private institutions. In conjunction with Volume 1, this volume describes technologies being examined as well as current and future efforts in Federal energy research, developmen[illegible]nd demonstration (RD&D) programs. Seventy-six program descriptions or "Building Blocks" are presented; each building block corresponds to a line item in the ERDA budget and represents the energy RD&D activities of one or more Federal

agencies. Part I, Energy Technology Programs, presents 62 Building Blocks explaining Federal program activities oriented toward a single energy technology. These building blocks are grouped into nine major program areas: Fossil Energy, Solar Energy, Geothermal Energy, Conservation, Fusion Power, Nuclear Fuel Cycle R & D and Safeguards, Fission Power, Environmental Control Technology, and Synthetic Fuels Commercial Demonstration. Parts II and III of the Program Implementation Volume include Building Blocks describing supportive programs that tend to cut across several energy technologies. Part II is divided into two major program areas: Environmental Research and Safety, and Basic Energy Sciences. Part III lists six activities which are not unique to energy RD&D, but which are essential to such research. Three tables containing cross-referencing data make up Part III, which permits examination of the Building Blocks from the different perspectives of the National Energy Technology Goals, Volume I Technologies, and Federal Agency Involvement. A glossary of acronyms and abbreviations is included in the Appendix (Part V). (BYB)
Availability: GPO $3.45, Stock No. 052-010-00492-1

Energy Research and Development Administration
Address: Washington, DC 20545
A National Plan for Energy Research, Development and Demonstration

Report No. ERDA 77-1, 51 p.
23 Jun 1977
Abstract: Pursuant to Section 15 of the Federal Nonnuclear Energy Research and Development Act of 1974, this document reports on the energy RD&D program of ERDA. As outlined in the President's National Energy Plan, submitted to the Congress on April 20, 1977, the research program focuses on developing new technologies to: (1) increase the efficiency of energy use, (2) expand the use of existing fuels, and (3) make the transition to new fuels. In Chapter One, Understanding Conservation, it is pointed out that three kinds of action are needed to reach conservation goals: promotion of an energy conservation ethic; conversion of facilities and equipment; and development of new, energy-efficient methodologies and technologies that conserve energy. The conservation technology base is reviewed for three end-use sectors (transportation, residential/commercial, and industrial) in Chapter Two. In the near future, alterations in existing types of vehicles, engines, and components will be the major means to achieve conservation. Two alternative engines, the turbine and the Stirling, may play a significant role in meeting fuel economy and emission objectives. Efforts are also being made to develop and introduce electric and hybrid vehicles. Considering the residential/commercial sector, retrofitting buildings can have substantial near-term impacts. Because industries developed during a period of plentiful, cheap energy, many industrial processes are inefficient and can be improved. Chapter Three examines technologies that would expand existing fuel sources. Through the early 1980's the U.S. should work on technologies that: produce additional petroleum and natural gas through enhanced recovery techniques; expand the direct use of coal in the utility and industry sectors; and expand the use of light water reactors in a once-through fuel cycle for electric power production. In Chapter Four, technologies that use new fuels (shale oil, synthetic fuels from waste and biomass, geothermal heat, and solar energy) are considered. Chapter Five looks at the broad-based support programs and activities needed, (e.g., basic research, data collection and dissemination, education, and training). Two major ERDA studies, now in progress, are described in Chapter Six: the Market-Oriented Program Planning Study and the Inexhaustible Energy Resources Study. The final chapter provides an overview of ERDA's budget, which totals $7.3 billion. (BYB)
Availability: GPO, Stock No. 060-000-00067-1

Energy Research and Development Administration, Office of Conservation, Division of Buildings and Community Systems
Address: Washington, DC
Consumer Products and Technology Branch: Program Plan

Report No. ERDA 77/22, 31 p.
1977
Abstract: The research program plan of the Consumer Products and Technology (CPT) Branch of ERDA's Division of Buildings and Community Systems is described in this report. The purpose of the CPT Branch is to encourage and manage RD&D of new energy-saving technologies in heating, cooling, and ventilation; lighting and windows; appliances and other consumer products; controls; materials; telecommunications; and diagnostic equipment used to calculate the efficiency of energy use in buildings. The CPT Branch has organized its approach into three areas: (1) the development of more energy-efficient technologies, (2) the development of energy-efficient consumer products, and (3) the analysis of and dissemination of information about energy conservation. A decentralized management plan has been established with the CPT Branch having responsibility for program direction and policy making and three national laboratories assuming all other normal functions of program managers. These chapters are included: (1) Introduction; (2) Headquarters Program, including heat pumps and building diagnostics; (3) Oak Ridge National Laboratory Program (appliances and analysis and information); (4) Brookhaven National Laboratory Program (building systems controls, materials, and space conditioning); and (5) Lawrence Berkeley Laboratory Program (lighting and windows). (BYB)
Availability: TIC free

Energy Resources Co. Inc.
Address: 185 Alewife Brook Parkway, Cambridge, MA 02138
A Study of the Impact of Reduced Retail Store Operating Hours on Sales, Employment, Economic Concentration, and Energy Consumption

Report No. PB-243579, Conservation Paper Number 7, 305 p.
22 Oct 1974
Sponsor: Federal Energy Administration, Office of Energy Conservation and Environment, Office of Industrial Programs
Abstract: This project was undertaken to analyze the possible impacts of government regulation of retail selling hours on sales, employment, economic concentration, and energy consumption. Specific major results provide: (1) estimates of energy savings which may accrue from regulating retail selling hours; (2) scenarios of regulatory schemes deemed economically and socially feasible; (3) analysis of likely economic retail hours; and (4) statement of the least disruptive hours of closing if regulations on commercial hours were to be introduced. (132 references) (auth)
Availability: NTIS

Enviro-Management & Research Inc.
Address: 901 8th St. NW, Washington, DC 20001
Evaluation of Building Characteristics Relative to Energy Consumption in Office Buildings

Report No. PB-248774, FEA/D-76/006, 68 p.
22 Sep 1975
Sponsor: Federal Energy Administration, Office of Energy Conservation and Environment, Office of Buildings Programs
Abstract: The purpose of the project was to survey data on a limited sample of office buildings to identify those factors which have an impact on energy consumption. Such data can be used for the development of coefficients for monitoring energy consumption, or as the basis of future research. Findings indicated that: 1) an EUI (energy use index) expressed as BTUs/gross conditioned cubic foot per year appears to be a more effective measure of energy than BTUs/gross conditioned square foot per year; and 2) the following factors appear to correlate significantly with energy consumption: total building refrigeration capacity, hours of cooling system operation, type of HVAC system installed, thermal transmission of gross wall area, lighting power density, and maintenance and systems control practices. (GRA)
Availability: NTIS

Erth, R.A.; Ginder, H.B.
Borg-Warner Corp., York Division, Advance Engineering Dept.; Borg-Warner Corp., York Division, Centrifugal Systems Dept.
Address: York, PA 17405
First Cost - Operating Cost Tradeoffs for Air Conditioning Equipment

Paper presented at the Conference on Improving Efficiency in HVAC Equipment and Components for Residential and Small Commercial Buildings held October 7-8, 1974 at Purdue University, pp. 147-154
1974
Abstract: This paper reviews several methods for evaluation of not only contrasting (air conditioning) units with different rating point performances, but also with different part load performances. Expected increases in the cost of electric power are considered and tabular multipliers are provided to take these increases into account. In making this evaluation, two assumptions are invoked. One is that comparison of alternative equipment will be on a life-cycle cost basis, that is, owning and operating costs over the entire life of the equipment will be considered. The second is that a comparison of life cycle costs will be based on an average annual cost, determined by computing the cost for an average year, taking into account expected increases in operating costs and a rate of return on investment (or time value of money). (auth, from introduction)

Executive Office of the President, [illegible]
Management and Budget, Statist[illegible]olicy Division
Address: Washington, DC
S[illegible]rd Metropolitan Statistical Areas: 1975

R[illegible]ed Edition, 115 p.
Abstract: The concept of "Standard Metropolitan Statistical Area" (SMSA) was developed to allow Federal agencies to present general-purpose statistics about metropolitan areas. Part I of this publication describes the criteria used to design and to define SMSAs. Part II lists the titles and definitions of the 276 SMSAs and includes the following information for each SMSA: the component counties or county equivalents, central cities and other places of 20,000 or more within the SMSAs, and the 1970 population for each geographic area. The third part details the criteria followed in establishing Standard Consolidated Statistical Areas, which are listed in Part IV. The counties of each state within SMSAs (excluding New England) are listed in Part V, and the cities and towns of each New England state within SMSAs are listed in Part VI. Part VII provides a list of New England County Metropolitan Areas. The final two parts cover: definitions affected by Criterion 5 or Criterion 8, and changes in SMSAs from 1950 to 1975. A map of the SMSAs defined by the Office of Management and Budget, October 1975, is provided. (BYB)
Availability: GPO $2.30, Stock No. 041-001-00101-8

Fariss, T.
Oklahoma Gas & Electric Co.
Major Appliance Saturation Survey, 1968 Marketing Report

Statistical and marketing report by O.G.&E., 22 p.
1969
Abstract: This report summarizes data obtained from questionnaries sent to residential customers of an electric utility. The questions concerned their use of major appliances (electric ranges, televisions, water heaters, clothes dryers, freezers, air conditioners, dishwashers, clothes washers, and refrigerators). From the data, the saturation levels of appliances were determined. The characteristics of the households using the appliances were also determined (age of house, number of occupants, and age of head of household). (MPG)

Federal Energy Administration
Address: Washington, DC 20461
Findings and Views Concerning the Exemption of Middle Distillates from the Mandatory Petroleum Allocation and Price Regulations

169 p.
15 Jun 1976
Abstract: The Federal Energy Administration has concluded that mandatory allocation and price regulations on middle distillates are no longer necessary and is therefore transmitting such an amendment to the Congress as specified by Section 12 of the Emergency Petroleum Allocation Act (EPAA). Middle distillates are not in short supply, and adequate supplies are expected for the near term. Ample unused refinery capacity guarantees that excluding middle distillates from controls will not adversely affect the supply of any other petroleum product. Exemption of middle distillates from price and allocation regulations is not likely to result in any significant price increases. Competition and market forces are sufficient to protect consumers. Deregulation of middle distillates will not cause inequitable prices for any class of end users or other product users, nor will such action have significant impact on the rate of unemployment, the Consumer Price Index, or the Gross National Product. Continued regulation of middle distillates is no longer necessary to accomplish the goals of the EPAA and is now operating to impede the achievement of those goals. (BYB)

Federal Energy Administration
Address: Washington, DC 20461

Findings and Views Concerning the Exemption of Residual Fuel Oil from the Mandatory Petroleum Allocation and Price Regulations

112 p.
29 Mar 1976
Abstract: An amendment to the Federal Energy Administration's regulations has been prepared that would exempt residual fuel oil from mandatory allocations and price controls. This report has been written to fulfill requirements of Section 12 of the Emergency Petroleum Allocation Act, which calls for findings and FEA's views to support such amendments. Provided in this document is an analysis of (1) the supply of and demand for residual fuel oil, (2) the pricing of the product, and (3) the potential economic impact of exempting residual fuel oil from regulation. The following conclusions are reached: residual fuel oil is not in short supply; exemption of residual fuel oil from regulations will not adversely affect the supply of any other oil or refined product subject to the EPAA; competition and market forces are adequate to protect consumers; and exemption of residual fuel oil from regulation will not result in inequitable prices for any class of residual fuel oil or other product user. (BYB)

Federal Energy Administration
Address: Washington, DC
1977 National Energy Outlook

2 Volumes, v.p.
1977
Abstract: Updating forecasts made in the 1976 National Energy Outlook, this report presents a revised appraisal of the nation's energy situation with current information on legislation, prices, and resource development. This period is considered a transition time in which traditional energy sources--oil and gas--are depleting. Coal is expected to again become a major energy source. New energy technologies--nuclear, solar, and geothermal--will be important in the long range. This report relates the world energy market to the energy situation in the U.S. The factors influencing oil and gas supply are analyzed, and an analysis of the effects of regulation of the wellhead price of natural gas is presented. Higher energy prices plus conservation programs are expected to reduce the energy growth rate to 2.5% from the historical rate of 2.9%. U.S. petroleum production is projected to increase to 10.0 MMB/D by 1985 and then decrease to 9.3 MMB/D in 1990. Natural gas production is expected to decrease from the 1976 level of 19.0 Tcf to 16.6 Tcf by 1985 if interstate gas prices are still set by current Federal Power Commission regulations. Coal will increase from 660 million tons in 1976 to 1,050 million tons in 1985. It is anticipated that electric-power generation will grow at an annual rate of 5% from 1975 to 1985 compared to the historical rate of about 7 to 8%. New energy technologies--solar, geothermal, and synthetic fuels--are expected to make only a minor contribution by 1985 (about 1% of the total energy demand), but by the year 2000, these sources may contribute as much as 11% to total energy needs. Investment costs for energy supplies will be as high as $630 billion (in 1975 dollars) in the next decade, in comparison to $325 billion for the 1966-1975 time period. (BYB)
Availability: GPO

Federal Energy Administration
Address: Washington, DC 20461

A Pricing Guide for Natural Gas Processors

Report No. FEA/H-76/410, 12 p.
Oct 1976
Abstract: This booklet has been developed by the Federal Energy Administration (FEA) to assist natural gas processors in understanding and complying with FEA regulations on the pricing of Natural Gas Liquids (NGLs) and NGL products. Included in this guide is a description of the main provisions of Part 212, Subpart K--Natural Gas Liquids (Title 10, CFR), of the Federal Energy Regulations as they apply to the processors of Natural Gas Liquids. The purpose of this guide is to describe and summarize these provisions, so that all firms affected by the regulations have a simplified explanation, and also have a means of obtaining further information from the FEA. Although certain provisions of these regulations may change in the future, the guide was current as of September 1976. Information in this guide is general. For specific questions about the FEA regulations, the Federal Energy Guidelines should be consulted, or an FEA regional office can be contacted. (from introductory letter)

Federal Energy Administration
Address: Washington, DC 20461
Energy in Focus: Basic Data

Report No. FEA/A-77/144, 13 p.
May 1977
Abstract: This publication provides basic data on energy resources and consumption from 1950 to 1976 in the following tables: Domestic Consumption Per Capita by Source (5-year increments); Historical Energy Consumption Patterns--1860-1976; Domestic Energy Consumption by Type of Fuel; Domestic Energy Consumption by Economic Sector (commercial/residential, industrial, transportation, and electricity generation); Domestic Energy Consumption Per Capita by Source; Total Domestic Energy Production; Domestic Crude Oil Production and Proved Reserves; Domestic Demand for Refined Petroleum Products; U.S. Oil Imports; U.S. Crude Oil Refining Capacity; U.S. Natural Gas Production, Consumption, and Reserves; Number of Wells Drilled in the U.S.--Oil, Gas, and Dry; Bituminous and Lignite Production and Consumption; Bituminous and Lignite Production by Geographical Location; Nuclear Power Capacity and Production; Electricity Generation by Source; Crude Oil Prices; Motor Gasoline Prices; Natural Gas Prices; and Coal Prices. This report is to be updated periodically and expanded to furnish more comprehensive data. (BYB)

Federal Energy Administration
Address: Washington, DC 20461
A Compliance Guide for Domestic Crude Oil Pricing for Producers and First Purchasers

Report No. FEA/R-76/173, 36 p.
Apr 1977
Abstract: This booklet has been developed to assist producers and first purchasers in both understanding and complying with Federal Energy Administration regulations regarding the pricing of domestic crude oil. The guide presents the changes in regulations resulting from the Energy Policy and Conservation Act for both the "first stage" implementation effective February 1, 1976 and the "second stage" implementation effective March 1, 1976. Also included are subsequent amendments by the Energy Conservation and Production Act as well as clarifications of definitions of property, posted prices, et al., that have been issued since that time.

(from Preface)

Federal Energy Administration, National Energy
Information Center
Address: Washington, DC 20461
Monthly Petroleum Statistics Report

Monthly report, approximately 15 p.
Abstract: This series of reports is developed from data collected under the Joint Federal Energy Administration--Bureau of Mines Petroleum Reporting System. Data are presented in these tables: U.S. Petroleum Industry Operations Excluding Puerto Rico; Refinery Operations; Refinery Production of Petroleum Products; Primary Stocks of Crude Oil and Petroleum Products; and Imports of Crude Oil, Unfinished Oils, and Petroleum Products. Graphs depict Petroleum Imports; Crude Runs-to-Stills; Crude Oil Refiner Acquisition Cost; Crude Oil Wellhead Price; Distillate Fuel-Heating Oil Stocks; Motor Gasoline Stocks; and Retail Price (Gasoline, Home Heating, and Residual Fuel Oil). Statistics in these publications are not final and are subject to change. (BYB)

Federal Energy Administration, National Energy
Information Center
Address: Washington, DC 20461
Directory of Federal Energy Data Sources:
Computer Products and Recurring Publications

Report No. PB-254163, FEA/B-76/219, 84 p.
May 1976
Abstract: The purpose of this directory is to announce two major types of Federally-sponsored energy-related information: energy information on magnetic tape and recurring publications which contain energy-related numerical data. The information on magnetic tape is primarily in the form of data files. However, there are also computer programs, data base reference services, and mathematical models. The items are listed under broad subject categories. The citations include title, responsible agency, dates of coverage, accession number, availability information, and abstract. Each entry is indexed by subject, originating agency, and accession number. (from Foreword)
Availability: NTIS

Federal Energy Administration, Office of Consumer
Affairs, Special Impact
Address: Washington, DC
Analysis of a Retrofit Program for Low-Income
Consumers

Report No. PB-245149, FEA/E-75/273, 112 p.
Nov 1974
Abstract: An analysis is made of energy and the consumer price index, the problems of home heating, and home heating costs for the poor. A retrofit program is outlined for low-income families that tend to live in homes with fewer energy saving features than homes of the non-poor. The study is divided into three major sections: statement of the problem; a retrofit program which includes housing conditions of the poor, conservation and cost savings, crude oil savings, employment generation, and inflationary impact; scope of existing programs including existing funding sources and existing manpower and volunteer resources; and new programs including legislation relating to retrofit programs, a model bill, and a local delivery program. Appendixes include fuel price data for selected northern cities, current legislation relating to retrofit programs, cost analysis and identification of households, and identification of poor households by state, owner vs. renter occupied. (16 references) (GRA)
Availability: NTIS

Federal Energy Administration, Office of Energy
Conservation and Environment
Address: Washington, DC 20461
Lighting and Thermal Operations: Energy
Management Action Program for Commercial,
Public, Industrial Buildings - Guidelines

10 p.
1974
Abstract: Guidelines are set out for conserving energy in commercial, public, and industrial buildings. These guidelines represent desirable targets with regard to illumination levels, efficiency in lighting, and operating heating and cooling systems. The outline of conservation measures covers both indoor and outdoor lighting with the following recommendations: 50 foot candles at desks, work stations, etc.; 30 foot candles in work areas; and 10 foot candles in hallways, storerooms, etc. Thermostat settings of 65-68 degrees F in winter and 78-80 degrees F in summer are recommended. (BLM)
Availability: GPO $2.30

Federal Energy Administration, Office of Energy
Conservation and Environment, Marketing Office
Address: Washington, DC 20461
Consumers' Attitudes, Knowledge, and Behavior
Regarding Energy Conservation

Report No. FEA/D-76/469, 200 p.
Dec 1976
Abstract: Based on over 1,000 telephone interviews, this report examines people's attitudes, knowledge, and behavior concerning energy conservation. Chapter I looks at consumers' willingness to conserve and their perception of the probability that others will conserve. Indivi[illegible] who are already conserving ~~are the~~ ones [illegible] are most willing to drive 55 mph and sl[illegible]r or to set their thermostats at 68 degrees and lower. The second chapter, which discusses public knowledge, attitudes, and behavior concerning natural gas issues, states that most people believe that there is a serious need to save natural gas, and that they are willing to conserve. Data presented in Chapter III indicate that most drivers drive in ways that save gasoline. However, 69% of the chief wage earners drive themselves to work and do not carpool or take passengers. In Chapter IV, Energy Saving Behavior Around the Home, it is concluded that beliefs about energy conservation affect the way people behave. Therefore, informing people about more energy-efficient behavior would result in more conservation. The fifth chapter, which observes parents' perceptions of their children's source of energy information, indicates that a significant amount of energy information has been transmitted to American homes by children who obtained this information in school. The final chapter considers people's understanding of the energy situation and their evaluations of alternative actions. Carpooling, driving 55 mph, and walking short distances are preferred over using mass transit as means of conserving gasoline. In the home, people prefer weatherproofing to raising the setting of air conditioners and lowering the setting of thermostats. (BIB)

Federal Energy Administration, Office of Energy Conservation and Environment, Office of Industrial Programs
Address: Washington, DC
Guide to Energy Conservation for Food Service

Report No. PB-249462, FEA/D-75/411, 79 p.
Oct 1975
Abstract: The guide opens with a chapter that offers suggestions on how to begin an energy conservation program in a food service establishment. It is followed by four chapters on the four major types of energy-consuming equipment used by food service operations for: food preparation and storage; lighting; heating, ventilating and air conditioning; and sanitation. Each of these chapters begins with a general discussion of how energy losses can occur for the types of equipment discussed and what the potential is for savings. Emphasis is placed on increasing the efficiency of presently owned equipment. This introduction is followed by three parallel sections called Operation, Maintenance, and Planning. The Operation section in each chapter is concerned with day-to-day energy-saving changes that can be made in the way restaurant equipment is currently operated. For the most part, these measures can be implemented at no cost. The Maintenance section describes simple procedures and maintenance tasks that can be undertaken at little, if any, cost and generally without professional assistance. The Planning section describes energy-saving equipment and procedures that should be considered when renovating an existing food service establishment or building a new one. Considerable savings can be achieved by implementing these suggestions; however, a significant capital investment may be required. This guide concludes with a chapter containing a step-by-step procedure that will enable the food service operator to chart fuel usage and monthly energy consumption. (from Introduction)
Availability: NTIS; also available from GPO $2.[illegible], Stock No. 041-016-00085-2

Federal Energy Administration, Office of Energy Conservation and Environment, Office of Utilities Programs
Address: Washington, DC 20461
The Challenge of Load Management, A Convergence of Diverse Interests. Proceedings of the Conference Held June 11-12, 1975

Report No. PB-244576, FEA/D-75/492, Conservation Paper No. 24, 118 p.
1975
Sponsor: American Public Power Association; Edison Electric Institute; National Association of Regulatory Utility Commissioners; National Rural Electric Cooperative Association
Abstract: The papers in these proceedings summarize the elements of the challenge of load management, by presenting issues in rate reform, enabling technology, and load management practices. In particular, these papers indicate the "convergence of diverse interests" in the relationship between energy conservation and load management. Included in the proceedings are the following papers: the Keynote Address by the Honorable Frank G. Zarb, Administrator of the Federal Energy Administration; "Load Management--Historical Perspective" by John S.K. Shanrahan of the Edison Electric Institute; "Load Management Potential--An Overview" by Dr. Jules Joskow and William B. Shew; "Time of Day Pricing: Why and How" by Dr. Charles J. Cicchetti; "A Century Past and a Decade Ahead" by Henry J. Rice; "Enabling Technology--Metering and Control" by Robert R. Wylie; "Solar Climate Control, Storage and Electric Utility Load Management" by Dr. Peter E. Glaser and Melvin D. Piatte; "Consumer Education and End-Use Conservation" by Dr. Jay B. Kennedy; "Impact of Load Management on Regional Reliability Councils and Power Pools" by Walter J. Matthews of the National Electric Reliability Council; "Some Aspects of the Impact of Electricity Marketing on the System Load Pattern" by Geoffrey J. Hughes of the Electricity Council of England; "Load Management--Economic and Practical Considerations" by Wallace W. Carpenter; "Impact of Load Management--A Regulator's Perspective" by Richard D. Cudahy; "The Energy Puzzle: Electricity Rates, Space Conditioning and Load Management" by Dr. Ernst R. Habicht, Jr.; "The Impact of Load Management on the Industrial and Commercial Sectors" by Edward V. Sherry; "Rural Electric Cooperative's Efforts" by Frank Linder; "A National Perspective--Convergence of Interests" by Roger W. Sant of FEA; and "Utilities Action Plan" by Dr. Douglas C. Bauer of FEA. (BYB)
Availability: NTIS

Federal Energy Administration, Office of Energy Conservation and Environment, State Energy Conservation Programs
Address: Washington, DC
Energy Conservation on Campus. Volume II. Case Studies

Report No. FEA/D-76/230, 30 p.
Dec 1976
Abstract: Since 1973 energy costs on campuses have doubled, and, on some tripled. Prior to that time, cost emphasis was primarily directed toward materials and labor rather than oil, gas, and electricity. The high cost of energy and the curtailment of primary preferred fuel has upset many long-standing maintenance and operation policies, forcing institutions to look quickly for ways to reduce energy usage. During this search administrators found that many college buildings consume large quantities of energy by virtue of their design. Alteration of many of these facilities would be difficult and costly, thus initial low cost alternatives were taken permitting time for study in order to devise long-range methods to lower the amount of energy consumed. This publication is comprised of a selection of case studies from a diversity of institutions which, in spite of design limitations, implemented initial conservation programs which saved 15% to 25% of the energy previously used. At some institutions the percentages have been higher. Reporting institutions continued to reduce energy consumption through the development of an energy management program, as discussed in Volume I of this publication. (from Introduction)
Availability: GPO $0.80, Stock No. 041-018-00126-3

Federal Energy Administration, Office of Energy Conservation and Environment, State Energy Conservation Programs
Address: Washington, DC
Energy Conservation on Campus. Volume I: Guidelines

Report No. FEA/D-76/229, 36 p.
Dec 1976
Abstract: Based on extensive analysis of existing energy management programs, these guidelines were developed to assist colleges and universities in establishing or improving energy conservation programs. The development of a campus energy management program is described in Chapter I, which

outlines these program elements: commitment; the energy conservation committee; an energy management officer; energy use and cost information; and results, measurement, and evaluation. Chapter II, Energy Consumption Reduction Categories, defines three categories of consumption reduction opportunities: Quick Fix, measures that achieve rapid and significant energy savings at negligible cost with little or no disruption of the academic environment; Refits, measures which require moderate capital investment to achieve additional energy savings of 10% to 15%; and Systems Convert, a major change of a system design. A Quick Fix Checklist is provided in Chapter III for these energy use categories--operations; vehicle/transportation; utilities; and heating, ventilating, and air conditioning. The Refit Checklists in Chapter IV cover utilities systems, steam systems, water systems, air distribution systems, control adjustment and modifications, electric power, ventilation, domestic hot and cold water, lighting, and elevators-escalators. The Systems Convert Checklists, Chapter V, lists suggestions on central campus environmental systems, utility systems, steam systems, air distribution systems, control adjustment and modifications, ventilation, domestic hot and cold water, lighting, elevators-escalators, and operations. Appendices include: an Energy Survey Form, a Building Information Survey Form, Consumption Charts, and recommended lighting levels. (EYB)
Availability: GPO, Stock No. 041-C18-00125-5, Cat. No. FE 1.8:C15/V.1

Federal Energy Administration, Office of Energy Information and Analysis, Competition Task Force
Address: Washington, DC 20461
Petroleum Market Shares. A Report on Sales of Distillate and Residual Fuel Oil to Ultimate Consumers - 1975

Report No. PB-260565, FEA/B-76/352, 57 p.
Jun 1976
Abstract: This report presents the results of the Federal Energy Administration (FEA) survey of firms that sold distillate and residual fuel oil to ultimate consumers during the period January 1, 1975, through December 31, 1975. Nationally, refiner-marketers sold approximately 42 percent of their distillate fuel oil in 1975 to ultimate consumers (i.e., end-users and wholesale purchasers-consumers), and 58 percent of their volume to independent marketers as either branded or nonbranded product. Refiner-marketers sold nationally approximately 80 percent of their 1975 residual fuel to ultimate consumers and 20 percent of their volume to independent marketers as branded or nonbranded product. (2 references) (GRA)
Availability: NTIS

Federal Energy Administration, Office of Energy Information and Analysis, Competition Task Force
Address: Washington, DC 20461
Petroleum Market Shares - Regional Sales of No. 2 Distillate Fuel Oil to Ultimate Consumers, 1972 through 1975

Report No. PB-259944, FEA/B-76/371, 117 p.
Jul 1976
Abstract: This report presents regional results of the Federal Energy Administration (FEA) survey of firms that sold distillate and residual fuel oil to ultimate consumers during the period January 1, 1972 through December 31, 1975. The survey covers the sales of No. 2 distillate fuel for home heating, commercial, and miscellaneous industrial fuel applications. Sales of No. 2 diesel fuel for highway use by refiner-marketers are included. Since the survey was designed primarily to monitor market shares in the critical heating oil market, independent truckstop operators were not surveyed; their diesel sales, therefore, are not represented in the survey results. The survey results, however, establish a consistent time series for measuring trends in the market share position of refiner-marketers versus independent fuel oil distributors in the No. 2 distillate market. (2 references) (GRA)
Availability: NTIS

Federal Energy Administration, Office of Policy and Analysis; Federal Energy Administration, Office of Energy Resource Development
Address: Washington, DC 20461
Oil and Gas Resources, Reserves, and Productive Capacities, Submitted in Compliance with Public Law 93-275, Section 15(b). Final Report. Volumes I and II

Report No. PB-246354, FEA/G-75-618, 75 p. for Volume I; Report No. PB-246355, FEA/G-75-619, 156 p. for Volume II
Oct 1975
Abstract: An essential element in formulating a national energy policy is the development of a reliable estimate of domestic crude oil and natural gas resources, reserves, and productive capacities. The Federal Energy Administration (FEA) Act directs the FEA to prepare a "complete and independent analysis of actual oil and gas reserves and resources in the United States and its Outer Continental Shelf, as well as of the existing productive capacity and the extent to which such capacity could be increased for crude oil and each major petroleum product each year for the next ten years through full utilization of available technology and capacity." ... Volume I of the final report provides final reserve and productive capacity estimates, compares these estimates with estimates from other sources, projects a U.S. crude oil productive capacity estimate, evaluates the procedures used to develop these estimates, and recommends procedures to be used for future estimates.. Volume II of the final report provides summaries of engineering analyses of major domestic oil and gas fields. (from Summary)
Availability: NTIS

Federal Energy Administration, Office of Policy and Analysis, Office of Data and Analysis, Competition Task Force
Address: Washington, DC 20461
Petroleum Market Shares. Report on Sales of Propane to Ultimate Consumers: 1975

Report No. PB-255624, FEA/B-76/307, 82 p.
30 Apr 1976
Abstract: Written in response to requirements of Section 4(c)(2)(A) of the Emergency Petroleum Allocation Act of 1973 (Public Law 93-159), this report summarizes data, for the period January 1975 through December 1975, provided by refiners and by a sample of independent marketers of propane and propane-butane mixes. Nationally, the total 1975 sales of propane to ultimate consumers as reported in the survey decreased approximately 944 million gallons (10 percentage points) relative to 1974 levels. In 1975, the market share of refiner sales to ultimate consumers decreased approximately 4.7 percentage points over 1974 levels. Nonbranded and branded

independent marketers appeared to have increased their market share by 2.6 and 2.1 percentage points, respectively. A summary of the performance of refiner marketers, nonbranded independent marketers, and branded independent marketers follows in this report. (3 references) (from Summary)
Availability: NTIS

Federal Power Commission, Bureau of Power
Address: General Accounting Office Building, 441 G St. NW, Washington, DC 20426
All Electric Homes in the United States, Annual Bills - January 1, 1975, Cities of 50,000 and More

Report No. FPC R-87, 30 p.
1963 through 1975
Abstract: The Federal Power Commission annually reviews the electric rate levels and power consumption in homes using electricity exclusively for energy purposes. Utilities report bills for all communities of 50,000 population and more throughout the United States. Data are analyzed and presented in tables and maps. (BYB)
Availability: GPO $0.75 for 1975 report

Federal Power Commission, National Power Survey, Technical Advisory Committee on Conservation of Energy, Task Force on Practices and Standards
Address: Washington, DC
National Power Survey. Practices and Standards: Opportunities for Energy Conservation

The Report and Recommendations of the Task Force on Practices and Standards to the Technical Advisory Committee on Conservation of Energy, 250 p.
Dec 1973
Abstract: The purpose of this study was to determine the impact on electric power consumption and the potential for conservation by altering the current practices and standards in electric utility operations, transportation, construction, and industry generally. The practices considered include technical practices used at the point of energy consumption in buildings, in industrial processes, and in transportation; technical practices used in power generation; non-technical practices in pricing and rates; and practices in assessment and evaluation of the effectiveness of energy use. Considering power generation and distribution, possible improvement of practice in power pooling would provide the most significant energy saving opportunity. Changes in present practices and equipment to operate industrial processes and building services offer the greatest potential for conservation of primary energy sources. Existing methods to evaluate the effectiveness of energy use are found to be inadequate to provide a basis for planning conservation efforts. The influence of price upon conservation efforts is observed. The 22 appendixes are case studies of practices and equipment which can be modified to conserve energy. (BYB)
Availability: GPO $3.20

Fenves, S.J.; Rankin, K.; Tejuje, B.K
Carnegie-Mellon Univ., Dept. of Civil Engineering; U.S. Dept. of Commerce, National Bureau of Standards, Institute for Applied Technology, Center for Building Technology
Address: CMU, Pittsburgh, PA 15213; DOC, Washington, DC 20234
The Structure of Building Specifications

Report No. NBS BSS-90, 83 p.
Sep 1976
Abstract: This paper provides a scientific basis for the formulation and expression of performance standards and specifications and for explicit attention to performance in procedural and prescriptive standards and specifications. The provisions of the NBS-developed Interim Performance Criteria for Solar Heating and Combined Heating/Cooling Systems and Dwellings, a performance specification, are classified in terms of the physical entities addressed, the attributes of the built environment, and the properties which group together particular physical entities which may be subject to similar dysfunctions. These provisions are also subjected to a linguistic analysis which examines in detail the wording used and formalizes certain key concepts which are realized in the wording. The provisions of the Uniform Plumbing Code, a prescriptive code, are classified in terms of the physical entities addressed and the performance attributes which can be inferred (though they are not explicitly addressed). Guidelines for the expression of provisions in performance codes and specifications are presented. These guidelines are based on the classification studies and the linguistic analysis mentioned above. (auth)
Availability: GPO $1.45, SD Cat. No. C13.29/2:90

Ferrell, D.T., Jr.; Strohlein, E.M.; Chreitzberg, A.M.; Doe, J.B.
ESB Inc., C.E. Norberg Technology Center
Address: 19 West College Ave., Yardley, PA 19067
Design and Cost Study for State-of-the-Art Lead Acid Load Leveling and Peaking Batteries

Report No. EPRI EM-375, Research Project 419-1, 99 p.
Feb 1977
Sponsor: Electric Power Research Institute
Abstract: This design and cost study has applied state-of-the-art tubular positive lead-acid battery technology to estimate the selling prices for one 2500 cycle 10 MW 100 MWhr load leveling battery and two 2000 cycle 20 MW peaking batteries delivering 60 and 100 MWhr. Accessories for the batteries judged vital to meeting the EPRI performance and life requirements are described and priced. These prices, including transportation and installation, are respectively $62, $65, and $73/kWhr for the first battery purchased, but are reduced by salvage-reuse credits to $29, $30, and $33/kWhr for the second battery purchased. Amortized in the price is a battery manufacturing plant investment of 14.4 million for a three-shift operation producing 1000 MWhr/yr. (8 references) (auth)

Fischer, H.C.
Oak Ridge National Laboratory, Energy Division
Address: Oak Ridge, TN 37830
The Annual Cycle Energy System

Report No. CONF-750812-4, presented at the Intersociety Engineering Conference in Newark, NJ, August 19, 1975, 34 p.
1975
Sponsor: U.S. Dept. of Housing and Urban Development; Federal Energy Administration
Abstract: The Annual Cycle Energy System (ACES) is a residential and commercial heating and air conditioning system that also provides domestic water heating. The energy transfer is by an electrically driven heat pump which obtains its heat from water stored in situ in an underground insulated tank. Most of the water is frozen during the winter heating season and the stored ice provides air conditioning in the summer. The resulting

annual coefficient of performance of the heat pump can be as high as five, since both heating and cooling outputs of the heat pump are used. The concept draws a heat balance around the structure on an annual basis. In 80% of the country, the heating and cooling requirements are in or can be brought into balance for a well insulated building. Reduction of ice bin insulation, gain of heat from outside air, or use of solar panels or outside air coils are possible means to compensate for unbalanced heating and cooling loads in the north. In the south, occasional supplemental compressor operation as an off-peak ice maker may be necessary in the summer. The ice freezing process is analyzed and calculations are compared to experimental tests results. Topics discussed in this paper include: the results of analysis on the heat leak into the ice storage tank; and the effect of latitude on the heat balance in the buildings as it affects the size of storage tank, insulation of storage tank, supplemental solar panels, and cost of operation. Cost calculations based on a 9%, 20-year mortgage and associated costs and credits are shown which indicate that the system breaks even with electric resistance heating and individual air conditioners at about 2.5 to 3.5 cent/kWhr electricity cost. (auth)

Availability: NTIS

Ford, G.R.

Executive Office of the President, Office of the White House Press Secretary

Address: Washington, DC 20500

Message to Congress from the President; Summary Fact Sheet: President's Energy Message

White House Press Release, (February 26, 1976), 24 p.

26 Feb 1976

Abstract: The President's message to Congress reiterated the importance of energy independence, outlined actions he had taken to achieve energy goals, and urged Congressional action on 18 major energy proposals. The President summarized his energy programs, which were designed to stimulate energy conservation; to increase the domestic supply of natural gas, nuclear energy, coal, and oil; and to develop advanced technology to obtain energy from solar, geothermal, fusion, and other sources. In addition, he announced these new actions: legislation to expedite the delivery of natural gas from the north slope of Alaska; a new policy for encouraging needed liquefied natural gas imports; a special contribution of up to $5 million over the next five years to strengthen the safeguards program of the International Atomic Energy Agency; and a $1 billion program of financial assistance to areas impacted by the development of Federally-owned energy resources. The 18 proposals awaiting Congressional action include proposals to: deregulate the price of new natural gas; provide the added short-term authorities needed to manage potential natural gas shortages; reform the nuclear facilities licensing process by providing for early site review and approval and by encouraging design standardization; assure the availability of enriched uranium fuel for nuclear power plants and facilitate the creation of a private enrichment industry; allow commercial oil production from the Naval Petroleum Reserves; modify automobile and stationary source pollution control requirements in the Clean Air Act; create a new Energy Independence Authority; authorize financial assistance to assure construction of plants to furnish a minimum of 350,000 barrels per day of synthetic fuels production by 1985; develop state plans and procedures to assure sites for necessary energy facilities; reform the utility rate-setting practices of state regulatory commissions; and provide tax incentives to stimulate investment in the construction of new power plants. (BYB)

Availability: White House, Press Release Office, Washington, DC 20500

Forrest Coile and Associates; Moore (Charles W.) Associates

Address: FCA, 11721 Jefferson Ave., Newport News, VA; CWMA; Essex, CT

Technology Utilization House Study Report

Report No. N76-13595, NASA CR-144896, 132 p.

Sponsor: National Aeronautics and Space Administration

Abstract: Energy management and the construction of energy efficient structures will be the goal of innovative builders for the next few decades. The National Aeronautics and Space Administration, in its Project TECH, will build a single-family demonstration house using available cost effective components designed to reduce the requirements for energy and utility service. This review of the TECH house plans and component specifications emphasizes the importance of placement on the lot and orientation of windows and vegetation to take advantage of both area and immediate climate characteristics. A solar collector and radiator system with thermal storage and waste-water partial reclamation are designed for the project. Detailed cost effectiveness data are analyzed, and approval is given to fiberglass insulation, urea tri-polymer foam insulation, thermal shutters and insulating curtains, and masonry walls. Door and window manufacturers are urged to routinely furnish information on thermal and infiltration performance of their products. (28 references) (DCK)

Availability: NTIS

Frabetti, A.J., Jr.; Wilcock, D.K.; Lovell, R.A., Jr.; Gordon, M.; Maddox, K.; Sheldon, C., II; Westfield, J.D.

Development Sciences Inc.

Address: East Sandwich, MA

Application of Net Energy Analysis to Consumer Technologies

Report No. ERDA-77-14, 371 p.

Feb 1977

Sponsor: Energy Research and Development Administration, Office of Planning, Analysis, and Evaluation

Abstract: Utilizing a net energy methodology that examines both direct and indirect energy consumption, this report determines the overall energy resource consumption effects of satisfying several selected consumer demands for energy: a residential demand for the provision of heat, cooling, and hot water; a transportation sector demand to power an automobile; and an industrial demand for process steam and electricity. Energy consumption is described through the use of trajectories that, in modular fashion, trace from in situ resource to the particular final demand. This allows the analyst to examine changing fuel forms in the supply path as well as changing technology in the user demand path. The beneficial effects of the developing residential energy use technologies are quantified, the flexibility of the electric automobile with regard to resource use is demonstrated, and the overall energy savings via on-site power generation are detailed. In particular, the study demonstrates the usefulness of the net energy methodology as a tool for assessing the true

implications for fossil reserves when substituting different energy sources. (78 references) (auth)
Availability: NTIS

Frey, D.
Wisconsin Univ., Institute for Environmental Studies, Energy Systems and Policy Research Group
Address: Madison, WI 53706
A Model of Residential Energy Use in Wisconsin

Energy Systems and Policy Research Report No. 11, IES Report 37, 26 p.
Dec 1974
Sponsor: National Science Foundation, RANN Program; Upper Great lakes Regional Commission
Abstract: The Wisconsin residential energy use model is designed to provide a means of analyzing energy demand for the residential sector of the State of Wisconsin. The model is highly disaggregate and relates energy demand to ownership fractions and average use for thirteen major appliances. Space heating, water heating and air conditioning parameters are further broken down according to the type of home, type, and age. By varying new home construction rates, appliance blends and annual use a variety of alternative futures may be created and analyzed. (11 references) (auth)
Availability: Communications Office, Institute for Environmental Studies, University of Wisconsin, 610 Walnut St., Madison, WI 53706

Frieden, B.J.; Solomon, A.P.; Birch, D.L.; Pitkin, J.
Joint Center for Urban Studies of the Massachusetts Institute of Technology and Harvard Univ.
Address: 53 Church Street, Cambridge, MA 02138
The Nation's Housing: 1975 to 1985

159 p.
Apr 1977
Abstract: This publication describes work done on measuring housing needs and housing deprivation in the U.S. Housing construction levels for 1975 through 1985 are predicted, and factors that this prediction is based on are described. Following an Introduction (Chapter One), the second chapter discusses basic population pressures that will influence housing construction--the formation of new households during the time period 1975 to 1985. Chapter Three analyzes the other principle factors affecting construction levels: the demand for improved housing, the replacement of accidental losses and of obsolete mobile homes, the demand for second homes, and adjustments in vacancy rates. Chapter Three also reports on the location of new construction. The fourth chapter studies the nature and extent of housing deprivation experienced by families whose housing choices are limited by low incomes. Chapter Five examines the declining opportunities for home ownership by middle- and poor-income families, resulting from the rapid rise in prices since 1970. The final chapter discusses the implications of this study on public policies and private decisions that will affect the housing situation through 1985. (BYB)

Gaynor, J. (ed.)
Federal Energy Administration, National Energy Information Center
Address: Washington, DC 20461
Monthly Energy Review

Monthly publication, approximately 90 p.
Abstract: Monthly statistics are presented on crude oil and refined products, natural gas, coal, electric utilities, nuclear power, energy consumption, resource development, energy prices, and international petroleum consumption and crude oil production. Tables provide data on production, price, imports and exports, stocks, demand, and development of fossil fuels and refined petroleum products. The section on electric utilities looks at net power production, fuel consumption, stocks, and sales. An examination of nuclear power includes data on power plant operations, the status of nuclear power plants, U.S. uranium enrichment, nuclear power generation by major non-communist countries, and the nuclear fuel cycle. Feature articles on energy concerns appear in various issues, e.g., articles on the price of oil, on propane, and on trends in U.S. petroleum imports. (BYB)
Availability: NTIS

General American Transportation Corp., General American Research Division
NASA's Energy-Cost Analysis Program. Volume I. User's Manual. Volume II. Engineering Manual

Report No. N76-10751 for Volume I, v.p.; Report No. N76-10752 for Volume II, v.p.
Mar 1975
Sponsor: National Aeronautics and Space Administration, Langley Research Center
Abstract: The NASA's Energy-Cost Analysis Program (NECAP) is an extremely powerful and sophisticated computerized system to determine and minimize building energy consumption. The program complies with ASHRAE's "Procedures for Determining Heating and Cooling Loads for Computerized Energy Calculations" manual. It calculates the thermodynamic heat gains and losses of a structure, taking account of the building's thermal storage and hourly weather data. It uses new weighting factors for building lights, and environmental equipment schedules. Infiltration is allowed to vary in accordance to wind velocity. Internal temperatures are allowed to vary when equipment capacity is scheduled or does not meet loads. Standard walls and schedules can be used to simplify program input. Systems now in general use are modeled by system simulation. Users of NECAP can obtain data for selection of the most economical system, system size, fuels, window area, thermal barriers, etc., during the design phase. After installation, users can optimize operating schedules, most economical temperature settings for components, and other valuable data. (auth)
Availability: NTIS

Gibbons, J.H. (chairman)
U.S. Dept. of Interior, Office of Energy Conservation
Address: Washington, DC
End-Use Energy Conservation. Report of Subpanel XII

Report No. WASH 1281-12, used in preparing the AEC Chairman's Report to the President, 226 p.
1973
Sponsor: U.S. Atomic Energy Commission
Abstract: A proposed energy conservation R & D program is described which is intended to decrease the rate of growth in energy demand while maintaining adequate living and environmental standards. Programs are detailed for three main end-use sectors (transportation, buildings, and industry) and for two research sectors (integrated

Annual publication, Report No. NCES 77-401, 229 p.
1977
Abstract: The 1976 edition of the Digest of Education Statistics is the fifteenth in a series of annual publications initiated in 1962. Its primary purpose is to provide an abstract of statistical information covering the broad field of American education from prekindergarten through graduate school. In order to perform this function, it utilizes materials from numerous sources, including the statistical surveys and estimates of the National Center for Education Statistics and other appropriate sources, both governmental and nongovernmental. The publication contains information on a variety of subjects within the field of education statistics, including the number of schools and colleges, enrollments, teachers, graduates, educational attainment, finances, Federal funds for education, libraries, international education, and research and development. The Digest is divided into six chapters: All Levels of Education, Elementary and Secondary Education, College and University Education, Adult and Vocational Education, Federal Programs for Education and Related Activities, and Special Studies and Statistics Related to American Education. To qualify for inclusion in this publication, material must be nationwide in scope and of current interest and value. Series of data extending as far back as 1870 have been employed in many instances in order to give some historical perspective. The introduction supplements the tabular materials in chapters I through VI by providing a brief description of current trends in American education. In addition to updating many of the statistics that appeared in previous years, this edition of the Digest contains a number of new tables and charts. Included in the new material are data from the National Assessment of Educational Progress showing trends over time in performance on science and reading tests; statistics from the National Longitudinal Study on the percent of high school seniors participating in post-secondary education and the sources of their financial support; enrollment in institutions of higher education, by race; trend data on total higher education enrollment, including students in terminal-occupational programs; trend data on the percent of earned degrees conferred upon women; average charges and percent of students completing occupational programs in noncollegiate postsecondary institutions; and statistics on instructional and other staff members in noncollegiate institutions. (from Foreword)
Availability: GPO, Stock No. 017-080-01718-1

Griffin, C.W., Jr.
Construction Specifications Institute Inc.
Address: 1150 Seventeenth St., NW, Washington, DC 20036
Energy Conservation in Buildings: Techniques for Economical Design

189 p.
1974
Abstract: Methods for architects and engineers to design economical, energy-conserving buildings are surveyed. Chapters are included on Thermal Insulation; Glass Wall Design; Heating, Ventilating, and Air-Conditioning (HVAC) Systems; Waste-Heat Recovery; Improved Mechanical Design, Operating and Maintenance Economies; HVAC System Controls; Lighting and Electrical Design; Solar Energy; and the General Service Administration's Demonstration Building. The financial, political, and tax obstacles to reducing energy consumption in buildings are discussed. A new technology, Thermal Energy Storage, is described; this technology could help decrease peak-hour demands on power utilities, while reducing the building owner's electric bills. Throughout the book life-cycle costing is used rather than capital costs to provide a more accurate economic evaluation. (62 references) (auth)
Availability: Construction Specifications Institute, Inc. $20.00

Gross, G.E.; Harper, R.D.; Ahlstrom, S.; Sharp, M.
Midwest Research Institute
Address: 425 Volker Blvd., Kansas City, MO 64110
Energy Conservation Implications of Master Metering. Final Report. Volumes I and II

MRI Project No. 4CC8-E, 224 p.
Oct 1975
Sponsor: Federal Energy Administration, Office of Energy Conservation
Abstract: A study of master metering of electrical service in apartment and office buildings is reported here. The objectives of the study were to determine (1) the difference between electrical energy consumption by tenants with master metered electric service and those who must pay individual electric bills; (2) the extent and trends of the use of master metering of electrical service in apartment and office buildings; and (3) the economic and other factors which influence the initial selection or later conversion to master or individual metering. An additional objective was to provide and evaluate policy alternatives which could control the practice of master metering. ... It was found that residential customers whose electrical service is provided through master meters consume about 35% more electrical energy than those who receive service through an individual meter and who pay directly for the energy used. These master metered customers are found to number about 4,433,000 (about one-third of all U.S. family dwelling units found in buildings of three or more dwelling units per building), and they will consume an estimated 26 billion kwh of electric energy in 1975. Had they used energy as done by individually metered customers, they would have consumed only about 19 billion kwh--a saving of about 7 billion kwh. ... The study of master metering in office buildings provides much less information than does the residential case. High-rise office buildings tend to be master metered and most single story office buildings (as in row developments or shopping centers) tend to be individually metered. The many differences in performance and operation of these two classes of buildings precludes meaningful comparison of their energy consumptions. Furthermore, requirements of special flexibility in rental space causes building owners and managers to avoid individual metering of office space. Seven appendixes are contained in Volume II. (auth, abstract modified)

Grot, R.A.; Socolow, R.H.
Princeton Univ., Center for Environmental Studies
Address: Princeton, NJ
Energy Utilization in a Residential Community

Working Paper W-7, presented at the NSF/RANN Symposium, Energy: Demand, Conservation, and Institutional Problems, held at MIT, February 14, 1973, 27 p., proceedings published by MIT Press, M.S. Macrakis (ed.), 1974, 556 p.
20 Feb 1973
Sponsor: National Science Foundation, RANN Program
Abstract: Twin Rivers, New Jersey, a Planned Unit Development now under construction and already occupied to the extent of 1500 dwelling units, is being used as a laboratory to understand energy usage in residential

utilities systems and cross-sectoral studies). The implementation plan is outlined and the expected impact of this conservation program is discussed. (BYB)
Availability: NTIS

Goldschmidt, V.W.(ed.); Didion, D.(ed.)
Purdue Univ., School of Mechanical Engineering, Ray W. Herrick Laboratories; U.S. Dept. of Commerce, National Bureau of Standards
Address: West Lafayette, IN
Proceedings of the Conference on Improving Efficiency in HVAC Equipment and Components for Residential and Small Commercial Buildings

Conference held October 7-8, 1974 at Purdue University, 226 p.
1974
Sponsor: Federal Energy Administration; American Society for Heating, Refrigerating and Air-Conditioning Engineers Inc.; U.S. Dept. of Commerce, National Bureau of Standards; Purdue Univ.
Abstract: The goals of the Conference were to exchange and document concepts and applications that could lead to a reduction of the energy used in air conditioning and heating. The conference related itself to the needs of industry and concerns of the federal government while discussing engineering concepts and systems of heating and air conditioning. Papers that dealt with current practices leading to minimization of energy consumption were included. (from Foreword) The Sessions were entitled: 1) Designing for Better Efficiency at Part Load Operation; 2) Ducting and Air Distribution for Optimum Utilization; 3) Operating Vs. Rating Condition Efficiencies; 4) Improving Efficiency in Room Air Conditioners; 5) Prototype Equipment for High Efficiency; 6) Life Cycle Costing Factors; 7) Component Selection and Matching for Increased Efficiency; and 9) Future Improvements for Standards, Specifications and Codes. Papers in Session 8 dealt with refrigeration, air conditioning, heat pumps, and energy requirements of residential homes. (BYB)

Gordian Associates Inc.
Address: 299 Park Ave., New York
Opportunities and Incentives for Electric Utility Load Management

Report No. PB-249348, FEA/D-75/52E, Conservation Paper No. 32, 321 p.
1975
Sponsor: Federal Energy Administration, Office of Energy Conservation and Environment, Office of Utilities Programs
Abstract: Opportunities for both the utilities and consumers to improve electric utility load management are discussed. Potential actions by utilities include institutional, economic, and technological changes which require the support of Federal and state regulatory agencies. In particular, power pooling and energy storage load leveling techniques are described. Consumers can alter their patterns of consumption, if they are guided by proper rate structures. Load leveling techniques that can be used by the consumer include industrial load management and management of the space conditioning load. It is concluded that: 1) improved load management can conserve scarce primary energy resources; and 2) improved load management can minimize the escalation of rates and alleviate the financial difficulties of investor-owned utilities by reducing the need for capital equipment and by ensuring that incremental revenues equal incremental costs. (72 references) (BYB)
Availability: NTIS

Gordian Associates Inc.
Address: 711 Third Avenue, New York, NY 10017
Evaluation of the Air-to-Air Heat Pump for Residential Space Conditioning

Report No. PB-255652, FEA/D-76/340, 291 p.
23 Apr 1976
Sponsor: Federal Energy Administration, Office of Energy Conservation and Environment, Office of Buildings Programs
Abstract: The objective of the study described in this report was to evaluate the (a) reliability, (b) market acceptance and (c) energy effectiveness (in comparison to electric resistance and fossil fuel space heating systems) of the electric heat pump for residential space heating. An additional objective was to evaluate the impact of increased heat pump saturation on the nation's primary fuel reserves and to develop justified policy options for the government toward this form of space heating. The approach adopted in the study, as established by the requirements of the contract, was (a) to critically evaluate available sources of technical information on heat pump performance and market applicability, (b) to make inquiries of selected electric utilities, heat pump manufacturers and heating and air-conditioning contractors, and (c) to compare by computer simulation the energy effectiveness of the heat pump versus electric resistance and fossil fuel space heating systems for representative climatological regions of the continental United States. (from Executive Summary)
Availability: NTIS

Gordon, R.L.; Schenck, G.H.K.
Pennsylvania State Univ., College of Earth and Mineral Sciences, Dept. of Mineral Economics
Address: University Park, PA 16802
Historical Trends in Coal Utilization and Supply

Report No. PB-261278, BuMines OFR 121-76, 634 p.
Aug 1976
Sponsor: U.S. Dept. of Commerce, Bureau of Mines
Abstract: This study examined in considerable detail the historical behavior of coal consumption, the forces that are affecting prospective coal use and provided various scenarios of future consumption in selected markets. The study has made three basic contributions in the areas it treated. First, the report has consolidated and analyzed available historical data on the role of coal in the U.S. energy economy. Second, the proliferation of materials analyzing the forces affecting coal market developments has been synthesized. Third, an effort has been made to delineate possible patterns of future coal use. Experience with the debate on coal suggests that the first two contributions are clearly ones of value to students of the issues. Bringing together this information should help to provide better perspective on energy prospects. The report has sought to place the mass of emotional arguments for various energy policies affecting coal into perspective. (13 references) (GRA)
Availability: NTIS

Grant, W.V.; Lind, C.G.
U.S. Dept. of Health, Education, and Welfare, Education Division; U.S. Dept. of Health, Education, and Welfare, National Center for Education Statistics
Address: Washington, DC 20202
Digest of Education Statistics: 1976 Edition

communities. The consumption of gas and electricity is being monitored and correlations are being established with weather data, housing type, architectural design, mechanical subsystems, and demographic characteristics of the residents. In parallel, an extensive study of the consequences for energy utilization of decision-making by the builder, architects, contractors, and public and utility officials is underway. Preliminary results indicate that there is a large variation in energy usage even when identical units are compared. The influence of such variations as architectural design, thermopane windows, and dwelling orientation on gas consumption for space heating is perceptible; however, the magnitude of the differences is not always in agreement with standard heat load calculations. There seems to be little correlation, at least in the sample of townhouses analyzed, between gas consumption and electrical consumption. Advanced data collection schemes are currently being deployed to provide a more detailed temporal and spatial resolution than is available from meter readings and weather records. (Auth)
Availability: MIT Press $25.00 for entire proceedings

Hall, S.A.; Harrje, D.T.
Princeton Univ., Center for Environmental Studies
Address: Princeton, NJ 08540
Instrumentation for the Omnibus Experiment in Home Energy Conservation

Center for Environmental Studies Report No. 21, 69 p.
1975
Sponsor: National Science Foundation, RANN Program
Abstract: In the Omnibus Experiment, residential energy consumption is being studied in thirty-two townhouses located at Twin Rivers, N.J. This paper enumerates the variables being monitored in the Omnibus study, and presents the technical details of the instrumentation system used for measurement and data collection. Calibration for the instrumentation is discussed. A numerical example indicates how to convert raw field data into physical units. (Auth)
Availability: Center for Environmental Studies, Engineering Quadrangle, Princeton University, Princeton, NJ 08540

Halvorsen, R.
Washington Univ.
Address: Seattle, WA
Residential Demand for Electric Energy

The Review of Economics and Statistics, LVII(1), pp. 12-18 (Feb. 1975)
Feb 1975
Abstract: The factors that influence the residential demand for electric power are studied by developing a model that can be used to estimate the direct and total elasticities of residential electricity demand. Contrary to the common belief that demand is not affected by price, the long-run own-price elasticity of demand is found to be at least unitary. The cross-elasticity of demand with respect to gas price is significant but small, and the total income elasticity of expenditure on electric power is less than one. To evaluate the importance of electric power price in forecasting future growth in demand, 20-year projections are made using different price assumptions. This analysis indicates that the past growth in residential electricity demand has been a result of the decline in its real price. This downward trend in real price will probably be less rapid, and may be reversed in the future. Thus, long-run forecasts that assume a continuation of past growth rates are probably much too high. (BYB)

Hannon, B.
Illinois Univ., Center for Advanced Computation
Address: Urbana, IL 61801
Energy, Labor, and the Conserver Society

Technology Review, pp. 47-53 (Mar/Apr 1977)
Mar/Apr 1977
Abstract: This article describes a "conserver society" which realizes that there is a limit to the availability of low-cost energy, and plans not only for energy shortages, but also for economic stability, full employment, and equity. The technical, social, and economic problems that would result in the U.S. becoming a conserver society are discussed. The relationship between the three basic inputs to production--capital, labor, and energy--is examined. In planning for energy shortages, the society would have to increase its flexible, renewable resources, labor and capital, to make up for shortages of nonrenewable resources, energy. With zero economic growth the U.S. can have full employment by raising the price of energy relative to wages (through taxes and rationing). Therefore, reduced energy use implies less material wealth. A major problem of the conserver society is in providing and maintaining an equitable distribution of reduced energy and material flows. This society must also use its energy efficiently by matching energy quality and quantity exchanges in production processes. Residential and commercial structures should locate near production, and electric power plants should be smaller in size. Cities of the conserver society would be more independent, more diverse, and smaller than today's. Using an energy and employment impact model (a type of input-output model), changes that will reduce energy demand and increase employment under conditions of income equilibrium are determined (e.g., changing from plane to train, from throwaway to refillable beverage containers, from car to train, from owner-operator truck to class 1 freight train, from car to bus, from new highway construction to personal consumption, from car to bus or bicycle, from plane to car or bus, from moderate to spartan kitchen, etc.). (16 references) (BYB)

Hannon, B.M.; Stein, R.G.; Segal, B.; Serber, D.; Stein C.
Illinois Univ., Center for Advanced Computation, Energy Research Group; Stein (Richard G.) & Associates, Architects
Address: IU, Urbana, IL 61801; SA, 588 Fifth Avenue, New York, NY 10036
Energy Use for Building Construction. Final Report for Period March 1, 1976 - December 31, 1976

Report No. COO-2791-3, 193 p.
Dec 1976
Sponsor: Energy Research and Development Administration, Division of Buildings and Community Systems
Abstract: Total (direct and indirect) energy requirements of the construction industry for 1967 were determined in order to examine the potential for energy savings. The Energy Input/Output Model developed at the Center for Advanced Computation, University of Illinois, was expanded to include 49 building and non-building construction sectors (new and maintenance). Total energy intensities were determined for these sectors, as well as energy requirements to final demand. Overall, the construction industry required

about 6000 trillion Btu, or about 9% of the total U.S. energy requirement in 1967. About 20% of this requirement was for direct energy. Energy requirements were further broken down according to goods and services purchased by individual construction sectors, and energy distribution patterns were determined within each construction sector. Energy cost per unit for various building materials were calculated, as well as 1967 energy cost per square foot for building sectors. Laboratories required the most energy per square foot (2,074,056 Btu/sq ft), while Farm Service required the least (149,071 Btu/sq ft). Comparative interchangeable building assemblies were evaluated for their energy costs, including initial construction and lifetime maintenance energy. Tradeoffs between construction and operational energy costs were determined for a selected wall frame assembly with different exterior finishes and varying degrees of insulation. A study was initiated to determine industries in which direct energy use led to a significant amount of the energy embodied in New Building Construction for 1967. The resulting Energy Flow Chart is included. (auth)

Availability: NTIS

Harris, Kerr, Forster & Co.; Pannell Kerr Forster & Co.

Address: HKF, 420 Lexington Avenue, New York, NY 10017; PKR, 420 Lexington Avenue, New York, NY 10017

Trends in the Hotel-Motel Business: 1976

Fortieth annual edition, 32 p.

1976

Abstract: This annual review of the nation's hotel-motel industry cites and characterizes trends in the accomodation industry, relates these trends to the nation's economy, and provides useful, practical operating data to aid hotel and motel management and others interested in the industry. The report provides 20-year analyses (1956-1975) of operating results for a total of 1,000 establishments, including 425 motels and motor hotels with restaurants and 125 motels and motor hotels not operating restaurants. Because this compilation is not derived from a scientifically drawn statistical sample, it is not necessarily representative of the industry as a whole. For these 1,000 establishments, room occupancies during the 20-year period reached a peak of 71.7% in 1967 and a low of 63.9% in 1975. In 15 of the years between 1956 and 1975, total sales and income increased; in 1975 sales and income totaled $10,759 per available room, exceeding the 1956 revenue by 36% (taking into account inflation). Total operating costs and expenses increased 16 of the 20 years. In 1975 costs were $8,708 per available room, 82% higher than costs in 1956. Profits after real estate taxes, but before capital charges peaked in 1969, averaging $2,141 per room, and hit a low point of $1,411 in 1963. The ratio of profits to total revenue reached a high in 1966 of 25.4% and a low in 1975 of 19.3%. (BYB)

Harrison, W.; Frigo, A.A.; Kartsounes, G.T.; Santini, D.J.; LaBelle, S.J.; Davis, F.H.

Argonne National Laboratory, Energy and Environmental Systems Division; Globe Engineering Co.

Address: ANL, 9700 South Cass Avenue, Argonne, IL 60439; GEC, Chicago, IL

Water Resources Research Program: District Heating and Cooling Utilizing Temperature Differences of Local Waters. Preliminary Feasibility Study for the Chicago 21, South Loop New Town Project

Report No. ANL/WR-77-1, 83 p.

May 1977

Sponsor: Energy Research and Development Administration, Integrated Community Energy Systems Program

Abstract: This report examines the feasibility of cooling and heating buildings of Chicago's South Loop New Town (SLNT) project by using cool Lake Michigan water and warm water from Commonwealth Edison Company's Fisk Generating Station. Three systems are considered for the heating/cooling requirements of the SLNT project: conventional, conventional with lake-water cooling, and modular heat-pump systems. Characteristics of the source waters and institutional constraints to their use are also considered. The modular heat-pump system, using water-to-water heat pumps, is the most attractive type of system for the SLNT project both from an economic and an energy-savings point of view. The modular heat-pump system offers an initial reduction in both the required capital investment for the heating, ventilating, and air-conditioning (HVAC) system when compared to a conventional system and also a significant reduction in annual operating expenses. The heat-pump system, however, requires a significant additional capital investment for the water supply and return system. Even with this investment, the heat-pump system savings in annual operating expenses and reduced capital investment for the HVAC system could pay for the cost of the water supply and return system in less than five years. Added to the economic savings would be an energy savings equivalent of about 450,000 barrels of fuel oil per year when the modular heat-pump system is compared to a conventional system. (6 references) (auth)

Availability: NTIS

Harrje, D.T.

Princeton University, Center for Environmental Studies

Address: Princeton, NJ 08540

Retrofitting: Plan, Action, and Early Results Using the Townhouses at Twin Rivers

Report No. CES-29, 50 p.

Jun 1976

Sponsor: Energy Research and Development Administration; U.S. Dept. of Commerce; National Science Foundation, RANN Program

Abstract: Based upon home energy data from a variety of sources, including three highly-instrumented townhouses, air infiltration and infrared scanning, and detailed experiments in a rented townhouse, a plan was established to retrofit a group of 25 townhouses within the Twin Rivers Planned Unit Development. The data employed in the evaluation of the effectiveness of the retrofit were gathered by both daily meter reading of the houses' gas and electric meters and by a specially designed instrumentation package that monitored hourly key parameters in the dwellings. This retrofit experiment also relied upon calculated winter and summer breakdowns of energy losses and gains to aid in the establishment of priorities for retrofit. Payback periods of no greater than three years was the goal of this first round of retrofit. Action was taken during the winter of 75-76, beginning in the highly-instrumented homes and moving to the larger sample of townhouses, with a basic three part retrofit that sought to reduce conduction losses, reduce air infiltration, and upgrade the heating system. Attic insulation levels were raised to the R-30 level (from R-11) with careful attention to sealing passages to the floors below; doors and windows were sealed; and furnace ducting and the hot water heater were insulated. The retrofit measures were applied to groups of townhouses in stages in order to determine the effectiveness of each retrofit individually. Before-after cross sample evaluations of the date were performed. The early results of these actions have shown gas savings on the order of 25% and electrical savings of 10%. The cost was approximately $400. When summer savings are included, payback periods should not exceed the three year goal. (17 references) (auth)

Heberlein, T.A.
Wisconsin Univ., Dept. of Rural Sociology
Address: Madison, WI
Conservation Information: The Energy Crisis and Electricity Consumption in an Apartment Complex

Energy Systems and Policy, 1(2), pp. 105-117 (1975)
1975
Sponsor: Wisconsin Univ., College of Agriculture and Life Sciences
Abstract: Informational material designed to either increase or decrease the amount of electricity used by apartment dwellers as predicted showed no effect on consumption. In March and April 1973 the mean daily use was 8.6 kwh with a standard deviation of 2.98 kwh across apartment units. During a 14-inch snowstorm consumption went up to 19% over comparable use. This was not due to the cloudy or cold conditions during the storm. In 1974 electricity use during comparable days was measured to determine the effect of the energy crisis on consumption. Apartment units showed no changes in electricity consumption during the energy crisis. The reasons for the lack of effect of informational appeals on household consumption of electricity are discussed. (10 references) (auth)

Heddleson, F.A.
Oak Ridge National Laboratory, Reactor Division
Address: Oak Ridge, TN 37830
Fuels Used for Single-Family Detached Residential Heating in the United States

Report No. ORNL-TM-4690, 33 p.
Mar 1975
Sponsor: Energy Research and Development Administration
Abstract: Basic data are provided which are needed for evaluation of fuels used for residential space heating. Further studies will examine the regional and national impacts of possible changes in fuels used for heating. Date from the 1970 U.S. census are tabulated to show numbers of single-family detached homes in each state and census region using oil, gas, electricity, coal, or wood for space heating, cooking, and water heating. Because single-family detached homes constituted about two-thirds of the total U.S. housing units in 1970, this study concentrates on these homes because they offer a greater opportunity for change in heating methods than do multifamily structures. (auth)
Availability: NTIS

Herendeen, R.A.
Illinois Univ., Center for Advanced Computation, Energy Research Group
Address: Urbana, IL 61801
Appliance Energy Use

19 p.
1975
Sponsor: Ford Foundation, Energy Policy Project; Illinois Office of the Energy Coordinator
Abstract: Energy is required to make and maintain appliances as well as to operate them. The magnitudes of these "other" energy costs imply different strategies for energy conservation. For example, does increasing the durability by x years save as much energy as improving the operating efficiency y percent? This report evaluates the relative importance of operating energy for 30 household and kitchen appliances, and looks at the total energy (gross energy requirement) for 3 example kitchens, from plush to rather Spartan. It also discusses the economic aspects of more efficient room air conditioners. (auth)

Hieronymus, W.H.
Charles River Associates Inc.
Address: 1050 Massachusetts Ave., Cambridge, MA 02138
Long-Range Forecasting Properties of State-of-the-Art Models of Demand for Electric Energy. Volume I: Final Report. Volume II: Annotated Bibliography

Report No. EPRI EA-221, Project 333, 454 p. in Volume I, 43 p. in Volume II
Dec 1976
Sponsor: Electric Power Research Institute
Abstract: This report evaluates the long-range forecasting effectiveness of selected econometric models of the demand for electric energy. The eight models tested represent those specifications and other features of extant models believed to be of potential use in developing improved models for long-range forecasting at the national and regional levels. These include the residential models of Anderson; Halvorsen; Houthakker et al.; and Mount et al.; the commercial model of Mount et al.; the industrial models of Fisher and Kaysen; Mount et al.; and an extension of Anderson's industrial model. Each model is replicated, reestimated on a common data set and tested for performance: forecast and backcast accuracy, parameter stability over time, robustness of parameter estimates to small changes in specification or variable measurement, consistency and plausibility of model results, and quality of model test statistics. ... The final chapter of the report presents recommendations for near-term and longer-range improvement in the state-of-the-art. Many of these improvements await availability of better data: for example, greater disaggregation of electricity data by end use and end user, improved fuel price and availability data, better data on stocks of appliances and buildings. An annotated bibliography of long-term electric energy forecasting models is presented in Volume II. (90 references) (auth, abstract modified)

Hill, J.E.; Kusuda, T.
U.S. Dept. of Commerce, National Bureau of Standards, Institute for Applied Technology, Center for Building Technology
Address: Washington, DC
Manchester's New Federal Building: An Energy Conservation Project

ASHRAE (American Society of Heating, Refrigerating and Air-Conditioning Engineers Inc.) Journal, 17(8), pp. 47-54 (Aug. 1975)
Aug 1975
Abstract: A Federal office building in Manchester, New Hampshire was designated as an energy conservation demonstration project

in 1972. The 7-story building (with two-level basement parking garage) will have a gross floor area of about 170,000 sq.ft., be occupied by some 400 people, and probably cost about $9.7 million. The effect of various alternate designs for the building are evaluated. Three phases of calculations are described: (1) Phase I considers a building of the approximate size that would be built according to typical design practice in the New England area; (2) Phase II models details of the design by breaking each of the seven floors into five zones; and (3) Phase III shows that with the utilization of solar collectors on the roof, additional energy savings are indicated. The objectives of the project were to dramatize the firm commitment of the Federal government to the conservation of energy in the design, construction, and operation of government buildings; provide a laboratory for the installation of both recognized and innovative energy conservation technologies; and inspire others in the building industry to pursue energy conservation as a goal. Construction on the foundation is under way, and occupancy is expected by early summer, 1976. (11 references) (TIC)

Hill, J.E.; Kusuda, T.; Liu, S.T.; Powell, F.J.
U.S. Dept. of Commerce, National Bureau of
Standards, Institute for Applied Technology
Address: Washington, DC 20234
A Proposed Concept for Determining the Need for Air Conditioning for Buildings Based on Building Thermal Response and Human Comfort

Report No. COM-75-11374, NBS BSS 71, 71 p.
Aug 1975
Sponsor: U.S. Dept. of Housing and Urban Development
Abstract: Determining the need for air conditioning can be based on a wide variety of factors. To date, the only criteria that have been written and can be referenced are those of several Federal organizations and many are not really criteria in the true sense of the word. They are guidelines to be used in the determination of fund allocation; in other words, provisions are made to air condition Federal facilities in specific geographical locations if pertinent weather characteristics of that locality meet certain requirements. This paper presents the concept that a true criteria can be established based both on weather characteristics of the locality as well as characteristics of the building or structure under consideration. The paper gives the details of a study showing the feasibility of such a scheme. A simulation was made of two proposed residences in several geographical localities. For the simulation, actual hour-by-hour weather data was used in conjunction with a sophisticated computer program. The results revealed for the non air-conditioned spaces, the extent and duration of undesirable indoor conditions based upon generally accepted comfort indices. The concept of a new "comfort" or "discomfort" index called Predicted Indoor Habitability Index (PIHI) is introduced. The authors indicate the way in which a criterion could be established that would be in the form of tables, indicating for a given specified building and geographical locality, whether mechanical cooling should or should not be installed. (33 references) (auth)
Availability: NTIS; GPO $2.25, SD Cat. No. C13.29/2:71

Hinman, G.W.
Washington State Univ.
Address: Pullman, WA
Projections of Energy, Demand, Supply, and Pricing

Report No. CONF-7506125, paper presented at conference on Societal Implications of Energy Scarcity: Social and Technological Priorities in Steady State and Constricting Systems, held at Thunderbird Motor Inn, Portland, OR, June 7 & 8, 1975, published in proceedings pp. 3-18
1975
Abstract: Technological changes are seen as effecting more efficiency in energy use and producing abundant but more costly energy supplies, with economic pressures for long-stabilization, or even reduction of, prices. No major societal nor economic dislocations are foreseen, and a sustained modest growth in the gross national product is projected. The conclusions are based on assumptions of: leveling of population growth, large elasticities in demand, massive conversion to coal resources, large scale conversion to nuclear plants, and price increases resulting in a one-time step effect. (from editorial summary)
Availability: NTIS

Hirst, E.
Oak Ridge National Laboratory, Energy Division
Address: Oak Ridge, TN 37830
Residential Energy Conservation Strategies

Report No. ORNL/CON-2, 42 p.
Sep 1976
Sponsor: Energy Research and Development Administration; Federal Energy Administration
Abstract: An engineering-economic model of residential energy use is used to evaluate the energy impacts from 1975 to 2000 of changes in: household formation, housing choices, per capita income, fuel prices, equipment efficiencies, and thermal integrities of new and existing residential buildings. Twelve cases are run with the computer model to determine the impacts on energy use of each factor. These runs suggest the following: (1) residential energy use will grow more slowly during the fourth quarter of this Century than during the third quarter because of slower growth in population and household formation, changes in fuel price trends, and near saturation of equipment ownership for the major residential energy end uses; ... (2) the high forecast discussed above is not a likely forecast because it assumes that fuel prices will remain constant at their 1975 values, that household formation will increase rapidly, and that the 1960-70 trend in housing choices (away from single-family units) will not continue; ... and (3) implementation of energy conservation programs to raise energy prices, increases in the efficiency of new household equipment, and improvements in the thermal integrity of both new and and existing housing units can have significant energy impacts. (15 references) (auth, abstract modified)
Availability: NTIS

Hirst, E.; Lin, W.; Cope, J.
Oak Ridge National Laboratory, Energy Division
Address: Oak Ridge, TN 37830
An Engineering-Economic Model of Residential Energy Use

Report No. ORNL/TM-5470, 58 p.
Jul 1976
Sponsor: Energy Research and Development Administration; Federal Energy Administration
Abstract: This report describes a comprehensive engineering-economic computer model used to simulate energy use in the residential sector from 1970 to 2000. The purpose of the model

is to provide an analytical tool with which to evaluate a variety of conservation policies, technologies, and strategies for their impacts on residential energy use and fuel expenditures over time. The present version of the model deals with energy use at the national level for four fuels (electricity, gas, oil, and other); six end uses (space heating, water heating, refrigeration, cooking, air conditioning, and other); and three housing types (single-family units, apartments, and trailers). Each of these fuel uses is determined for each year of the simulation as the product of: (1) stock of occupied housing units, (2) fraction of homes using each fuel for each end use, (3) average annual energy requirement for each type of equipment, (4) average thermal integrity for each housing type, and (5) household usage behavior for each fuel and end use. The baseline forecast shows total fuel use growing from 17.6 GGJ (10(exp18)J) in 1975 to 26.4 GGJ in 2000, with an average annual growth rate of 1.7%. The percentage of household fuel provided by electricity grows from 44% in 1975 to 56% in 2000. The percentages provided by all other fuels decline over time. Alternative high and low forecasts show a range in annual fuel use growth from 1975 to 2000 of 2.1 to 0.3%. In the high case, per household fuel use grows at 0.4%/year, whereas in the low case, per household fuel use declines 1.1%/year. (40 references) (auth)
Availability: NTIS

Hirst, E.; Moyers, J.C.
Oak Ridge National Laboratory, ORNI-NSF Environmental Program
Address: P.O. Box X, Oak Ridge, TN 37830
Potential for Energy Conservation through Increased Efficiency of Use

Testimony submitted to the U.S. Senate Committee on Interior and Insular Affairs pursuant to hearings on energy conservation, March 1973, 22 p.
1973
Sponsor: National Science Foundation, RANN Program
Abstract: Opportunities exist for significantly increasing the efficiency with which energy is used in the United States. This paper discusses such opportunities for (a) the transportation sector (shifts from energy-intensive modes to energy-efficient modes, increased use of existing equipment, and technological changes to increase vehicle energy efficiency) and (b) the household sector (additional building insulation, electric heat pumps rather than electric-resistance heating, energy-efficient air conditioners, and addition of insulation to water heaters). Such energy efficiency improvements may require institutional and social changes, but technologies are generally available to implement such strategies. The benefits to the nation in terms of energy conservation, reduced reliance on energy imports and improved balance of payments, reduced adverse environmental impacts, lower dollar costs, and a return to a more conservative resource-use ethic are potentially large. Policies to achieve such goals would involve some life-style changes and important institutional decisions, but they do not imply a return to "caves and candles." (Auth)

Hirst, E.; Moyers, J.C.
Oak Ridge National Laboratory, ORNL-NSF Environmental Program
Address: P.O. Box X, Oak Ridge, TN 37830
Efficiency of Energy Use in the United States

Science, 179(4080), pp. 1299-1304 (Mar. 30, 1973)
30 Mar 1973
Sponsor: National Science Foundation, RANN Program
Abstract: Two important ways of achieving the goal of satisfying the growing demand for energy without degrading the environment are (1) development, use, and improvement of pollution control and energy-conversion technologies and (2) improvement in the efficiency of energy use. This paper discusses the major areas of energy consumption, energy consumption growth rate of such categories as space heating, space cooling, and transportation, and areas where more efficient energy use would result in energy savings. (DCM)

Hise, E.C.
Oak Ridge National Laboratory
Address: P.O. Box X, Oak Ridge, TN 37830
Seasonal Fuel Utilization Efficiency of Residential Heating Systems

Report No. ORNL-NSF-EP-82, 56 p.
Apr 1975
Sponsor: Federal Energy Administration, Office of Energy Conservation; National Science Foundation, RANN Program
Abstract: Three residential heating systems - electric resistance, fired furnaces with forced circulating air, and electric driven air-to-air heat pumps - are analyzed and compared for their present and potential fuel utilization efficiency. The sources of inefficiency are discussed and quantified where adequate information is available. A program to obtain data not found in the literature is proposed. The case histories of two heat pumps that were improperly installed are presented, the effect of the poor installation upon the operating and maintenance cost is discussed, and the corrective measures that were taken are discussed. A residential heating system installation standard or code is proposed. (54 references) (auth)
Availability: NTIS

Hise, E.C.; Holman, A.S.
Oak Ridge National Laboratory
Address: Oak Ridge, TN 37830
Heat Balance and Efficiency Measurements of Central, Forced-Air, Residential Gas Furnaces

Report No. ORNL-NSF-EP-88, 70 p.
Oct 1975
Sponsor: National Science Foundation, RANN Program; Federal Energy Administration, Office of Energy Conservation
Abstract: Residential central gas furnaces of the atmospheric combustion and sealed combustion types were tested in the laboratory and in residences. Complete heat balances were taken at steady-state operation, cyclic operation, and off-design conditions, and the instantaneous efficiencies were determined. The seasonal fuel utilization efficiencies were synthesized for the two types of furnaces and for a range of adjustments in four climates. Recommendations are offered for a high-efficiency furnace design and installation standards which will reduce fuel consumption by one-third. (auth)
Availability: NTIS

Hise, E.C.; Moyers, J.C.; Fischer, H.C.
Oak Ridge National Laboratory
Address: Oak Ridge, TN 37830
Annual Cycle Energy System - Demonstration House Design Report

Report No. ORNL/CON-1, 50 p.
Oct 1976
Sponsor: Energy Research and Development Administration, Division of Buildings and Industry; U.S. Dept. of Housing and Urban Development
Abstract: A 2000 sq. ft. single family residence will be constructed in first quarter 1976 to demonstrate the energy conserving features of additional insulation, the Annual Cycle Energy System (ACES), and an automatic economy cycle in the cooling season. The design specifications for the house and for the ACES components are given. ACES is a water-to-air heat pump system with ice and thermal storage. The calculated loads and predicted performance of the system along with the calculated performance of conventional systems are presented. The design calculations indicate that ACES can supply the space heating, space cooling, and the domestic hot water for about 42% of the electrical consumption required by a system composed of an electric furnace, electric air conditioner, and an electric water heater and for about 54% of the electrical consumption of an air-to-air heat pump and an electric water heater. (auth)
Availability: NTIS

Hittman Associates Inc.
Address: Columbia, MD 21045
Residential Energy Consumption - Multi-Family Housing Data Acquisition

Report No. HUD-HAI-3, 76 p.
30 Mar 1973
Sponsor: U.S. Dept. of Housing and Urban Development, Office of the Secretary, Office of the Assistant Secretary for Research and Technology; National Science Foundation, RANN Program; U.S. Environmental Protection Agency
Abstract: The subject of this report is Data Acquisition. The data to be acquired will be sufficient to: (a) Completely characterize the design and construction of recent and new multi-family structures in the Baltimore/Washington area. Such structures include: (1) town house apartments - typically two-story structures with common party walls between dwelling units. Each dwelling unit has a roof exposed to weather; (2) low-rise apartments (also called garden-type apartments) - typically not more than four stories, without elevators and interior halls, and having enclosed or open stairwells serving up to four apartments per floor; (3) high-rise apartments typically structures with more than four stories, central elevators, interior halls, and central HVAC systems. (b) Establish the total energy consumption as a function of the energy type at point of use and of the types of energy consuming equipment. (c) Identify the effects of airflow patterns and air change-over and infiltration rates on the total energy consumption. (Auth modified)
Availability: NTIS

Hittman Associates Inc.
Address: Columbia, MD 21045
Residential Energy Consumption Single Family Housing. Final Report

Report No. HUD-PDR-29-2, HUD-HAI-2, 178 p.
Mar 1973
Sponsor: U.S. Dept. of Housing and Urban Development, Office of the Secretary, Office of the Assistant Secretary for Policy Development and Research
Abstract: The objectives of this program were: identify and quantify the total energy balance in single-family dwellings in the Baltimore/Washington area; and evaluate the capability of various technical innovations in minimizing energy consumption. It was concluded that the annual energy consumption of a good quality residence could be reduced up to 40% without affecting the life style of the occupants. Methods of minimizing energy consumption include: selection of gas-fired appliances rather than electric appliances; improved design of furnace flue to recover waste heat and close furnace flue during off cycles; use of high performance air conditioning units; and reduction of air infiltration through windows and doors and reduction of conductive heat transfer through the walls and windows. (MFG)
Availability: NTIS

Hittman Associates Inc.
Address: Columbia, MD
Residential Energy Conservation (A Summary Report)

Report No, HUD-HAI-8, 28 p.
Jul 1974
Sponsor: U.S. Dept. of Housing and Urban Development, Office of the Secretary, Office of the Assistant Secretary for Policy Development and Research
Abstract: The results obtained from an energy balance computer program to establish the hourly energy consumption in different type structures in the Baltimore/Washington area, are presented in this report. The characteristic buildings studied were single family, townhouse, low-rise, and high-rise structures. Energy-conserving modifications within the three following categories were evaluated for each type of structure: modifications in dwelling construction, such as insulation and window placement; modifications in the heating and cooling equipment; and modifications in internal factors, such as appliances, lights, etc. The analysis clearly points out that a great deal of energy can be saved in the Baltimore/Washington area if proper attention is paid to optimizing the various modifications. Qualitative conclusions can be made from the results in this report for multifamily housing and for other geographical areas. (7 references) (BLM)

Hittman Associates Inc.
Address: Columbia, MD
Environmental Impacts, Efficiency, and Cost of Energy Supply and End Use. Volume I

Report No. PB-238784, HIT-593, v.p.
Nov 1974
Sponsor: Executive Office of the President, Council on Environmental Quality; National Science Foundation; U.S. Environmental Protection Agency
Abstract: The purpose of this study was to determine the environmental impacts, efficiency, and costs associated with supply and end use of fossil fuels. The output is a 2-volume report, which presents tabular, foot-noted, and referenced data quantifying the energy-related environmental impacts on land, water, air, solid waste, and occupational health. All the information is also available in the form of a computerized data base, Matrix of Environmental Residuals for Energy Systems (MERES). Brookhaven created the data base and has written a number of data management and energy modeling programs, which with MERES are known as the Energy Model and Data Base. Volume II, which characterizes six technologies with respect to their environmental impacts, efficiency, and cost, will be released at a later date. (166 references) (auth)
Availability: NTIS

Hittman Associates Inc.
Address: Columbia, MD 21045
Physical Characteristics, Energy Consumptions, and Related Institutional Factors in the Commercial Sector

Report No. FEA/D-77/040, HIT-630, 181 p.; Report No. PB-249470, FEA/D-76/053, HIT-630 for Final Draft Report, published Dec. 1975, 199 p.
Feb 1977
Sponsor: Federal Energy Administration, Office of Energy Conservation and Environment, Office of Policy, Program Development and Environment
Abstract: A unified study of commercial sector energy consumption and conservation potential is presented. Specific areas addressed in the report are: physical characteristics of existing commercial buildings in Baltimore, MD and Denver, CC; energy consumption of existing commercial buildings in Baltimore; institutional factors related to constructing and/or operating more energy-efficient commercial buildings; and policy options and their feasibility for inducing energy conservation through retrofit. The discussion of physical characteristics of commercial buildings presents the data obtained from a field survey of all commercial establishments (... excluding schools and hospitals) in the central business districts (CBD's) of Baltimore and Denver. This survey included approximately 2600 commercial establishments. Data were collected on the height, age, floorspace, heating system, cooling system, heating fuel, exterior glass fraction, and functional use of commercial buildings as independent variables. The distribution of the dependent variable, commercial square feet, over the various values of each independent variable was presented for both CBD's. The discussion of energy consumption of existing commercial buildings in Baltimore presents a quantitative analysis of the empirical relationships between various building physical parameters, such as age, height, floorspace, etc., and the annual building energy consumption rate (expressed in Btu per gross square foot per year)... ... The discussion of institutional factors related to constructing and/or operating more energy efficient commercial buildings presents a qualitative description of institutional constraints and incentives which have led to the current energy-use patterns observed in the commercial sector. Numerous areas of institutional concern are discussed, including the practices of regulatory bodies, the practices of trade and professional groups, microeconomic incentives and disincentives, and the macroeconomic implications of increased use of retrofit devices. The discussion of policy options capable of inducing energy conservation through retrofit of commercial buildings incorporates the information gained and quantitative analysis of eight possible Federal policy options capable of inducing greater use of retrofitting as an energy conservation alternative in the commercial sector. The quantitative policy analysis has included estimates of the probable energy savings, costs to the nation's building owners, and costs to the U.S. Government associated with implementation of each policy option. In addition, a comparison of the eight policy options based on a series of hypothetical government goal orientations is given. (auth, abstract modified)
Availability: GPO $2.50, Stock No. 041-018-00130-1; NTIS for Final Draft Report

Hittman Associates Inc.
Address: Columbia, MD 21045
Technology Assessment of Residential Energy Conservation Innovations. Final Report

Report No. HUD-PDR-117, 211 p.
May 1975
Sponsor: U.S. Dept. of Housing and Urban Development, Office of Policy Development and Research
Abstract: This technology assessment examines the desirability to the Nation and to the consumer of selected technical innovations intended to reduce residential energy consumption. Government policy options capable of promoting mass implementation of innovations found desirable are identified and discussed. The scope of the study includes life cycle energy, economic, air emissions, and materials effects. Innovations include storm doors and windows, a furnace energy recovery device, open air cycle air conditioning in single-family housing, ventilation energy recovery and double glazed windows in multifamily housing. Conclusions address the desirability and potential for implementation of each innovation. Storm doors and windows, the furnace energy recovery device, double glazed windows, and ventilation energy recovery all provide some life cycle energy savings and [illegible] effective in northern regions of the Nation. Open air cycle air conditioning provides poor energy resource conservation and is not cost effective. Recommendations are made for Federal Government policy action to force use of storm doors and windows and double glazing in northern areas of the Nation, to perform detailed analysis and testing of furnace energy recovery devices, to incorporate ventilation energy recovery in a high-rise demonstration project, and to abandon open air cycle air conditioning technology for single-family housing. (56 references) (auth)
Availability: GPO $3.10, Stock No. 023-000-00309-1

Hittman Associates Inc.
Address: Columbia, MD 21045
Barriers Connected with Certifying or Listing of Energy Conserving Products Used in Buildings

Report No. CONS/1211-1, v.p.
May 1977
Sponsor: Energy Research and Development Administration, Division of Buildings and Community Systems
Abstract: There is no lack of residential energy conservation technology. There is a large disparity between the rapid rate of technological progress and the slow rate of implementation in this complex marketplace. Of concern is that energy conserving innovations are restricted, and in some cases, blocked entirely from reaching the marketplace by a variety of institutional barriers. In particular, it is suspected that innovations offered by independent inventors and small manufacturers are not reaching the marketplace. ... The project summarized in this report examined the market restrictions connected with the certifying and/or listing of energy conserving products used in residential structures. The project focused on fully developed products whose market penetration was being restricted by certifying or listing practices and procedures. The overall objective of the project was to identify practical policy or program options whose implementation would increase the rate and degree of market penetration of these products. (from Introduction and Summary)
Availability: NTIS

Hoskins, R.A.; Hirst, E.
Oak Ridge National Laboratory, Energy Division

Address: Oak Ridge, TN 37830
Energy and Cost Analysis of Residential Water Heaters

Report No. ORNL/CON-10, 55 p.
Jun 1977
Sponsor: Federal Energy Administration; Energy Research and Development Administration
Abstract: A detailed computer model is developed to calculate energy flows for residential electric and gas water heaters. Model equations are derived from applications of the first law of thermodynamics, analysis of manufacturers' literature, and related studies. The model is used to evaluate the energy (and associated initial cost) impacts of alternative designs to reduce water heater fuel use. Model results show that the largest heat loss in an electric water heater is conduction through jacket walls (14% of energy input). An additional 5% is lost through the distribution pipe for a 7.6 m (25 ft) long pipe. The remaining 81% of energy input is used to heat water. In a gas water heater, conduction losses through jacket and distribution pipe are 12% and 3%, respectively; and 33% is lost up the flue (due to main burner and pilot light operation). Only 52% of energy input to a gas water heater is used to heat water. Several energy-saving design changes are examined using the energy model. Changes for both electric and gas water heaters are: increase jacket insulation thickness, reduce jacket insulation thermal conductivity, reduce thermostat setting, and add insulation to the distribution line. Application of all these changes to an electric water heater would reduce electricity use 17% and increase initial cost 27%. Additional changes examined for gas water heaters are: reduce pilot rate, eliminate pilot and add electric ignitor and flue closure, and reduce excess air for combustion by increasing flue baffling. Implementing all these changes to a gas water heater (except addition of electric ignitor) would reduce gas use 27% and increase initial cost 26%. These results show that there are large opportunities for reducing water heater energy use with only small initial cost increases. (11 references) (auth)
Availability: NTIS

Hub, K.; Conley, L.; Buehring, W.; Rowland, B.; Stephenson, M.
Argonne National Laboratory, Energy and Environmental Systems Division; Wisconsin Univ.; Argonne National Laboratory, Engineering Division
Address: ANL, 9700 South Cass Avenue, Argonne, IL 60439
Social Cost Studies Program: Electrical Utility Generating System Reliability Analysis Code, SYSREL

Report No. ANL/AA-4, v.p.
Sep 1975
Sponsor: Energy Research and Development Administration, Division of Biomedical and Environmental Research
Abstract: The system reliability code, SYSREL, is a system planning tool that can be used to assess the reliability and economic performance of alternative expansion patterns of electric utility generation systems. Given input information such as capacity, forced-outage rate, number of weeks of annual scheduled maintenance, and economic data for individual units along with the expected load characteristics, the code produces estimates of the mean time between system failures, required reserve capacity to meet a specified system-failure-frequency criterion, expected energy generation from each unit, and system energy cost. The categories of calculations performed by the code are five: maintenance scheduling, reliability, capacity requirement, energy production allocation, and energy cost. The code is designed to examine alternative generating units and system expansion patterns based on the constraints and general economic conditions imposed by the investigator. The computer running time to execute a study is short and many system alternatives can be examined at a relatively low cost. The report contains a technical description of the code, list of input data requirements, program listing, sample execution, and parameter studies. (auth)
Availability: NTIS

Hughes, G.J. (Chairman); Ambrose, E.; Fitter, J.W.; Gillingham, D.S.; Griffith, M.V.; Crevis, N.; Hardy, A.C.; McIntyre, D.A.; Mitchell, H.G.; Parker, L.C.; Haslett, G.; O'Sullivan, P.; Shepherd, L.; Grant, S.; Smith, H.E.
Institution of Electrical Engineers, Power Division; Institution of Heating and Ventilating Engineers
Address: IEE, Savoy Place, London WC2R 0BL, England
Electrical Heating in Buildings

IEE Conference Publication No. 75, 123 p.
Apr 1971
Abstract: The following papers were presented at this conference: Building materials and thermal insulation; Direct heating systems; The integration of engineering services in buildings; New and improved materials for electric heating systems; Architectural and structural aspects of integrated design; Domestic heating in the late '70's; Storage heating systems; Environmental systems; Control methods for electrical heating in buildings; and Domestic hot water supply systems. (MFG)
Availability: Publications Dept., IEE, Savoy Place, London WC2R 0BL, England ($15.52)

Hundemann, A.S.
National Technical Information Service
Address: 5285 Port Royal Road, Springfield, VA 22161
Total Energy Systems for Buildings: Citations from the Engineering Index Data Base

Report No. NTIS/PS-77/0273, 68 p.
May 1977
Sponsor: National Technical Information Service
Abstract: Technology for total energy systems as applied to residential complexes and industrial plants is discussed in these citations from worldwide research. These systems employ a primary source of energy, such as oil, natural gas, or solar heat to provide comprehensive energy requirements in the form of light, heating, cooling, air conditioning, drying, process heat, and power for an industrial plant or for a commercial or public building. Included are schemes for electricity generation, waste heat recovery, and direct power drive of mechanical equipment coupled to a prime mover. Modular Integrated Utility Systems (MIUS) are covered, including studies on gas turbines for use in MIUS systems, and computerized simulation studies. This updated bibliography contains 61 abstracts, 6 of which are new entries to a previous edition. (GRA)
Availability: NTIS

Hundemann, A.S. (ed.)
National Technical Information Service

Address: 5285 Port Royal Road, Springfield, VA 22161
Energy Conservation. Part 2. Buildings (A Bibliography with Abstracts)

Report No. NTIS/PS-76/0403 (updates NTIS/PS-75/214 and COM-74-11138, v.p.
May 1976
Abstract: Energy conservation in residential, commercial, and industrial buildings through use of efficient heating, air conditioning, and lighting systems is discussed. Topic areas cover the retrofitting of existing buildings, methods of detecting heat loss, and better use of electric power using thermal energy storage and solar heat. A few abstracts deal with general studies on the potential for conserving energy in buildings and guidelines and manuals for building owners. This bibliography contains 116 abstracts. (GRA)
Availability: NTIS

Jackson, J.R.; Johnson, W.S.
Oak Ridge National Laboratory, Energy Division
Address: Oak Ridge, TN 37830
Commercial Energy Use: A Disaggregation by Fuel, Building Type, and End Use

Report No. ORNL/CON-14, v.p.
1977
Sponsor: Federal Energy Administration; Energy Research and Development Administration
Abstract: This report describes the development of detailed estimates of energy use in the commercial sector. The level of detail includes five end uses (space heating, water heating, cooling, lighting, other), four fuel types (gas, electricity, oil, other), and ten commercial subsectors (retail and wholesale, auto repair and garages, finance and other office activities, warehouse activites, public administration, educational services, health services, religious services, hotels and motels, and miscellaneous commercial activities). Detailed energy use figures are developed for the years 1965 to 1975. This study was initiated to develop input data for an engineering-economic model of commercial energy use. ... This report is organized as follows. Section II discusses estimates of commercial energy use. In Section III estimates of the stock of commercial floor space are developed. Energy use indexes are developed by subsector and fuel type for each end use in section IV. Section IV also presents the process by which total energy use, floor space, and energy use figures from published studies are reconciled. A brief analysis of the resulting energy use indexes for the years 1965-1975 provides an interesting picture of recent trends in fuel use. A description of future efforts to improve this estimation of disaggregated energy use is summarized in the final section. (from Section I)
Availability: NTIS (when available)

Jacobson, C.A.; Mitchell, J.W.; Pappas, J.L.
Wisconsin Univ., Institute for Environmental Studies, Energy Systems and Policy Research Group
Address: Madison, WI 53706
A Model of Commercial Energy Use in Wisconsin

Energy Systems and Policy Research Report No. 5, IES Report 36, 22 p.
Dec 1974
Sponsor: National Science Foundation, RANN Program; Upper Great Lakes Regional Commission
Abstract: The commercial submodel relies upon an engineering design approach to arrive at the parameters and functional relationships which characterize energy intensities per square foot of floor area in commercial buildings. Resultant energy consumption by end use and fuel type is determined by the product of calculated energy intensities and total commercial floor area assignable to each element of the end use/fuel type matrix. Initial values for the parameters are derived from published sources, or when not available, from estimates obtained from professionals in the field of energy systems design. (8 references) (auth)
Availability: Communications Office, Institute for Environmental Studies, University of Wisconsin-Madison, 610 Walnut St., Madison, WI 53706

Jacquet, C.H., Jr. (ed.)
National Council of the Churches of Christ in the U.S.A., Office of Research, Evaluation and Planning
Address: 475 Riverside Drive, New York, NY 10027
Yearbook of American and Canadian Churches (Formerly Yearbook of American Churches)

Annual publication, forty-fifth issue, ISBN 0-687-46632-6 for 1977 Yearbook
Abstract: This bi-national volume on organized religion in the U.S. and Canada reports data from approximately 220 religions bodies, including almost all established religious organizations and accounting for most of the church membership. Data are obtained by annually mailing out statistical and directory forms to individuals in ecclesiastical and secular organizations. The Yearbook is organized into these three sections: I - a Calendar for Church Use, listing important religious dates; II - a directory section, with directories on cooperative organizations, religious bodies in the U.S. and in Canada, international agencies, regional and local ecumenical agencies, theological seminaries, church-related and accredited colleges and universities, religious periodicals, and service agencies; III - a Statistical and Historical Section, with sections on current and non-current statistical data, church financial statistics and related data, trends and developments, surveys of religion in American life, and main depositories of church history material and sources. (EYB)
Availability: Abingdon Press, Nashville, TN, $12.95 for 1977 Yearbook (paperback)

Johnson, R.J.; Johnson, A.W.
National Association of Home Builders Research Foundation Inc.
Address: 15th & M St. NW, Washington, DC 20005
Retrofitting Homes for Energy Conservation - A Business Guide

Conservation Paper No. 23, Report No. PB-250061, FEA/D-75/403, 72 p.
Dec 1975
Sponsor: Federal Energy Administration, Office of Energy Conservation and Environment, Office of Buildings Programs
Abstract: The purpose of this Guide is to provide information to entrepreneurs with home building industry, remodeling or related experience about the nature of the potential new business opportunity for retrofitting existing single-family homes with sensible energy conserving items. The Guide is prepared on the assumption that the entrepreneur has proper and adequate experience and is capable of managing a business. It sets forth facts about the energy crisis, discusses the potential market opportunity and some of the new and different aspects of the retrofit business, contains information on marketing Retrofit Packages, sets forth groups of energy conserving items

in several logical Packages for each of the different climate zones, and contains newly developed Factors, Worksheets, Formulas and Methods for calculating the amount of energy cost savings related to the retrofit items. As a result of the pilot study, it was concluded that there is a large potential retrofit business opportunity if the government undertakes some substantial promotion programs to create basic demand for the additon of energy conserving items to homes and if some significant financial incentives to home owners become available, for example, tax rebates. (from Preface)
Availability: NTIS

Jones, C.D. (ed.); Sepsy, C.F. (ed.)
Ohio State Univ., Dept. of Mechanical
Engineering, Environmental Control Group
Address: Columbus, OH 43210
Load Profiles and Energy Requirements for Heating and Cooling Buildings. A Report to the ASHRAE Task Group on Energy Requirements

ASHRAE Research Project No. 66-OS, Energy Calculations 4, 317 p.
1976
Sponsor: American Society of Heating, Refrigerating and Air-Conditioning Engineers Inc.
Abstract: This study was conducted to field verify algorithms and the calculation methodology for determining heating and cooling load requirements of buildings and the energy consumed in heating, air conditioning, and ventilating. This report is organized into two volumes bound together. Reprints of 12 previously published papers on phases of the study are reproduced in Volume I. The second part of this volume presents experimental and simulated daily energy consumption profiles for the year 1972 to supplement the sample profiles contained in the previously published papers. The computer load program and system simulation program listings and documentation are contained in the second volume. This volume includes the wall construction and conditioned space details of the building to document the input listings. (BYB)
Availability: American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc., 345 E 47th St., New York, NY 10017 $18.00

Jorgensen, D.W.
Harvard Univ.
Address: Cambridge, MA
Consumer Demand for Energy

Published in "Proceedings of the Workshop on Energy Demand," W.D. Nordhaus, ed., International Institute for Applied Systems Analysis, Laxenburg, Austria, Report No. CP-76-1, CONF-75C5110, pp. 765-802
1976
Abstract: Energy policy which increases the price of energy (e.g., through excise taxes) can bring about energy conservation without affecting capital services. Allocation of U.S. personal consumption expenditures for capital services, energy, and non-durables is analyzed with the result that the price of energy appears to affect conservation by consumers. A paper with the same title was presented by this author at the annual meeting of the American Statistical Association, held in St. Louis, MO on August 29, 1974. (15 references) (DCK)

Jorgenson, D.W.
Harvard Univ., Harvard Institute of Economic Research
Address: Cambridge, MA
Consumer Demand for Energy

Discussion Paper Number 386, prepared for presentation at the Annual Meetings of the American Statistical Association, St. Louis, MO, August 29, 1974, 42 p.
1974
Abstract: Consumer demand for energy is analyzed using a complete model for the allocation of U.S. personal consumption expenditures. Research results are presented for a model of consumer expenditure allocation among capital services, energy, and non-durables. The purposes of this work are 1) to determine the effects of changes in total expenditure and changes in preference on the distribution of the consumer budget between energy and non-energy commodities; and 2) to determine patterns of substitution between energy and non-energy commodities. Statistical tests of the model's restrictions on preferences are carried out, and applications of this econometric model of consumer demand for energy are described. It is concluded that increases in the price of energy can effect substantial energy conservation by consumers. Results also indicate that growth in income has a slightly negative impact on energy demand. The stability of the percentage of the consumer budget spent on energy from 1947-1971 is due to the positive effect of a declining price of energy relative to non-energy products offsetting the negative effect of income growth (15 references) (BYB)

Kaufman, A.; Mathusa, P.; Irvine, G.; Michon, G.T.; Isaacson, P.; Putnam, A.
New York, State of, Department of Public Service
A Study of Electric Space Conditioning in New York State

Report prepared for the Energy Conservation Symposium at Albany State University, N.Y., 33 p.
1971, December 29
Abstract: The staff report on electric space conditioning attempts to deal with three basic considerations. These are resource availability and impact, power system benefits, and environmental degradation. In doing so, we have attempted to develop a conceptual framework for the analysis of comparative costs and benefits of electric space conditioning versus alternative forms of such conditioning. We have restricted the study to the concerns of the Public Service Commission and the State of New York. As a consequence, social impacts outside the State (such as increased surface mining) are not considered. (Auth)

Kaufman, H.A.; Anderson, W.; McElroy, J.; Kennerty, K.; Mueller, L.J.
Faucett (Jack) Associates Inc.
Address: 5454 Wisconsin Ave., Chevy Chase, MD 20015
Energy Consumption in Commercial Industries by Census Division - 1974

Report No. PB-268851, FEA/B-77/167, JACKFAU-77-143-3, 390 p.
Mar 1977
Sponsor: Federal Energy Administration, Office of Energy Information and Analysis, Office of Energy Systems Data
Abstract: The Federal Energy Administration (FEA), through its mandate from Congress, is engaged in the design, development, and collection of energy information necessary to carry out FEA and other government agencies'

statistical and forecasting activities. A Functional End-Use Data Base for eight sectors of the economy has been developed. The eight sectors are: mining, manufacturing, agriculture, construction, residential, transportation, commercial, and electric utilities. For most of the sectors, data are provided by fuels and functional end uses and geographic areas for designated years. The actual data in the Functional End-Use Data Base consist of numbers representing quantities consumed in traditional physical units, Btu, and dollars. This report focuses on the commercial sector only. Primary data are not collected on a routine basis for most segments of the commercial/services sector of the economy as they are for other sectors, such as the residential and the manufacturing sectors. Various agencies of the Federal government collect data for hospitals, schools, state, and local governments, as well as retail and wholesale establishments. However, data are not collected on a regular basis for the financial, insurance, and real estate segments, and only for selected services of the commercial sector. In addition, data are not collected on energy consumption by building types for the commercial sector. Therefore, this report is a compilation of secondary data collections compiled by many different public and private organizations for the various segments of the commercial sector. Following a common methodology, the data are estimated for the various segments of each of the commercial sectors, and then Census Division and national totals are developed. (7 references) (from Foreword)
Availability: NTIS

Kell, J.R.; Martin, P.L.
Heating and Air-Conditioning of Buildings

The Architectural Press, London, 562 p.
1971
Abstract: This book provides engineering information in SI units (Systeme International d'Unites) on the following topics: Heat; The Building and the Heating System; Choice of Heating System; Boilers and Combustion; Oil Firing; Gas Firing; Low-Pressure Hot-Water Heat Emitters; Pipe Sizing for Hot-Water Heating; Hot-Water Heating Auxiliaries; Heating by Steam; Heating by High-Pressure Hot Water; Heating by Electricity; Hot-Water Supply; Piping for Hot-Water Supply Systems; Running Costs of Heating Systems; Ventilation; Air-Conditioning; Air Distribution; Fans, Ducts and Sound Control; Air Filters, Heaters and Coolers; Refrigeration for Air-Conditioning; Tall Buildings; District Heating; and Total Energy. (MFG)

Kelly, G.E.; Bean, J.
U.S. Dept. of Commerce, National Bureau of Standards, Institute for Applied Technology, Center for Building Technology
Address: Washington, DC 20234
Dynamic Performance of a Residential Air-to-Air Heat Pump

Report No. NBS BSS-93, 18 p.
Mar 1977
Sponsor: Federal Energy Administration
Abstract: Information is presented on the dynamic performance of a 5-ton air-to-air heat pump, which was installed in a residence in the Washington, D.C. area. The effect of part-load operation on the heat pump's COOLING and HEATING coefficients of performance (COP) was determined. When the pump operated in the heating mode at outdoor temperatures below 40 degrees F (4.4 degrees C), a considerable discrepancy was found to exist between the measured performance and the performance data supplied by the manufacturers. This discrepancy is apparently due to the adverse effects of frost buildup and defrosting of the outdoor coil. The seasonal performance factor (SPF) of the heat pump was estimated and then traced back to the power plant to obtain an "EFFECTIVE SPF" which is then compared with the performance which might be expected from fossil-fuel heating equipment. (7 references) (auth)
Availability: GPO $0.45, SD Cat. No. C13.29/2:93

Kelly, G.E.; Didion, D.A.
U.S. Dept. of Commerce, National Bureau of Standards, Institute for Applied Technology, Center for Building Technology
Address: Washington, DC 20234
Energy Conservation Potential of Modular Gas-Fired Boiler Systems

Report No. NBS-BSS-79, 54 p.
Dec 1975
Abstract: The modular concept of boiler operation was examined in a laboratory test of five gas-fired, cast iron, hydronic boilers. Four of the boilers, each having an input rating of 85,000 Btu per hour, were arranged so that they could either be operated like a single boiler (i.e., all of the boilers either on or off) or as a modular installation in which the boilers are sequentially fired to match the number in operation with the heating load. The fifth boiler had an input rating of 300,000 Btu per hour and was operated as a single boiler installation. Efficiency vs. heating load curves were obtained for the single boiler installation, the four small boilers run like a single boiler, and the modular installation operated with and without water flowing through the "idle" modules. These efficiency curves were then used to theoretically predict the effect of the modular concept and boiler oversizing on the seasonal efficiency of gas-fired heating plants. It was found that under certain conditions the use of a gas-fired modular boiler installation instead of a single large boiler could result in considerable energy savings. (auth)
Availability: GPO $1.15, SD Catalog No. C13.29:2/79

Kelnhofer, W.J.; Wood, L.A.
U.S. Dept. of Commerce, National Bureau of Standards, Center for Building Technology, Office of Energy Conservation; Catholic Univ. of America, Dept. of Mechanical Engineering
Address: Washington, DC 20234
Energy Management Guide for Light Industry and Commerce

NBS Handbook 120, EPIC Energy Management Series, 28 p.
Dec. 1976
Sponsor: U.S. Dept. of Commerce, Domestic and International Business Administration, Office of Energy Policy and Programs
Abstract: This Energy Management Guide describes some simple methods by which the manager of a small business can analyze his energy use, determine the areas in which energy savings can be made, and estimate the magnitude of the possible cost savings. The program starts with an energy audit based on fuel and utility bills. A more detailed audit, designed to locate the major energy uses and, therefore, the most promising targets for energy conservation, is discussed in some detail. The methods described require little or no instrumentation; they primarily involve the summarizing of data taken from such

sources as light bulb labels and the nameplates on electric motors. The importance of this audit is stressed as a necessary prelude to a good energy management program. A check list suggests some seventy items which might be important cost saving opportunities to an individual business. Eight of these opportunities are expanded in the appendix into miniature case studies illustrating simple methods for estimating savings. These Cost Saving Opportunities (CSO's) range from the simple case of reducing temperatures at night and on weekends (saving up to a third of the heating fuel), to the more complex case of installing a heat exchanger on a restaurant air conditioner (cost $800) in order to save money in heating water (saving $1100 yearly). It is pointed out that while many energy conservation actions will require no outside help and little or no capital investment, others, particularly those involving a major expenditure, should be discussed with an experr in the field. A listing of sources of assistance is included as a guide to obtaining such consulting advice. (18 references) (from Summary)
Availability: GPO $0.70, Stock No.
003-003-01667-5, Superintendent of Documents
Catalog No. C13.11:120

Kidman, R.B.; Barrett, R.J.; Koenig, D.R.
Los Alamos Scientific Laboratory
Address: Los Alamos, NM 87545
Energy Flow Patterns for 1975

Report No. LA-6770, 72 p.
Jun 1977
Sponsor: Energy Research and Development Administration; Federal Energy Administration
Abstract: Highly visual and self-explanatory 1975 energy flow diagrams are presented for each of the 50 states, the 10 U.S. Federal Standard Regions, and the entire United States. Each diagram illustrates the energy produced and how it is consumed or lost. The diagrams are meant to serve as a convenient and useful reference (or starting point) for consideration of energy-related problems. (auth)
Availability: NTIS

Kunstadt, R.
V.I. Falctico Inc.
The M/E Engineer's Role on the Building Energy Conservation

Building Systems Design, 71(2), p. 48-50 (Feb/Mar 1974)
Feb/Mar 1974
Abstract: This article asserts that the consulting engineer, in conjunction with the owner and architect, must design buildings that use energy efficiently. It is suggested that the engineer: 1) prepare comments for the architect on primary decisions that will effect the building's energy use; 2) alert the architect on new technical developments relating to energy use; 3) delineate to the architect the various system options available; and 4) prepare an economic analysis for all-air systems, air-water systems, heating source, cooling source, and electric energy source. Various energy recovery equipment and systems are described, including the rotary heat exchanger, heat pumps, heat pipe, economizer cycle, "bootstrap" recovery systems, water cooled lumineires, solar energy utilization, off-season "free" cooling systems, and light source selection. (BYE)

Kusuda, T.
U.S. Dept. of Commerce, National Bureau of Standards, Institute for Applied Technolo
Center for Building Technology
Address: Washington, DC 20234
NBSLD, Computer Program for Heating and Cooling Loads in Buildings

Report No. PB-246184, NBSIR 74-574, [illegible] p.
Nov 1974
Sponsor: U.S. Dept. of Housing and Urban Development
Abstract: A comprehensive computer program called NBSLD, the National Bureau of Standards Load Determination program, has been developed at NBS to reflect the time change of the many building parameters which are pertinent to accurate estimation of energy usage for heating and cooling. Current status of heating and cooling load techniques is reviewed. Of general interest are unique features of NBSLD which are not available in existing computer programs. A summary of various subroutines of NBSLD is given along with the detailed procedures for them. These subroutines constitute the recommended subroutine algorithms of the ASHRAE Task Group on Energy Requirements. Complete Fortran listing of of NBSLD and data preparation forms are given for those who wish to use the program. The NBSLD computation is on the basis of the detailed solution of simultaneous heat balance equations at all the interior surfaces of a room or space. Transient heat conduction through exterior walls in the interior structures is handled by using conduction transfer functions. The use of heat balance equations, although time consuming in calculation, can avoid the vagueness and uncertainties inherent in the more popularly used weighting factor approach. In addition, it is more accurate for a specific building design. (7 references) (auth)
Availability: NTIS

Kusuda, T.; Hill, J.E.; Liu, S.T.; Barnett, J.P.; Bean, J.W.
U.S. Dept. of Commerce, National Bureau of Standards, Institute for Applied Technology
Address: Washington, DC 20234
Pre-Design Analysis of Energy Conservation Options for a Multi-Story Demonstration Office Building

Report No. NBS-BSS-78, 64 p.
1975
Sponsor: General Services Administration
Abstract: The design phase of the General Services Administration-Manchester Building included extensive analysis of the building design and operation to determine the potential for energy conservation. Described in this report are highlights and a summary of the calculations performed during the design phase. The analysis included a study of the effect of the exterior shell, ventilation rate, lighting and occupancy levels, room temperature controls, and nighttime flushing of the building using outdoor air on the predicted yearly energy consumption of the building. (11 references) (auth)
Availability: GPO $1.25, SD Cat. No. C13.29/2:78

Laaspere, T.
Dartmouth College, Thayer School of Engineering
Address: Hanover, NH
The Technological Alternatives for Metering and for Load Management. Testimony of Thomas Laaspere Before the Public Service Commission of New York. Case No. 26806

Report No. NP-20674, 42 p.
11 Aug 1975
Abstract: Time/demand rates affect load management when customers are encouraged to change their patterns of electric consumption. The cost of load management metering equipment using time switches, radios, or ripple control will be substantially higher than the $20 single phase watthour meters now used in the U.S. Options already available include: dual register watthour time switches, which cost about $71 and require manual adjustments; radio control systems, which are good for control of urban water heating but not for all equipment; and a European one-way ripple system, which uses a power grid to transmit coded audio-frequency signals and seems to be the most reliable and flexible system. Tests are underway on two-way ripple, over-the-phone metering, magnetic cartridge recorders, and other systems. Costs, up to $400 per unit, increase with the complexity and comprehensiveness of the system. European experience indicates that consumers respond quickly to rate changes based on peak load demand management, and the high cost of complex equipment is quickly made up with reduced energy consumption and lower rates. (DCK)
Availability: TIC

Landsberg, H.H.
Resources for the Future Inc.
Address: 1755 Massachusetts Ave. NW., Washington, DC 20036
Learning from the Past: RFF's 1960-1970 Energy Projections

Paper presented for a Seminar on Energy Modeling, January 25-26, 1973, Washington, DC, sponsored by Resources for the Future, Inc., pp 416-436
Mar 1973
Sponsor: Resources for the Future Inc.
Abstract: This closing paper of the seminar by Landsberg brings matters, in a manner of speaking, back to earth with a hard look at the performance for the 1960-1970 period of one of the major energy projection efforts covering that decade. Landsberg also speculates on whether the longer-term projections may prove more or less accurate than those of the last decade. The experience with the forecast described, and the tentative principles formulated on the basis of that experience, should prove useful to current modeling efforts. (Editor's Introduction)
Availability: Resources for the Future, Inc., 1755 Massachusetts Ave. NW, Washington, DC 20036 ($5.00 for entire proceedings)

Langlois, R.N.
Brookhaven National Laboratory, National Center for Analysis of Energy Systems, Policy Analysis Division
Address: Upton, NY 11973
Future Natural Gas Supply to the Northeast

Report No. BNL-50558, 77 p.
Apr 1976
Sponsor: Energy Research and Development Administration, Division of Biomedical and Environmental Research
Abstract: Due to the shortage of natural gas, especially on the interstate market, the Northeast has suffered curtailments of its firm-contract supplies in recent years. The curtailment priorities are regulated by the Federal Power Commission and the individual state based on end use mix as well as the amount of gas each pipeline company has available. Nationwide gas production reached its peak of 22.6 trillion cubic feet in 1973 and has been declining ever since. This situation is further aggravated by the two-tiered price structure. The disparity between interstate and intrastate gas prices gives the gas producing states a competitive edge in securing newly discovered gas reserves and results in the further shortage of natural gas available to other states. Partially because of this reason, the continued price regulation has become a very controversial issue. Based on estimates of total U.S. gas reserves (discovered as well as undiscovered) and applying a modified Hubbert method to a number of assumptions, projections of natural gas production were made for 1985 and 2000. From these, the amount of gas supply available to the Northeast was projected based on further assumptions, e.g. if there is gas deposit on the Atlantic Outer Continental Shelf, whether it will be developed in time, how much of the Alaskan gas is available to this part of the nation, etc. The conclusion is that under most scenarios the supply of natural gas to the Northeast will be severely constrained. (57 references) (auth, abstract modified)
Availability: NTIS

Lee, J.
Brookhaven National Laboratory, National Center for Analysis of Energy Systems, Policy Analysis Division
Address: Upton, NY 11973
Future Residential and Commercial Energy Demand in the Northeast

Report No. BNL-50552, 141 p.
Mar 1976
Sponsor: Energy Research and Development Administration, Division of Biomedical and Environmental Research
Abstract: In 1972 the Northeast consumed 5.02 quadrillion Btu's (quads) or 44% of its energy use in the residential and commercial sectors. Of this total, about two-thirds (3.30 quads) was consumed in residential households and the balance (1.72 quads) in commercial buildings. By end use, space heating is dominant in both sectors, accounting for about 71% of the energy used in the residential sector and 76% in the commercial sector. In terms of fuel distribution, both sectors are highly dependent on oil, with more than half of their energy supplied from petroleum products. Based on existing demographic projections and considering different levels of change in technology, government policy, consumer behavior, and related factors, three alternative energy consumption patterns were constructed for 1985 and 2000. The Base Case projections, which assume a continuation of the consumption patterns which have developed since the "energy crisis" of 1973-74, indicate a total residential energy use in the region that remains roughly at the 1972 level until 1985. This consumption is projected to increase at an annually compounded gro[illegible] rate of 0.6% from 1985 to 2000. The commercial energy demand is projected to grow at an annual rate of 2.7% between 1972 and 1985 and 4.1% between 1985 and 2000. The conservation scenarios indicate that there is a tremendous potential for energy conservation in the two sectors. (17 references) (auth, abstract modified)
Availability: NTIS

Leighton, G.S.
U.S. Dept. of Housing and Urban Development, Modular Integrated Utility System Program
Address: Washington, DC
The Modular Integrated Utility System - A New

Approach to the Supply of Utility Services

Paper 739147 presented at 8th Intersociety Energy Conversion Engineering Conference held at University of Pennsylvania, Philadelphia, PA, Aug. 13-17, 1973, p. 648-652 of Proceedings
1973
Abstract: This paper provides an overview of the Modular Integrated Utility System (MIUS) Program. The Program, sponsored and directed by the Department of Housing and Urban Development (HUD) is directed at effecting widespread application of the MIUS concept via a limited number of demonstrations. The MIUS is a combined processing plant that generates electricity, utilizes residential and recycled energy for heating, air conditioning and hot water; treats water; and processes solid and liquid wastes. The MIUS Program is being carried out for HUD in Phase I (pre-demonstration) by numerous Government agencies: the AEC through the Oak Ridge National Laboratory; the Environmental Protection Agency; the Department of Commerce through the National Bureau of Standards; and the National Aeronautics and Space Administration. (Auth)

Levy, P.F.
Massachusetts Institute of Technology, Energy Laboratory
Address: 77 Massachusetts Avenue, Cambridge, MA 02139
The Residential Demand for Electricity in New England

Report No. PB-227172, MIT-EL-73-017, 124 p.
Nov 1973
Sponsor: National Science Foundation, RANN Program
Abstract: This report examines the residential demand for electricity at a very detailed level of aggregation. An econometric model is developed for the New England region using a cross-section of sixty-seven electric utilities and their service areas as the data base. Both supply price and demand equations are estimated, using the two-stage least squares technique, to account for the simultaneous nature of the system. Conclusions are presented and policy implications discussed. Suggestions for future work in the field are also presented. (Auth)
Availability: NTIS

Lin, W.; Hirst, E.; Cohn, S.
Oak Ridge National Laboratory
Address: Oak Ridge, TN 37830
Fuel Choices in the Household Sector

Report No. ORNL/CON-3, 46 p.
Oct 1976
Sponsor: Federal Energy Administration; Energy Research and Development Administration
Abstract: This study analyzes residential fuel choices for five major end-uses: space heating, water heating, cooking, air conditioning, and food freezing. Market share models for electricity, gas, oil, and "other/none" are estimated using 1970 cross-section data for 48 states, sensitive to changes in fuel prices, equipment prices, income, demographic, and climatic variables. Logit models are estimated jointly for each end use by incorporating a set of linear restrictions derived from the requirement that the sum of market shares equals unity. Estimated saturation elasticities with respect to own fuel prices are generally greater than unity. Cross-price elasticities are generally less than the own-price elasticities and usually less than unity. Saturation elasticities with respect to equipment prices are generally greater than unity. A comparison of fuel price and equipment price elasticities suggests that households are more reluctant (require a higher internal rate of return) to invest in energy-efficient household equipment if the investment requires a change in fuel than if the investment requires no fuel switching. Also, higher interest rates are required for investments in energy-efficiency appliances (ranges, freezers) than for investments in basic household equipment (space heating systems). (18 references) (Auth)
Availability: NTIS

Little (Arthur D.) Inc.
Address: Acorn Park, Cambridge, MA
Energy Conservation in New Building Design. An Impact Assessment of ASHRAE Standard 90-75

Report No. PB-252639, FEA/D-76/078, Conservation Paper No. 43B, 271 p.
Mar 1976
Sponsor: Federal Energy Administration, Office of Conservation and Environment, Office of Buildings Programs
Abstract: The objective of this study was to assess the energy, economic, and institutional impacts that may result from the broad voluntary adoption of American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE) Standard 90-75 by individual building regulatory authorities. This Standard is the first major voluntary consensus standard dealing with energy use in new buildings, and is available for optional acceptance by state and local governments. With strict use of the Standard, annual energy consumption would be reduced in all building types and locations. In applying ASHRAE 90-75, physical changes are brought about in exterior glass, exterior walls, insulation, lighting, and heating, ventilating, and air conditioning (HVA/C) system capacities. Considering the economic impact of the Standard, ASHRAE 90-75 modified buildings should cost no more to build than conventional buildings and would have substantially less annual energy costs. It is estimated that if this Standard were adopted throughout the U.S., the annual energy consumed in new construction would drop 27%; annual energy consumption in the Nation's buildings would also be reduced significantly. The examination of building materials and equipment markets concluded that the adoption of ASHRAE 90-75 would create opportunities for suppliers of commodity building materials at the expense of decreasing those markets for general building equipment and HVA/C systems. Impacts on key industry participants were also investigated. The most important effect of the Standard on the building habitability would result from reduced ventilation and infiltration. (56 references) (BYB)
Availability: GPO

Little (Arthur D.) Inc.; Executive Office of the President, Council on Environmental Quality; Federal Energy Administration; Interagency Task Force on Energy Conservation
Project Independence Blueprint: Final Task Force Report - Energy Conservation, volume 1, Residential and Commercial Energy Use Patterns 1970-1990

306 p.
Nov 1974
Abstract: A foundation is laid for energy policy in the residential and commercial sectors on the basis of this technical analysis. Residential and commercial energy use patterns from 1970 to 1990 are constructed so

that assumptions may be altered at any time. The present levels of consumption, the projected growth of this consumption under several energy price assumptions, and the potential for reducing this growth by various means are explained. Energy demand for residential and commercial sectors is divided into 500 cells in four dimensions--geographic regions, building types, end uses, and fuels--for 1970. The unit demand for each fuel, in each building type, for each end use, in each region and the penetration of that fuel in that market is estimated. The building inventory to 1990 by type and region, and the unit demand and penetrations to develop the estimated total demand under various assumptions are projected. In an Appendix, computer simulations of the energy usage patterns are described, and details of the processes used and data sources consulted to derive the input data are presented. (TIC)
Availability: GPO $3.75, Stock No. 4118-00038

Lockeretz, W.
Washington Univ.
Address: St. Louis
Growth of Residential Consumption of Electricity: Distribution Among Households at Various Consumption Levels

Land Economics, 51(2), pp. 150-157 (May 1975)
May 1975
Abstract: The purpose of this paper is to determine how consumers, who use different amounts of electricity, have shared in the growth of residential electricity consumption. The distribution of residential electricity consumption has changed from 1968 to 1973 for base load and peak load months. Results of this study indicate that the greatest increase in electricity consumption was due to consumers at the highest levels. It is concluded that a reduction in total future growth will not necessarily adversely affect the small consumer. The problem is not how much total consumption increases, but how much of any growth in power generation will go to the small consumer. (19 references) (BYF)

Lokmanhekim, M.; Harvey, D.G.
Hittman Associates Inc.
Address: 9190 Red Branch Road, Columbia, MD 21045
Residential Energy Consumption, Multifamily Housing

Report No. PB-232637, HUD-HAI-4, v.p.
Jun 1974
Sponsor: U.S. Dept. of Housing and Urban Development, Policy Development and Research; U.S. Environmental Protection Agency; National Science Foundation, RANN Program
Abstract: Analyses were performed on the consumption of energy within multifamily residences to define their energy consumption patterns and to evaluate modifications whereby energy consumption could be reduced. The types of multifamily residences included in this study were townhouses, low-rise, and high-rise apartments. Major emphases were placed on the analyses of energy consumption for heating and cooling and on modifications that would reduce the energy requirements for heating and cooling. The evaluation of modifications for reducing energy consumption for lighting and appliances had been performed previously in the study of single-family residences, and the results would be directly applicable to multifamily residences. (39 references) (auth, from Summary and Conclusions)
Availability: NTIS

Lyons, J.; Flood, J.
Merchandising Week
Address: One Astor Plaza (1515 Broadway), New York, NY 10036
Annual Major Appliance Statistical Report

First Annual Report, 58 p.
10 Nov 1975
Abstract: This annual report provides a statistical and marketing analysis of the major appliance industry, including refrigeration, laundry appliances, cooking appliances, air treatment equipment, dishwashers, disposers, and compactors. Tables and graphs provide information on the number of shipments, average retail prices, percentage of sales by month, and where appliances are sold (e.g., builder-contractors, kitchen remodelers, department stores, appliance stores, discount stores, and catalog chains). The 1976 report indicates gains in all areas except for freezers and electronic air cleaners. In 1976, sales of refrigerators increased 7% over 1975. A trend toward larger capacity refrigerators is noted. After two years of recession, the home laundry industry experienced gains in all its product categories. Cooking appliance sales increased in 1976 in every category, including a 65% increase in microwave oven sales. In the air treatment industry, shipments of room air conditioners and humidifiers increased, but shipments of electronic air cleaners fell 11% over the 1975 level. Industry estimates indicate that shipments of dishwashers, food waste disposers, and trash compactors increased in 1976, due to a comeback in housing and to replacements. (BYB)
Availability: Merchandising Week, One Astor Plaza (1515 Broadway), New York, NY 10036 $10

Lyons, J.; Tyll, A.
Merchandising (Formerly Merchandising Week)
Address: 1515 Broadway, New York, NY 10036
Statistical and Marketing Report

Annual report, Merchandising Week, 107(8), pp. 18-90 (Feb. 24, 1975) for 1975 Report; Merchandising, 1(1), pp. 40-128 (March 1976) for 1976 Report; Merchandising, 2(3), pp. 35-103 (March 1977) for 1977 Report
Abstract: These annual reports present marketing and trend analyses for the major appliance, home and auto electronics, personal communications, high fidelity, and electric and non-electric housewares industries. The 1977 report is organized into these main sections: Product Sales Growth, with ten-year tables on major appliances, auto electronics, tape/audio/hifi, housewares, and manufacturer sales and retail values; Product Saturation Levels, including a saturation index for key products and a ten-year table on saturation levels; Replacement and Trade-Ins; Imports/Exports; Retail Sales Survey; Marketing Data; Major Appliances; Home and Auto Electronics/Tape-Audio-HiFi; Calculators; Digital Watches; Electric Housewares; Kitchen Electrics; Personal Care; Outdoor Products; Non-Electric Housewares and Hardware; Cookware; and Floor Care. (BYB)

Makhijani, A.B.; Lichtenberg, A.J.
California Univ., Electronics Research Laboratory
Address: Berkeley, CA
An Assessment of Residential Energy Utilization in the U.S.A.

Memorandum No. ERL-M370, paper presented at the Department of EECS, University of California,

Berkeley, Seminar on the Ecology of Power Production, 51 p.
6 Jan 1973
Sponsor: National Science Foundation
Abstract: The use of energy in households is tabulated by use and by fuel. Trends in electrical energy consumption by use are given for the period 1960-1970. Comparison of energy use for households employing various appliances are made. Projections of the use of electrical appliances are made to the year 2000. These projections are used to project the total residential use of electricity to the year 2000. The results are found to be a factor of 4 below the straight line (exponential) predictions usually found in the literature. Electricity and total energy fuel savings, primarily through the use of better insulation and the partial employment of solar energy, are calculated. Approximately a thirty percent reduction of electricity and total energy consumption, over the projection without conservation measures, can be achieved. (Auth)

Martin, R.S.
East Tennessee Development District
Address: 1810 Lake Ave., Knoxville, TN 37916
Housing and Building Code Study, East Tennessee Development District.

Re[illegible] No. ET-7-7C, 88 p.
Co[illegible]
Ab[illegible] The general scope of this study has [illegible] (1) to determine which cities have [illegible]ted codes and their degree of success in [illegible]nforcing codes, (2) to reveal the effectiveness of codes in accomplishing the objectives desired, (3) to point out problem areas and make recommendations concerning administration and enforcement, (4) to determine if overly restrictive provisions exist and make recommendations concerning their continued use, and (5) to advocate the adoption and enforcement of building and housing codes by each local unit of government. (Auth)

Mathematica Inc.
Address: 2021 L St. NW, Washington, DC
Impact of Energy Price Increases on Low-Income Families

Report No. PB-262098, FEA/B-76/126, 246 p.
Dec 1976
Sponsor: Federal Energy Administration, Office of Energy Information and Analysis, Office of Economic Impact Analysis
Abstract: The Federal Energy Administration is charged with conducting economic analyses to determine the socioeconomic impacts of various energy problems and policies. In particular, FEA is expected to analyze higher energy prices and their effects on consumer household energy expenditures and on distribution of income. In order to develop a data file to be used for analysis, FEA sponsored a research contract which provided for (1) the development of a comprehensive data file descriptive of U.S. households and their energy characteristics and expenditures, (2) the economic analysis of the impact of the 1973-74 Arab Oil Embargo on the household sector, and (3) the installation of the household energy data file on the FEA computer system along with supporting software to allow screening and extrapolation of the data file to analyze various energy scenarios. The essential component of this study is the development of a household energy consumption model which enables FEA to explain and predict the distributional impact of energy price increases on households according to income groups. The model serves as a valuable tool in evaluating alternative energy policies and in choosing a means to alleviate the burden on low-income families. (from Foreword)
Availability: NTIS

Mayer, L.S.; Robinson, J.A.
Princeton Univ., Center for Environmental Studies
Address: Engineering Quadrangle, Princeton, NJ 08540
A Statistical Analysis of the Monthly Consumption of Gas and Electricity in the Home

Center for Environmental Studies Report No. 18, 170 p.
1975
Sponsor: National Science Foundation, RANN Program
Abstract: The macroconsumption of energy in residential buildings was studied by using monthly readings of the gas and electricity meters. The buildings surveyed in this study had gas space heating and electric air conditioning. Results show that the energy crisis caused a 10% decrease in gas consumed. Although no significant decrease in winter electric power consumption was observed after the energy crisis using classical methods, a 6% decrease was detected by a "robust" analysis. People who were high gas consumers in the winter were not necessarily high electricity consumers in the summer. Occupant behavior was found to be an important factor in monthly gas consumption. Evidence indicated that neither extremely high nor extremely low users responded differently to the energy crisis than moderate users. Monthly energy consumption was modeled using an additive model with both standard least squares and "resistant fitting" methods. (BYB)

Mayer, N.S.
U.S. Congress, Congressional Budget Office, Human Resources Division
Address: Washington, DC
Homeownership: The Changing Relationship of Costs and Incomes, and Possible Federal Roles

Budget Issue Paper, 57 p.
Jan 1977
Abstract: Changes in homeownership affordability (i.e., the American family's ability to buy and maintain a home, or income to housing cost ratio) over the period 1970 to 1975 are examined, and some possible government policies that would affect affordability are discussed. First-time homebuyers, who make up about half of all homebuyers in a given year, experienced large declines in affordability during this time period, because their costs for median new houses rose approximately two times as fast as their incomes, and their costs for existing homes rose one-and-one-half times as fast as income. Repurchasers benefited from increased values in the homes they sold. Homeowners who did not move faced increases only in housing operating costs and had incomes rising faster than housing costs. Although changes in affordability do not vary substantially between income groups, the real difficulty for low income families is much higher than for other groups. Downpayments for conventially-financed homes have become more burdensome for first-time buyers during this 5-year period. Four major types of Federal policies to improve homeownership affordability are discussed: changes in macro-economic policy, actions to limit increases in specific components of housing costs, homeownership subsidies, and development of alternative mortgage instruments. (BYB)

Availability: GPO $1.40

McGuire, B.J. Jr.
U.S. Dept. of Commerce, National Bureau of Standards
Address: Washington, DC
The Department of Commerce Energy Labeling and Energy Efficiency Programs for Household Appliances

Part of 1976 U.S. Agricultural Outlook: Papers Presented at the National Agricultural Outlook Conference Sponsored by the U.S. Department of Agriculture, held in Washington, DC, Nov. 17-20, 1975, pp. 369-377
1975
Abstract: Legislation mandating programs to reduce residential energy consumption has been passed in both houses of Congress and would preempt diverse state and local programs. Regulations of the Energy Labeling Program cover energy data to advise consumers of product efficiency, with specifications given for rating room air conditioners, refrigerators, freezers, and water heaters. It is expected that specifications for all appliances will be available by the end of 1976. The Commerce Energy Efficiency Program would involve only the manufacturers in a voluntary goal of 20% reduction of energy usage in appliances by 1980. (ECK)

Miller, B.M.; Thomsen, H.L.; Dolton, G.L.; Coury, A.B.; Hendricks, T.A.; Lennartz, F.E.; Powers, R.B.; Sable, E.G.; Varnes, K.L.
U.S. Dept. of Interior, Geological Survey
Address: National Center, Reston, VA 22092
Geological Estimates of Undiscovered Recoverable Oil and Gas Resources in the United States

Geological Survey Circular 725, 82 p.
1975
Sponsor: Federal Energy Administration
Abstract: The primary purpose of this study was to estimate the amount of oil and gas available for discovery and recovery under conditions representing a continuation of historical trends of technology and economics; no attempt has been made to predict how much will be discovered, nor when discoveries will be made. The uncertainties involved are emphasized by reporting undiscovered recoverable resource estimates in terms of ranges of values. ... Thus, the current appraisals indicate that the estimated statistical mean of undiscovered recoverable resources of crude oil in the United States, onshore and offshore, amounts to 82 billion barrels, but this value lies within a range of 50 to 127 billion barrels. The corresponding figures for gas are: a statistical mean of 484 trillion cubic feet, within a range of 322 to 655 trillion cubic feet. In each case the mean value of the undiscovered recoverable quantity is on the order of one-half the amount which has been identified and produced to date. The results also suggest that nearly one-half of the undiscovered recoverable oil resources and more than one-quarter of the undiscovered recoverable gas resources may occur in offshore regions of the United States and in the onshore frontier provinces of the State of Alaska. It is important to note that these resources are located in regions of difficult and costly operations--particularly in the hostile physical environment of the Arctic--and require long lead times for exploration and development. (77 references) (from Conclusions)

Minnesota Energy Agency
Address: 740 American Center Building, 160 East Kellogg Blvd., St. Paul, MN 55101
The Chicago Project: Evaluation and Testing of Three Types of Energy Audit Processes for School Buildings

Report No. PB-255321, FEA/D-76/318, 280 p.
Feb 1976
Sponsor: Federal Energy Administration, Office of Energy Conservation and Environment, Office of Buildings Programs
Abstract: This report presents the findings of a project undertaken by the National Association of Counties to determine appropriate techniques for identifying and alleviating excessive and unnecessary energy use in the public schools of America. Three methods for accomplishing these goals have been tried and are analyzed in this report: (1) a computer simulation model (PSECS) developed by Educational Facilities Laboratories; (2) the Mini-Audit system developed by the Minnesota Energy Agency; and (3) extensive energy use audits (Maxi-Audit) that can be performed by qualified engineering firms. Each of the methods studied has its peculiar advantages and disadvantages, but all have proven to be of value by assisting school districts in making rational decisions on energy matters. (from Introduction)
Availability: NTIS

Mitalas, G.P.; Stephenson, D.G.
National Research Council, Division of Building Research, Buildings Services Section
Address: Ottawa, Canada
Room Thermal Response Factors

American Society of Heating, Refrigerating, and Air-Conditioning Engineers Transactions, Vol. 73, Part 1, Paper 2019, 10 p.
1967
Abstract: The derivation of a set of heat balance equations to describe the dynamic thermal characteristics of a room are described in this paper. These equations take into account radiation and convection heat transfer within the room and heat storage by the room envelope. The equations can be used to calculate surface temperatures, room air temperature, and heating and cooling of room air and can also be used to calculate the room thermal response factors. These factors contain all the information needed for air-conditioning design calculations. Once the thermal response factors are calculated, they can be combined with any set of excitation data to give the room's response for particular conditions. These factors are a convenient way of presenting data for air-conditioning design calculations by digital computer. (MPG)

Mitchell, J.W.; Jacobson, D.A.
Wisconsin Univ., Institute for Environmental Studies, Energy Systems and Policy Research Group
Address: Madison, WI 53706
Implications of Commercial Building Codes for Energy Conservation

Energy Systems and Policy Research Report No. 15, IES Report 42, 12 p.
Dec 1974
Sponsor: National Science Foundation, RANN Program; Upper Great Lakes Regional Commission
Abstract: Various codes and guidelines for commercial building construction have been proposed as a means of effecting energy savings. In Wisconsin, design ventilation values for buildings have been reduced, and a code specifying the allowable envelope (walls

and roof) heat flow has been proposed. On a nationwide basis NBS is working with ASHRAE to establish a set of guidelines for building construction. In this report, the cumulative energy savings in the commercial building sector to the year 2000 that would result from the implementation of the Wisconsin codes are estimated. This estimate is based on a realistic appraisal of the trends in commercial building construction. In addition, the restrictions on building size and shape resulting from these codes are discussed, and the implications on the total energy use for the building considered. Finally, a brief evaluation of the consequences of a code specifying a conductance based on floor area are considered. (auth, introduction)
Availability: Communications Office, Institute for Environmental Studies, University of Wisconsin, 610 Walnut St., Madison, WI 53706

Mooz, W.E.; Mow, C.C.
Rand Corp.
Address: Santa Monica, CA 90406
A Methodology for Projecting the Electrical Energy Demand of the Commercial Sector in California

Report No. R-1106-NSF/CSRA, 40 p.
Mar 1973
Sponsor: Resources Agency of California; National Science Foundation
Abstract: This document describes the detailed projection methodologies which were developed for the commercial sector, the mining portion of the industrial sector, and other small sectors of the California economy. The largest electricity consumer is the commercial sector, which also is shown to be the fastest growing consumer at this time. The other sectors described in this document that are much smaller are treated separately because of their diverse nature and because the data allowed this to be done. These sectors include mining (a portion of the industrial sector), agriculture, railroads, governmental uses of electricity, and use of electricity by the utilities themselves, called interdepartmental uses. In virtually all cases the availability of sufficient data was a problem.----Despite these restrictions, we feel that the methodologies developed offer new insights into the sectors examined. In the commercial, mining, and governmental sectors, it was possible to develop methodologies based upon the output of the sector, measured in terms of dollars of value added or dollars contributed to gross state product, on the electrical-energy intensiveness of the sector, and upon the price of electricity and natural gas.----In the other smaller sectors, such as agriculture and railroads, the use of electricity was found to be either constant or the result of fairly simple forces that could be described by equally simple relationships. Each of these is described in conjunction with an exposition of the past data, and with reasonable projections where these appear to be independent of other variables explicitly considered in the model. (Auth, Summary modified)

Morris, D.N.
Rand Corp.
Address: 1700 Main St., Santa Monica, CA 90406
Evaluation of Measures for Conserving Energy

Report No. P-5477, 40 p.; this paper was presented at the SIAM Institute for Mathematics and Society (SIMS) Research Application Conference on Energy at Alta, UT, July 7-11, 1975
1975
Sponsor: National Science Foundation
Abstract: Energy forecasting models are useful in making effective policy decisions that will encourage changes in consumer behavior through advisory, incentive, or regulatory channels. A study of primary energy sources and end use consumption was applied to residential households and personal transportation, in which individual consumers are the major users. Space and water heating, which account for 82% of residential energy consumption, should be the principal target for household conservation. With major fuel types concentrated, fuel type conservation efforts must be regional. Income and energy price changes in the use and design of appliances as equipment is replaced and new houses built. Short range conservation effects will occur as people respond to higher energy prices by using less energy. With the private automobile using 25% of petroleum consumed in the U.S., models were used to estimate effects of design changes on costs, emissions, and fuel consumption. Weight is the major factor, and the consumer can choose to give it up in trunk space, engine size, comfort, etc. Conservation efforts can include incentives for public transport and carpools, additional gas taxes, and legislation to set fuel economy standards. Model results indicated a 15 cent tax increase could reduce gas consumption up to 20% as a result of fewer cars, fewer miles driven, improved efficiency of engines, and people living closer to work and shopping. Modeling techniques and parameters are illustrated in 22 figures. (DCF)

Moyers, J.C.
Oak Ridge National Laboratory, ORNL-NSF Environmental Program
Address: P.O. Box X, Oak Ridge, TN 37830
The Room Air Conditioner as an Energy Consumer

Report No. ORNL-NSF-EP-59, 38 p.
Oct 1973
Sponsor: National Science Foundation, RANN Program
Abstract: As a part of the ORNL-NSF Environmental Program's effort toward conservation of energy, large differences in the efficiency with which room air conditioners consume electricity to provide cooling are pointed out and examined. Efficiencies range from 4.9 to 12.2 Btu/watt-hr. An improvement in average efficiency from 6 to 10 Btu/watt-hr is estimated to result in a total saving of 212 billion kW-hr during the 1973-80 period and a reduction in connected load to the electrical utilities in 1980 of almost 58,000 MW. A method for predicting the change in efficiency due to a change in design is developed and used to estimate the additional cost entailed in providing higher efficiency. A simple method for evaluating the monetary worth of the power saving at higher efficiency, from the individual's standpoint, is presented. (Auth)
Availability: NTIS

Muller, J.G.
Federal Energy Administration, Office of Energy Conservation and Environment, Office of Analysis, Evaluation and Systems Studies
Address: Washington, DC 20461
The Potential for Energy Savings Through Reductions in Hot Water Consumption

Report No. PB-247370, paper presented to the Conference on Water Conservation and Sewage Flow Reduction with Water Saving Devices, 49 p.
Apr 1975

Abstract: America's patterns of heated water use are investigated. The report estimates the energy savings obtained from various methods of using hot water; it evaluates the economic, social, and institutional problems involved in using hot water, and makes recommendations for legislation concerning hot water consumption. This study sets forth some of the many possible techniques for conserving hot water. Implementation in some cases requires changes in building codes and/or new legislation. The report also estimates energy savings that would result from the more promising energy conservation measures proposed. The topics discussed in this report include the following: use patterns of heated water; water heaters, their efficiency, how heat loss can be reduced, reduction of tank size, and complete electricity/gas shut off for periods when the home is unoccupied; how piping heat losses can be reduced by insulation, reduced pipe size, lower heater thermostat setting, and by combining hydronic space heating systems with domestic hot water systems; how hot water use for showers can be reduced; and how appliance efficiency can be improved. (39 references) (GRA)

Availability: NTIS

Mutch, J.J.
Rand Corp.
Address: Santa Monica, CA 90406
Residential Water Heating: Fuel Conservation, Economics, and Public Policy

Report No. R-1498-NSF, 78 p.
May 1974
Sponsor: National Science Foundation, RANN Program

Abstract: In the United States, residential water heaters consume substantial amounts of electricity, natural gas, fuel oil, and liquefied petroleum gas (LPG), also called bottled gas. The purpose of this study is to examine possible alternatives that may reduce the amount of fossil fuel based energy needed to furnish residential hot water. Two categories of alternatives are considered: those that reduce thermal losses from the water heating system and those that reduce the non-renewable energy requirements of the system. The economic cost or benefit of each measure to the consumer is examined as a function of the price of fuel, allowing comparison of different fuel conservation approaches in terms of their life cycle costs. Finally, the potential of government policy as a tool for implementation of economically beneficial fuel conservation alternatives is discussed. (24 references) (auth, from Summary)

NAHB Research Foundation Inc.
Address: Rockville, MD 20850
Housing Statistics and Housing Characteristics Related to Energy Conservation in Tract and Non-Tract Homes Built in the 1950-1964 Time Period

Report No. NP-20634, 62 p.
Sep 1974
Sponsor: Federal Energy Administration

Abstract: The analysis of existing national housing statistics for housing volume, year, type, and characteristics by region (where available) was undertaken ... in order to select representative climate, subdivision characteristics, and location of specific subdivision. Information gathered also sought to determine selected housing characteristics of the typical "tract" homes or subdivision built during the 1950-1964 period. The information gathered will also be used in evaluating applicability of retrofit programs to the national market. This report is divided into two main sections. The first, entitled HOUSING STATISTICS, deals with the number of housing units in existence from 1940 on. It traces the chronological growth of housing production after the depression of the thirities, during World War II and through the housing boom of the 1950's and 1960's. Percentage and absolute gains in housing units are reported by geographic area. ... The second main section of the report, entitled HOUSING CHARACTERISTICS, deals with the "typical" features found in single-family houses. Information is presented on floor area, number of stories, foundation type, selling price, garages, exterior walls, insulation, appliances, and heating and air conditioning equipment and fuel. Changes in "typical" features over a 1940 to 1970 time period are reported in tabular form. Source material for HOUSING CHARACTERISTICS allows us to distinguish between characteristics of "all single-family homes" and "tract single-family homes." (from Introduction)

Availability: TIC

National Academy of Engineering - National Research Council, Integrated Utility Systems Board
Address: Washington, DC
Evaluating Integrated Utility Systems

NP-21007, HUD-PDR-77(2), 130 p.
1975
Sponsor: U.S. Dept. of Housing and Urban Development

Abstract: An integrated utility system would use wastes (rejected heat, liquid sewage, solid wastes, etc.) from the utility processes as inputs to other utility services. A Department of Housing and Urban Development (HUD) program reviews the technical and economic feasibility of alternative systems, identifying constraints and incentives, and formulating demonstration strategies. Integrated systems must meet competitive costs and environmental standards while providing service comparable to conventional utilities. HUD has focused primarily on the Modular Integrated Utility System (MIUS) with residential/commercial applications for individual on-site projects of 300 to 1000 dwellings. Other applications would include urban renewal; medical, university, and military complexes; National parks; remote recreation areas; and a disaster utility system. Desired benefits include lowering energy consumption and conserving natural resources, minimizing environmental impacts, saving costs, and improving options for more flexible community development (with particular emphasis on the needs of the poor). System designs, if poorly conceived, could result in health and environmental hazards and high operating costs. Present MIUS's rely solely on oil or gas. (59 references) (DCK)

Availability: TIC

National Academy of Sciences, National Research Council, Assembly of Engineering, Energy Engineering Board, Committee on Advanced Energy Storage Systems
Address: Washington, DC
Criteria for Energy Storage R & D

ISBN 0-309-02530-3, 110 p.
1976

Abstract: To investigate the potential of advanced energy storage systems, this report analyzes the criteria (e.g., storage capacity; charge/discharge rates; replacement lifetime; weight, volume, or other physical limits; critical safety parameters; environmental standards; and acceptable capital and operating costs) that these energy storage systems would have to meet in order to be feasible for commercial use. The opportunities and requirements for storage systems are examined in these current and potential applications areas: electric utilities, residential/commercial applications, industrial applications, transportation applications, solar-electric systems, and fusion reactors. The U.S. market for electric vehicles, using stored, externally-generated energy, will depend upon the intended use of the vehicle. An urban shopper-commuter car with a range of 50 miles might be technologically possible within a decade. A competitive, electric family vehicle with room for four to six passengers, having a 200-mile range and 55 mph speed, will need 25 years or more of R & D. A hybrid vehicle, combining storage with a conventional gasoline engine, might be commercialized earlier. (11 references) (BYB)

Availability: Printing and Publishing Office,
National Academy of Sciences, 2101
Constitution Ave. NW, Washington, DC 20418

National Academy of Sciences, National Research Council, Committee on Measurement of Energy Consumption
Address: Washington, DC
Energy Consumption Measurement: Data Needs for Public Policy

116 p.
1977

Abstract: Energy consumption data needs are identified, types of data that should be collected are specified, and methods of collecting and organizing data for formulating and assessing public policy are recommended. Measurement of energy consumption is covered in Chapter One. Chapters Two, Three, and Four on the household, industrial, and commercial/service sectors, respectively, discuss data needed to monitor and to model energy consumption. Data needed for assessing government policies in all sectors are treated in Chapter Five, which focuses on data collection methods. (109 references) (BYB)

National Association of Home Builders of the United States, Builders Services Division
Address: 15th and M Streets NW, Washington, DC 20005
The Builders Guide to Energy Conservation

National Housing Center Library No. 130.03, 63 p.
1974

Abstract: The purpose of this manual is to provide information to home builders on the relative effectiveness of alternate energy conservation methods. The impact of the energy shortages and price increases on the marketing of new homes is discussed. In considering the design of the house, the builder should examine the building site, orientation, glazing, insulation, shading devices, effects of building mass on energy consumption, lighting, and heating/air conditioning systems. Materials selection, which has a significant effect on the amount of energy consumed, is discussed for doors, windows, insulation, appliances, and heating/air conditioning equipment. Good construction techniques (e.g., in installing insulation, reducing air infiltration, and weatherstripping) are described in order to insure that the design methods used to conserve energy are effective. Solar energy and land use planning are considered as long-range solutions to the energy problem. Appendixes include the following: Methods of Energy Conservation for the Home Owner; Heat Loss and Heating Cost Calculations; and Heat Loss and Gain Calculations. (24 references) (BYB)

Availability: National Association of Home Builders, 15th and M Streets, NW, Washington, DC 20005 $3.50

National Coal Association, Economics and Statistics Division
Address: 1130 Seventeenth St., N.W., Washington, D.C. 20036
Bituminous Coal Data

Annual report, Twenty-Third (1972) Edition, 137 p.; Twenty-fourth (1973) Edition, 145 p.

Abstract: These reports provide basic data about the U.S. bituminous coal industry and related industrial and energy segments of the economy. Tables and graphs are presented under the following main headings: Salient Statistics; Production; Manpower & Safety; Machines & Efficiency; Cleaning, Crushing & Drying; Value & Prices; Coal Markets & Stocks; Coke & Steel; Reserves; and Energy Production & Fuel Use. (MPG)

Availability: National Coal Association

National Consumer Research Institute
Address: Washington, DC
Proceedings of the Energy Research and Development Administration Conference on: Cogeneration and Integrated Energy/Utility Systems

Report No. CONF-770632, conference held on June 3, 1977, Washington, DC, v.p.
1977
Sponsor: Argonne National Laboratory; Energy Research and Development Administration, Division of Buildings and Community Systems

Abstract: Many descriptions and terms have evolved over the past few years to describe various applications of the basic idea of combined heat/power systems. The two most commonly applied terms used today are "Cogeneration" and "Integrated Energy/Utility Systems." Cogeneration has been primarily associated with industrial processes, while integrated energy systems have been primarily associated with residential and commercial applications or with district heating of large metropolitan areas. The conference was conceived to bring the two ideas together as much as technically and economically possible. An attempt was made to broaden the scope and integrate the two concepts, establishing a very workable basis for the utilization of both in the performance of providing utility services to industrial applications and population centers. The resurgence of cogeneration evolves through the efforts to maximize the use of resources in the United States today. This forum, brought together for the first time some of the most prominent individuals associated with the concepts of cogeneration, community energy systems, and integrated utility systems. (from Summary and Conclusions)

Availability: NTIS

National Environmental Systems Contractors Association
Address: 1501 Wilson Blvd., Arlington, VA 22209
Load Calculation for Residential Winter and Summer Air Conditioning

Manual J, Third Edition, Third Printing, 44 p.
1967

Abstract: This manual contains practical

procedures for calculating heat loss and heat gain in residential structures. Heat loss and heat gain must be calculated for each room before equipment can be selected and the duct system designed. Accurate design data and logical, step-by-step calculation procedures are included. The sections of the manual deal with the following topics: measuring for heat transmission; factors which affect heat loss; heat loss of a structure; duct heat loss; heat loss calculation procedure; factors which affect heat gain; heat gain of the structure; duct heat gain; heat gain calculation procedure; and maps and tables. Two appendixes consider how to calculate heat transfer multipliers and how to determine shaded and unshaded glass areas for heat gain calculation. (MPG)
Availability: National Environmental Systems Contractors Association $6.00

Naval Weapons Center
Address: China Lake, CA 93555
A Program to Evaluate and Demonstrate Conservation of Fossil Fuel Energy for Single-Family Dwellings

Report No. PB-245064, FEA/D-75/529, 75 p.
Jun 1975
Sponsor: Federal Energy Administration, Office of Energy Conservation and Environment, Office of Analysis, Evaluation, and Systems Studies
Abstract: A program is outlined, which will demonstrate reduction in U.S. fossil-fuel energy usage, particularly residential, shopping, and commuting. Goals include: combining more efficient energy use with low-energy structures to demonstrate that fuel consumption in single-family dwellings can be cut at least in half; reducing fuel consumption further; where solar flux is adequate, replacing use of fossil fuels in the single-family home with high temperature solar energy; and demonstrating a solar-powered, thermal-storage car for short trips. Areas included in this report as as follows: total energy system for single-family dwelling; retrofit house; low-energy structure (LES) using dynamic insulation; low energy houses (IEH); farther-term solution (storage-solar); control houses; cluster of houses; shopper-commuter vehicles; impact analysis-socio/economic; appliance energy/cost/rate structure; and life cycle energy analysis (LCEA). Each of these areas is considered in terms of background, goals, approach, critical areas, and details. The key to the program is a "total energy system," in which all energy needs are provided at the dwelling. (GRA)
Availability: NTIS

Naval Weapons Center
Address: China Lake, CA 93555
A Program to Evaluate and Demonstrate Conservation of Fossil Fuel Energy for Single-Family Dwellings

Report No. PB-245064, FEA/D-75/529, 72 p.
Jun 1975
Sponsor: Federal Energy Administration, Office of Energy Conservation and Environment
Abstract: This report outlines a program which will demonstrate reduction in United States fossil-fuel energy usage, particularly residential, shopping and commuting. Goals include combining more efficient energy use with low-energy structures to demonstrate that fuel consumption in single-family dwellings can be cut at least in half, reducing fuel consumption further, and where solar flux is adequate, replacing use of fossil fuels in the single-family home with high temperature solar energy and demonstrating a solar-powered, thermal-storage car for short trips. Areas included in this report are as follows: total energy system for single-family dwelling; retrofit house; low-energy structure (LES) Using Dynamic Insulation; low energy houses (IEH); farther-term solution (storage-solar); control houses; cluster of houses; shopper-commuter vehicles; impact analysis-socio/economic appliance energy/cost/rate structure; life cycle energy analysis (LCEA). Each of these areas is considered in terms of background, goals, approach, critical areas, and details. The key to the program is a "total energy systems," in which all energy needs are provided at the dwelling. (GRA)
Availability: NTIS

Nelson, J.P.
Pennsylvania State Univ.
Address: University Park, PA
The Demand for Space Heating Energy

The Review of Economics and Statistics, LVII(4), pp. 508-512 (Nov. 1975)
Nov 1975
Abstract: The demand for space heating energy is analyzed using cross-sectional data by state for 1971. It is found that price is a significant determinant of demand with an elasticity of approximately -0.3. This study gives attention to: 1) discrimination among alternative functional forms since average price data rather than marginal prices are used; and 2) identification of relationships that depict the trade-off that exists between energy inputs and housing construction and insulation materials. Price increases for space heating fuels would have a rationing effect on energy use, especially for the long-term. It is emphasized that, for an equivalent degree of winter coldness, energy consumption rates will be higher in the south due to less costly construction standards. Both southern and northern parts of the country can conserve energy by increasing insulation. The relationships derived in this study may also be applied to non-market rationing (e.g., lowering thermostat settings). (20 references) (BYB)

Nelson, L.W.; Tobias, J.R.
Honeywell Inc.
Address: Minneapolis, MN
Energy Savings in Residential Buildings

ASHRAE Journal, 16(2), 38-45 (Feb. 1974)
Feb 1974
Abstract: This is a report of energy savings available in homes. It is based on two analog computer studies which examine different methods of reducing operation costs of residential heating and cooling systems through the use of air economizers and attic ventilation. An air economizer is designed to introduce air from the outside, when outdoor temperature and relative humidity are within prescribed limits, and circulate it indoors when the thermostat calls for cooling. This cuts down on compressor operating time. Some of the parameters included in the models are building specifications, such as insulation, window glazing and area, and type and capacity of air conditioning and heating systems; air infiltration due to wind velocity and outdoor temperature; relative humidity due to infiltration of outside moisture and that generated by indoor occupancy; and weather conditions for 8 cities representing a wide range of geographical and climatic conditions. (ECM)

New, W.R.
Tennessee Valley Authority
Address: Chattanooga, TN
The Utility Looks at Load Profiles of
All-Electric Buildings

Paper presented at National Electric Heating & Comfort Systems Exposition, Session on Load Study and Economics of Electric Space Heating, Atlantic City, NJ, 15 p.
Mar 1972

Abstract: The purpose of this paper is to present hourly load profile data on the day of the summer peak and on the day of the winter peak for 10 commercial buildings located in the city of Chattanooga; present background information on these buildings; and draw conclusions from the data relative to the characteristics of the individual building, reasons for differences among the buildings, and the effect of such buildings upon the system. (Auth)

Newman, D.K.; Day, D.
Washington Center for Metropolitan Studies
The American Energy Consumer

Ballinger Publishing Co., Cambridge, MA, 304 p.
1975
Sponsor: Ford Foundation, Energy Policy Project

Abstract: To determine how households use the 34 per cent of national energy (23 quadrillion Btu's in 1972-73) that goes for personal energy needs, the authors conducted a national sample survey of 1,500 households and a separate survey of the utility companies that served them. ... For the study the researchers surveyed households in four income groups: the poor, with an average income of only $2,500 per household (70 per cent of whom had incomes below $3,000); the lower-middle, with incomes below $12,000; the upper-middle, falling in the $12,000-$16,000 range; and the well-off, who had average incomes of $24,500. How those families used energy and what it cost was determined from the actual records of the 125 electric and natural gas utility companies serving the households that participated in the survey. ... One of the study's major findings is that the more money families have, the more energy they use, regardless of any other condition. ... The second major finding of the study is that almost all households have their choices limited for them in the most energy-related features of their homes--the design, the furnace, and the water heater. ... The number of appliances in a home is chiefly important as an indicator of total energy consumption. ... The other important area of personal energy use is transportation. ... (One conclusion) is that households by themselves may be able to play only a modest role in energy conservation. ... The data collected (are used) to examine energy use in terms of housing and construction, transportation, life-styles and income, utility prices, and energy use by race. A separate chapter, written by William J. Kruvant, takes up the issue of "People, Energy, and Pollution," and a closer look at the lives of several of the families in the survey is provided by Tom Kelly in "The Way Some People Live." ... The final chapter is devoted to recommendations for public policies that would be more energy-wise, in national as well as individual terms. (405 references) (from publisher's summary)

Availability: $5.95 paperback/$15.00 hardcover

Newman, D.K.; Day, D.
Project on Race and Social Policy
Address: Washington, DC
How Households Use Energy

Part of 1976 U.S. Agricultural Outlook: Papers Presented at the National Agricultural Outlook Conference Sponsored by the U.S. Department of Agriculture, held in Washington, DC, Nov. 17-20, 1975, pp. 354-368
1975

Abstract: Energy policy aimed at lowering consumption should take into account that all households are not alike in their energy habits, and measures to restrict overconsumption of the rich can lead to hardship for the poor. Two national sample surveys--one of households and the other of electric and natural gas utilities--were used to match the amount and cost of energy consumed with the characteristics of the households. Trends indicate a shift to single family dwellings with fewer persons per household and an increase in energy consumption with higher income. Since 1973 there has been an increase in oil use and a decrease in gas use for heating, and a substantial decrease in central air conditioning. The largest gap in income-related consumption is in the use of the automobile. Recommendations include a program of loans and subsidies for low- and middle-income housing, elimination of exclusionary zoning, flat-rate structure with peak-load pricing for electricity, and coordinated energy policies designed to raise housing standards and increase efficiency of construction, appliances, and automobiles. Taxes based on car weights are urged. In results of a 1973 questionnaire, most households at all incomes preferred increasing energy supplies and using less energy to higher prices and lower population. (DCK)

Nicholas, F.
Fred Nicholas Inc., Consulting Engineers
Address: 750 South Atherton St., State College,
PA 16801
Electrically Heated Buildings Compared With
Fossil Fuel Heated Buildings, An Empirical
Study of Energy Usage

22 p.
May 1972

Abstract: The comparative total raw or source energy requirements of apartment houses and office buildings heated and cooled either with electricity or fossil fuels were determined in this empirical study. Records of all of the electricity, gas, oil, and/or street steam consumptions of 73 residential and 56 commercial buildings in New York, Massachusetts, and Connecticut were analyzed. The results indicated that electric heating results in a reduction in source energy requirements. (MFG)

Northern States Power Co.
Address: Minneapolis, MN
Study of An All-Electric Office Building

14 p.
30 Nov 1970

Abstract: This electric utility conducted a four-year study of electricity consumption in their new office building. Using 20 sets of meters, they have accumulated numerous data which have been tabulated as kwh consumed and kw demand for each of 16 kinds of service (e.g., hot water, elevators, etc.) and each of 49 months of service between November 1965 and November 1969. (OLC)

O'Hara, A.C. (Chairman)
New York State, Office of General Services
Report of Ad Hoc Committee on Energy Efficiency in Large Buildings

210 p.
7 Mar 1973
Sponsor: New York State Interdepartmental Fuel and Energy Committee
Abstract: Unwarranted amounts of energy are wasted each year in providing major public and privately owned buildings and the desired enviornment within them. Improved design, construction, and maintenance and operation can save significant amounts of energy without impairment of these processes, throughout the life cycle of these buildings, arbitrarily established as 50 years. To successfully attain the above energy conservation, increased cooperation and coordination among owners, designers, contractors, maintenance and operation personnel, labor, and governmental agencies will be necessary. By implementing all of the recommendations contained in this report during the life cycle of a large building, the result will be a reduction in energy consumption of more than 50 percent. Therefore, there is great potential for energy conservation in large buildings, with the accompanying significant benefit of dollar savings. (Auth)
Availability: New York State Public Service Commission, 44 Polland Ave., Albany, NY

Pacific Gas & Electric Co.
Residential Electric Space Heating, Load Research Project

92 p.
Mar 1967
Abstract: The purpose of this survey is to determine the kw demand and kwh use characteristics of the customers' electric space heating circuits. A majority of the test homes was heated with resistance-type, baseboard units, supplemented by radiant wall or ceiling units. The heating circuits in a representative sample of electrically-heated (resistance-type) single family-dwelling units were measured by recording demand meters in an actual field test. (Auth)

Peck, A.E.; Doering, O.C., III
Purdue Univ.
Address: Lafayette, IN
Voluntarism and Price Response: Consumer Reaction to the Energy Shortage

Bell Journal of Economics, 7(1), pp. 287-292 (Spr. 1976)
Spr 1976
Abstract: In the winter 1973-1974, households using natural gas and liquid petroleum gas for heating were confronted by quite different price situations, though both were subjected to social pressure to conserve fuels. This paper examines data from a sample of these households over a three-year period to test the hypothesis that something more than a national conservation program is needed to create desired changes in consumption patterns. The results show that the national conservation ethic was not an effective inducement to change significantly household fuel-use efficiency. Households did make significant adjustments when, in addition to the conservation policy, they confronted higher prices. (auth)

Pilati, D.A.
Oak Ridge National Laboratory, ORNL-NSF Environmental Program
Address: Oak Ridge, TN 37830
The Energy Conservation Potential of Winter Thermostat Reductions and Night Setback

Report No. ORNL-NSF-EP-80, 27 p.
Feb 1975
Sponsor: National Science Foundation, RANN Program
Abstract: Space heating requirements for a model home have been calculated for several locations and thermostat settings. The energy savings for reducing thermostat settings and for further reductions during the night are given as a function of heating degree days. The percentage savings for a particular thermostat reduction are greater in milder climates than in more severe ones but, for a similar house design, the absolute savings are greater in the more severe climate. For example, the savings for reducing a thermostat setting from 72 degrees F to 68 degrees F in Minneapolis are 14% compared to 32% in Atlanta. However, for similar houses, the absolute savings in Minneapolis are more than 50% greater than in Atlanta. The question of thermal comfort at lower environmental temperatures is discussed. The use of blankets and a clock-actuated thermostat can alleviate much of the concern for thermal comfort when adopting night setback. The economic feasibility of installing such a device in a centrally heated home is evaluated. At present fuel prices, the payoff periods for installing a clock-actuated thermostat are short for all but the warmest climates. As energy prices increase, consumers will change their behavior to decrease energy use. The total U.S. energy budget could be reduced by 4% if homes typically heated at 72 degrees F were heated to 68 degrees F in the daytime and to 55 degrees F at night. This reduction is equivalent to one-fourth of the U.S. imported petroleum. The impact of an increased winter peak demand on electric utilities due to the adoption of night setback is discussed. This potential problem is very dependent upon the degree of utility interconnections. Also, if an individual simultaneously reduces the day thermostat setting when adopting night setback, the increase in peak heating demand will be insignificant. (auth)
Availability: NTIS

Pilati, D.A.
Oak Ridge National Laboratory
Address: Oak Ridge, TN 37830
Room Air-Conditioner Lifetime Cost Considerations: Annual Operating Hours and Efficiencies.

Report No. ORNL/NSF/EP-85, 29 p.
Oct 1975
Sponsor: National Science Foundation, RANN Program
Abstract: The annual hours of air-conditioning compressor operation are calculated for two types of use: (1) a house that is naturally ventilated to temperatures between 75 and 78 degrees F when the outdoor temperature and wind speed will permit, and air conditioned at 78 degrees F when required, and (2) a house that remains closed-up and is air conditioned at 78 degrees F. For the 10 cities investigated, compressor savings from natural ventilation ranged from 12% in Phoenix to 73% in San Diego. These results are generalized to estimate the compressor-operating hours for any U.S. location. Potential purchasers of air conditioners can use this information to estimate their operating costs. The variation of an air conditioner's energy efficiency ratio (EER) with outdoor conditions is given. For units having

continuously operating fans, the EER decreases dramatically at milder outdoor temperatures. For example, a high efficiency model is shown to suffer a 40% decrease in EER when the outdoor temperature is 75 degrees F compared to that when temperatures are in the low 90's. Seasonal EERs are given for four units in 10 cities. Units with continuously operating circulating fans have EERs that average 8.5% below the nameplate value. For the cities and four units investigated, the use of an automatic circulating fan that only operates during the cooling cycle would increase the EER from 12 to 34% over an identical unit using a continuous fan. If existing room air conditioners were converted to automatic fan operation, about 4.4 billion kilowatt hours would be saved in 1975. (auth)
Availability: NTIS

Powell, F.J.
U.S. Dept. of Commerce, National Bureau of Standards, Building Environment Division
Address: Washington, DC 20234
The Manchester, N.H., Experimental Energy Office Building

Report No. CONF-740384-1, presented at the Seminar on "Energy Conservation by Design," held in Orlando, FL, March 20-21, 1974, 14 p.
1974
Abstract: An office building incorporating innovative energy conserving designs, techniques, and equipment was constructed in Manchester, N.H. The use of a computerized mathematical model to determine thermal response and energy consumption in the building showed a 53% reduction of energy for heating and lighting with the new design. Details of roof, wall, and floor construction and temperature control systems are provided. Total annual energy consumption in the new design building was 6.18 billion Btu compared to 13.19 billion Btu for the base building. The same comparison is made in Orlando, Florida with the annual consumption lowered from 8.15 billion Btu to 4.95 billion with the new design. Operation of the building was planned to use minimum energy with custodial work done during regular work hours, and provisions for lowering and turning off equipment. Follow-up of employee reactions is planned. (DCK)
Availability: TIC

President of the United States
Executive Office of the President
Address: Washington, DC 20500
Economic Report of the President, Transmitted to the Congress January 1977, Together with the Annual Report of the Council of Economic Advisers

308 p.
Jan 1977
Abstract: The first part of this publication contains the Economic Report of the President, which briefly reviews the economic conditions of 1976 and discusses economic policies (e.g., tax reductions, international developments, energy policy, and regulation reform). The remainder of the publication contains the Annual Report of the Council of Economic Advisers, which is organized into these chapters: (1) Economic Policy and Outlook, (2) Economic Review of 1976, (3) The World Economy in 1976, and (4) Policies to Increase Supply. Over 35 tables are provided, including Table 10 on Changes in Selected Price Measures, 1973-76. Two appendixes contain (a) a Report to the President on the Activities of the Council of Economic Advisers During 1976; and (b) Statistical Tables Relating to Income, Employment, and Production. (BYB)
Availability: GPO $2.90, Stock No. 040-000-00376-2

Quinn, R.S., Jr.
Tennessee Univ., College of Engineering
Address: Knoxville, TN 37916
The Effect of Increased Capital Expenditure as a Method of Reducing Electricity Demand for Hot Water Generation in a New Home

Thesis presented to the Graduate Council of the University of Tennessee in partial fulfillment of the requirements for the Degree of Master of Science, 125 p.
Aug 1972
Sponsor: Oak Ridge National Laboratory, ORNL-NSF Environmental Program
Abstract: The purpose of this study was the investigation of possible methods of reducing electricity demand for hot water generation in a residential system. The three concepts considered for the accomplishment of this objective were: 1. The design and installation of a simple heat exchanger to utilize elevated temperatures in the attic to preheat the incoming water; 2. The insulation of all exposed hot water tubing to reduce heat losses between the water heater and usage points; and 3. The installation of additional insulation to the water heater to reduce stand-by heat losses. For each concept investigated, appropriate heat transfer theory was applied to estimate the annual savings of energy obtained. The results of the heat transfer calculations were compared with similar results published in the literature. An estimate was obtained of the installed cost of all additional material into a new home as it was built. By comparing the annual savings obtained with the initial capital investment, taking into consideration the time value of money, the economic feasibility of each concept was determined over a range of electricity rates. (Auth)

Rappeport, M.; Labaw, P.
Opinion Research Corp.
Address: North Harrison St., Princeton, NJ
Conservation of Energy in the Home. Highlight Report. Volume 17

Report No. PB-254626, FEA/D-76/274, 8 p.
Sep 1975
Sponsor: Federal Energy Administration, Office of Energy Conservation and Environment, Office of Marketing and Education
Abstract: One of a series of studies, this report deals with general public behavior and attitudes toward energy conservation. This volume reports that even though the Federal Government has been recommending that people turn their thermostats down to 68 degrees F during the day and 60 degrees F during the night, most Americans did not do so during the winter of 1974-75; nor did they intend to do so during the winter of 1975-76. One reason is that the Federal Government is not seen as a good source of advice on how to save energy in the home. Many people (42%) believe that personal conservation efforts can have great impact on total energy consumption, and two out of three believe they presently are doing everything they can to save energy. (GRA)
Availability: NTIS

Real Estate Research Corp.
Address: 1101 17th St. NW, Washington, DC 20461

Incentives for Energy Conservation in Multi-Family Housing

Report No. PB-255655, FEA/D-76/116, 196 p.
Nov 1975
Sponsor: Federal Energy Administration, Office of Energy Conservation and Environment, Office of Buildings Programs
Abstract: Relatively little is known about the characteristics of the multi-family housing market, particularly as they relate to energy consumption. One purpose of this study, then, is to develop information about the multi-family housing market, as a partial remedy of this lack of data. Another purpose is to define the factors that determine present patterns of energy consumption, including present incentives and disincentives to conservation. A third purpose is to outline, evaluate, and develop strategies that might be used to promote energy conservation in the multi-family residential sector. (19 references) (from Introduction and Overview)
Availability: NTIS

Redding, T.E.
National Aeronautics and Space Administration, Lyndon B. Johnson Space Center, Urban Systems Project Office
Address: Houston, TX
Application of the Integrated Utilities Concept to Community-Size Developments

Paper presented at the "9th Intersociety Energy Conversion Engineering Conference," held in San Francisco, CA on August 26-30, 1974, pp. 493-498
1974
Abstract: The National Aeronautics and Space Administration along with other government agencies is conducting a project entitled "MIUS (Modular Integrated Utility Systems)" sponsored by the Department of Housing and Urban Development. The MIUS concept combines the utility services of electrical power, heating and cooling, water supply and wastewater treatment, and solid waste management into a single, local plant while conserving energy. The objective of the MIUS project is to demonstrate the technical and economic feasibility of this concept. As a part of the conceptual design study efforts, NASA has investigated the application of the MIUS concept to a community model. The model is based upon a 20-year growth pattern to achieve a population of 110,000 people. The complete community consists of a central business district with seven surrounding villages. Two different MIUS installation options are defined. A ground rule of the design study was that hardware selection be limited to "articles of commerce." Each MIUS installation includes multiple diesel engine-generator units with jacket water and exhaust gas heat recovery, solid waste incinerators with heat recovery boilers, optimized space heating and cooling equipment installations, combined biological and physical/chemical wastewater treatment, and supervisory and local control systems for each installation. Each MIUS design option is evaluated relative to a conventional utilities system approach. Compared to the conventional system, MIUS energy savings were 38%, water savings 17%, effluent reduction 17%, and solid waste load reduction 80%. (auth)

Reed, R.D.
Texas Governor's Energy Advisory Council; Texas A & M University, College of Architecture and Environmental Design, Research Center
Address: TGEAC, Office of the Lieutenant Governor, Capital Station, Austin, TX 78711
The Impact of and Potential for Energy Conservation Practices in Residential and Commercial Buildings in Texas

Report No. PB-243323, NSF-RA-N-74-228, 130 p.
10 Dec 1974
Sponsor: National Science Foundation, RANN Program
Abstract: This study deals with the potential to conserve energy in the residential and commercial areas through the application of conservation oriented design practices and selected urban design and planning concepts. Profiles of energy consumption in the residential and commercial areas are reviewed and documented for comfort heating, cooking, and comfort cooling. Some of the many variables associated with the design of the built environment and their relationship to energy are reviewed. The spectrum of climatic conditions that exist in Texas are identified and categorized and studied to reflect more efficient energy uses as well as an architecture that supports rather than negates climatic factors. Specific elements of energy consumption in the residential sector are defined and profiles of energy use are presented. Primary energy consuming areas for the commercial sector are identified, analyzed, and associated conservation problems are discussed. The MIUS (Modular Integrated Utility System) total energy system is discussed as related to its potential to effect energy conservation. Conservation potential from implementing planning concepts resulting in alternate urban forms is discussed. Political ramifications and areas that require additional research are summarized. (GRA)
Availability: NTIS

Response Analysis Corp.
Address: Research Park, Route 206, Princeton, NJ 08540
Lifestyles and Household Energy Use: 1975 National Survey, Report on Methodology

Report No. RAC 3819, v.p.
Feb 1976
Sponsor: Washington Center for Metropolitan Studies
Abstract: This survey is based on two probability samples of households in the U.S.: (1) a repeat sample, the sample first selected for the 1973 survey and included again in the 1975 survey; and (2) a new sample, a second, matched sample of housing units included for the first time in the 1975 survey. A total of 4,529 households were included in the survey sample, and interviews were completed for 3,149 households. The respondent was the head of the household, with either spouse interviewed when households are headed by husband and wife. The length of the interview ranged from about 30 to 90 minutes, with a median length of approximately 60 minutes. For the selection of households for the survey, multi-stage area probability sampling procedures were employed. These households were chosen from 275 different locations throughout the U.S., including metropolitan, smaller urban, and rural areas. The survey oversampled the poor to include a greater number of poor households than would have been included in a proportionate sample of the total household population. The analysis of the survey data included weighting to compensate for differences in probability of selection. Weights were calculated for each household in order to: (1) compensate for differences in probabilities of selection by socio-economic quartile; (2) adjust for differences in interview completion experience in different sampling locations; and (3) expand data for sample households to estimates for the total

universe. In considering survey reliability, it is pointed out that all survey data are subject to random sampling variability, and that the results are also subject to errors of response and nonreporting. Estimates based on the sample are fairly consistent with independent estimates of household characteristics based on the Bureau of Census' Current Population Survey. (BYB)

Reynolds, Smith & Hills,
Architects-Engineers-Planners Inc.
Address: Jacksonville, FL 22201
Life Cycle Costing Emphasizing Energy Conservation: Guidelines for Investment Analysis

Report No. ERDA-76/130 (revised May 1977), v.p.
Sep 1976
Sponsor: Energy Research and Development Administration, Division of Facilities and Construction Management
Abstract: The guidebook sets forth a method for dealing with energy conservation design alternatives aimed primarily at retrofitting existing facilities. The procedures are adaptable for use over a broad range of project types, such as experimental facilities, laboratories, production plants, office buildings, and service facilities. ... The purpose of this guidebook is to provide applicable study parameters for capital expenditures emphasizing energy conservation. These parameters quantify such features as discount rates, energy escalation rates, study period, salvage value, Btu measurement, and analysis techniques. By using these analysis concepts, budget requests for energy conservation programs will be standardized and result in a common measurement basis. The format and measurement statistics requested allow a comparable ranking of budget contenders, thus assuring maximum benefit for the funds expended. The guidebook also serves to allow the magnitude and complexity of each individual project to dictate the level of analysis required. By setting forth appropriate life cycle costing analysis levels, the study effort is streamlined and decision reliability should be enhanced. Finally, this document is designed to serve as a working desk guide. (from Introduction)
Availability: NTIS

Rice, P.
Oak Ridge National Laboratory, Energy Division, Regional and Urban Studies Section
Address: Oak Ridge, TN 37830
Energy Conditions in the South

Report No. ORNL/TM-5568, 338 p.
Dec 1976
Sponsor: Energy Research and Development Administration
Abstract: This report depicts energy supply and demand conditions in the South in 1972 to highlight differences in production and utilization patterns relative to the United States. Each state within the region is described to ascertain the comparability of its energy patterns with other states in the South and with the nation as a whole. The most complete picture of these energy conditions was obtained by examining 1972, a year felt to be fairly representative. Post-1972 observations reflect the unusual disruption of energy markets attributable to the Arab oil embargo and subsequent energy crisis. Significant changes since 1972 are noted, though the belief is that regional patterns of both production and utilization have generally remained fairly stable. The intent is to provide a description rather than analysis of regional energy patterns, noting variations and emphasizing the comparative advantages of the South. Such a presentation can yield insight into the future role of the region in contributing to the economic growth and welfare of the nation as its natural resource base is depleted and the transition to alternative energy sources is made. (auth)
Availability: NTIS

Richardson, W.J.
U.S. Dept. of Commerce
Address: Washington, DC 20233
Expenditures on Residential Additions, Alterations, Maintenance and Repairs and Replacements: 1969

U.S. Department of Commerce News, CB70-46, 2 p.
21 Apr 1970
Abstract: This news release briefly summarizes residential expenditures for 1969. A table is given listing expenditures by owners for upkeep and construction improvement of residential properties by size of property. (MPG)

Rittgers, D.
Borg-Warner Corp., York Division, Energy Conservation Systems
Address: York, PA
First Investment vs. High Efficiency

Paper presented at the Conference on Improving Efficiency in HVAC Equipment and Components for Residential and Small Commercial Buildings Held October 7-8, 1974 at Purdue University, pp. 135-139
1974
Abstract: The economics and energy consumption of high efficiency air conditioning systems are analyzed as they relate to the consumer and the manufacturer. Consumer operating costs of high and low efficiency systems are compared with the capital investments. Various graphs show the financial variables in buying high efficiency air conditioning: system capacity, operating hours, EER (energy efficiency ratio), cost of electricity, opportunity cost (present value of an investment) of money, and escalation rate of electricity. The additional energy expended to manufacture a new high efficiency system (additional condenser material production, cabinet and other system materials production, manufacturing facility, manufacturing processing, warehousing, shipping, handling, and transportation) is compared to the ultimate energy savings in operating the system. (BYB)

Robinson, J.A.; Yeung, D.
Princeton Univ., Center for Environmental Studies
Address: Engineering Quadrangle, Princeton, NJ 08540
Summer Air Conditioning and Appliance Use Patterns: A Graphical Analysis

Center for Environmental Studies Report No. 22, 56 p.
1975
Sponsor: National Science Foundation, RANN Program
Abstract: Patterns of energy consumption for electric appliances during the summer are examined. Data were collected from three similar townhouses, each instrumented with meters on the air conditioner, the electric range, and the hot water heater, and another meter for lights and other appliances. Twenty-four graphs and plots are presented, which depict patterns of electric consumption

for individual appliances across time, and the relationship of energy consumption for appliances to outside weather conditions. (BYB)

Ross & Baruzzini Inc.
Address: 7912 Bonhomme Ave., St. Louis, MO 63105
Energy Conservation Applied to Office Lighting

Report No. PB-244154, FEA/D-75/404, Conservation Paper No. 18, 288 p.
15 Apr 1975
Sponsor: Federal Energy Administration, Office of Energy Conservation and Environment, Office of Buildings Programs
Abstract: A review is presented of the literature and findings upon which the past practice of lighting design has been based. Recommendations and suggestions are made for changes that can be instituted to make lighting design and installation in the future more responsive to the needs of energy conservation and at the same time not compromising the needs of office workers and employers relative to the performance of visual tasks. The report is divided into six sections: Section I is an introduction. Section II provides a summary of conclusions and recommendations covering energy use, human performance visual system design, and management guidelines. Section III, on assessment of energy use for office lighting, reviews the relative magnitude of office lighting energy use and shows the relationship of lighting energy to heating and cooling energy. Section IV deals with illumination of visual performance. Section V is a review of newer techniques and equipment for achieving energy conservation by proper design, and Section VI presents some guidelines and suggestions for energy management. (55 references) (GRA)
Availability: NTIS

Ross, D.K.
Ross & Baruzzini Inc.
Address: 7912 Bonhomme Ave., St. Louis, MO 63105
The Basis for Effective Management of Lighting Energy Symposium, October 29 and 30, 1976. Proceedings

Report No. PB-256070, FEA/D-76/343, 647 p.
15 Apr 1976
Sponsor: Federal Energy Administration, Office of Energy Conservation and Environment, Office of Buildings Programs
Abstract: The papers presented here will provide the Federal Energy Administration and the serious professional involved in lighting design with an in-depth summary of contemporary cross-disciplinary knowledge necessary to provide lighting for human tasks that conserve energy without compromising performance. ... These papers were presented at a symposium entitled, "The Basis for Effective Management of Lighting Energy" held in Washington, DC, October 29 and 30, 1975. It was an outgrowth of a report prepared under the same contract entitled "Energy Conservation Applied to Office Lighting" (Conservation Paper Number 18, NTIS PB 244154/AS). ... The program was arranged to present in sequence as follows: 1. Introductory; 2. Psychophysics and Neurophysiology; 3. Human Visual Performance; 4. Models of Visual Performance; 5. Potential for Lighting Design; 6. Energy Conservation; 7. Codes, Standards, and Policy; and 8. Concluding Remarks. (from Foreward)
Availability: NTIS

Rubin, A.I.
U.S. Dept. of Commerce, National Bureau of Standards, Institute for Applied Technology, Center for Building Technology
Address: Washington, DC 20234
Energy Conservation in Buildings - A Human Factors/Systems Viewpoint

Report No. NBS BSS-88, 19 p.
Nov 1976
Abstract: The current emphasis on energy conservation in buildings must be balanced by a careful consideration of how proposed approaches affect building occupants. A headlong rush toward building designs which conserve energy at the expense of the quality of buildings as judged by occupants, would be a very shortsighted approach. There must be a continual awareness and sensitivity of the consequences on people when selecting among alternative "technical" options designed as a result of energy conservation needs. An increasing understanding is needed of such factors as thermal comfort and illumination needs in buildings, as decisions likely to influence these requirements are made by designers. Another area of concern which should not be overlooked is the interactions of people with their environments. "Hardware" approaches to energy conservation problems are often defeated by building occupants. Tight seals around doors and windows are useless if doors and windows are kept open. Building occupants have no choice but to turn all of the lights on or off if these are the only control options available to them. Building managers, operators and occupants have an important, though not well understood role to play in any energy conservation program. This problem deserves serious attention. (14 references) (auth).
Availability: GPO $0.65, SD Cat. No. C13.29/2:88

Rubinstein, N.
Residential Alterations and Repairs

Construction Review, 23(3), pp. 4-14 (April/May 1977)
Apr/May 1977
Abstract: This article presents data from the Bureau of Census quarterly and annual construction report, Residential Alterations and Repairs (C-50). Included are statistics from 1962, 1963, and 1965 through 1976. Information is provided on expenditures incurred by owners of all residential properties--single and multi-unit structures, publicly and privately owned, nonfarm and farm buildings, and residential properties that are owner occupied, rented, or vacant. These tables are included: (1) Expenditures by All Residential Property Owners for Maintenance and Repairs and Construction Improvements, by Size of Property; (2) Expenditures for Heating and Central Air Conditioning Work; (3) Expenditures for Plumbing Work; (4) Expenditures for Roofing Work; (5) Expenditures for Painting Work; (6) Expenditures for Siding Work; (7) Expenditures for Remodeling Work; and (8) Expenditures for "Other" Work. (BYB)

Sabghir, A. (ed.)
U.S. Dept. of Commerce, Domestic and International Business Administration, Bureau of Domestic Commerce
Address: Washington, DC
Construction Review

Monthly Industry Report, v.p.
Abstract: These monthly reports provide statistical information on the construction industry. The first two tables summarize the construction situation and general economic

conditions. The remaining 40 tables present data on: New Construction Put in Place: Housing (housing starts, subsidized housing production, housing completions, housing in government programs, housing vacancy rates, and manufacturers' shipment of mobile homes); Building Permits; Contract Awards; Costs and Prices; Construction Materials, including information on production, shipments, and stocks; and Contract Construction Employment. A feature article is included in each issue. (BYB)
Availability: GPO

Salter, R.G.; Morris, D.N.
Rand Corp.
Address: Santa Monica, CA 90406
Energy Conservation in Public and Commercial Buildings

Rand Paper No. P-5053, 59 p.
Oct 1973
Sponsor: National Science Foundation, RANN Program
Abstract: A discussion of the preliminary results of an ongoing study of the use of energy in public and commercial buildings is presented. The effects of building location, design and operation alternatives are developed, together with initial estimates of the conservation potential in the sector. The work is part of Rand's energy conservation work for the National Science Foundation. (auth)

Salter, R.G.; Petruschell, R.L.; Wolf, K.A.
Rand Corp.
Address: Santa Monica, CA 90406
Energy Conservation in Nonresidential Buildings

Report No. R-1623-NSF, 214 p.
Oct 1976
Sponsor: National Science Foundation
Abstract: Energy use in commercial buildings and the potential for conservation are studied. The energy requirements of a typical office building are simulated for different levels of energy intensity and conservation methods and for different heating and cooling systems. A model was used to compare investment requirements, life-cycle costs, and energy consumption for each computer simulation. Energy use intensity (Btu/sq ft) in commercial buildings could be reduced by as much as 40 to 50% over pre-embargo levels. Building shell design constraints are only effective in decreasing annual heating energy consumption and are, therefore, appropriate in cold regions. Most energy savings can be accomplished through changes in operational procedures and do not require alterations in the building or equipment designs. It was found that building shell thermal characteristics have important impacts on the capacity or size of the cooling systems and on the average energy consumption of the heating system. Total energy systems offer substantial energy savings, but an increase in their use would increase the demand for gaseous and liquid fossil fuels while lessening the demand for central utility electric power produced from more plentiful resources. (BYB)

Schulze, J.L.
General Electric Co., Air Conditioning Products Division
Address: Louisville, KY
Room Air Conditioner Efficiency - Potentials and Limitations

Paper presented at the Conference on Improving Efficiency in HVAC Equipment and Components for Residential and Small Commercial Buildings held October 7-8, 1974 at Purdue University, pp. 91-102
1974
Abstract: The theoretical efficiency of an air conditioner, which is viewed as a system, is analyzed by mathematically deriving efficiencies for each sub-system (heat transfer sub-system, cycle efficiency, compressor sub-system, and miscellaneous sub-systems). The maximum limit for an air conditioner energy efficiency ratio is determined to be about 13.5 BTU/Watt Hour. The total cost of operating a 10,000 BTUH capacity air conditioner is stated as a function of energy cost, annual hours of cooling, and energy efficiency. Societal factors related to air conditioner design (i.e., size, price, weight) are also discussed. (9 references) (BYB)

Sebald, A.
Illinois Univ., Center for Advanced Computation, Energy Research Group
Address: Urbana, IL 61801
The Effect of the Energy Cost of Insulation and Storm Windows and Doors on the Decision to Install Them as an Energy Saving Policy

CAC Document No. 158, 42 p.
1975
Abstract: The total (direct plus indirect) cost of fabrication of various levels of ceiling insulation and aluminum combination storm windows and doors are calculated for a 1200 square foot model house. These energy costs are compared with gross energy savings during heating and air-conditioning seasons due to installation of the insulation and/or storms. The effects of various fuel types are also investigated. (12 references) (auth)

Seidel, M.R.
Federal Power Commission, Office of Energy Systems
Address: Washington, DC
Economic Benefits of Energy Conservation

Energy Systems and Policy, 2(1), pp. 1-30 (1977); this paper is a revision of one presented at Energy Conservation: A National Forum, Ft. Lauderdale, Florida, December 1-3, 1975
1977
Abstract: The magnitude of cost-effective energy conservation can be estimated from marginal rates of substitution between energy and other factors of production, in response to environmental and other increments of cost. It can be shown that conservation-oriented responses are more cost-effective than supply-expanding responses. This net cost effectiveness constitutes the economic benefit of conservation, which this paper has detailed and quantified in several dimensions of the nation's economy. The benefits of conservation are realized in different ways by the various end-use sectors of the economy. The residential and commercial sectors can achieve numerous benefits by operational improvements, but efficiency-improving changes to the existing stock are much more important. Industry's benefits come through major changes in future processes. For transportation, mode shifts are the most important aspect for freight, and increased automobile efficiency is most important for passenger transport. Utility conservation arises through improved generation efficiency and more efficient use of electricity; both kinds of conservation have significant benefits. The benefits of conservation can also be characterized in terms of impacts on various aspects of the economy. The most obvious of these is the

capital requirement; while this is large, it is smaller than either the capital for supply expansion or the capitalization of increased fuel costs in lieu of conservation. ... The environmental benefits of conservation are significant. ... Finally, conservation means increased labor intensiveness; this implies higher employment, but lower labor productivity, than otherwise. (9 references) (auth, abstract modified)

Sepsy, C.F. (Conference Director)
Ohio State Univ.
Address: Columbus, OH
Proceedings of the Conference on Energy Conservation in Commercial, Residential and Industrial Buildings

Conference held at Ohio State University on May 5-7, 1974, 343 p.
1974
Sponsor: National Science Foundation, RANN Program; Ohio State Univ.; American Society of Heating, Refrigerating and Air-Conditioning Engineers Inc. Association of Physical Plant Administrators
Abstract: The Conference on Energy Conservation in Commercial, Residential and Industrial Buildings was held for the purpose of disseminating timely information about current and proposed energy conservation programs in the United States. Speakers discussed ongoing programs of retrofitting existing buildings for energy conservation, providing actual field data from current programs. Speakers provided results of active research projects in which indepth studies are being made on energy conservation. In addition to the engineers and scientists attending the conference, many of the attendees were architects, manufacturers of heating, ventilating and air-conditioning equipment and operators of building and steam-generating plants. The topics that were covered are as follows: 1. Current Energy Conservation Test Projects; 2. Energy Conservation Methods, residential and industrial buildings and Associated Problems in Industry; 3. Problems of Energy Conservation in Existing Buildings; 4. Energy Conservation Methods in Buildings; 5. Computer Programs and System Simulations; 6. Future Changes in Codes and Buildings; and 7. Possible Research Projects in Energy Conservation in the Future. (auth, from Introduction)

Sheet Metal and Air Conditioning Contractors' National Association Inc.
Address: 8224 Old Courthouse Road, Tysons Corner, Vienna, VA 22180
Guidelines for Energy Conservation Systems in New Buildings

50 p.
1975
Abstract: Guidelines to the design of new building environmental systems urge good design and priority decisions and knowledge of energy sources to provide comfortable, economical, energy conserving living and working conditions. Emphasis is placed on integrating building configurations, construction, and choice of materials with an analysis of the equipment and environmental needs of the occupants. This will require developing new habits of close cooperation between owners, designers, and contractors, but will have more immediate effect than waiting for changes in building codes to be legislated. Major topics covered are (1) management of energy conservation, (2) heating and cooling systems (3) control systems, (4) heat pumps, (5) primary energy sources, (6) total energy systems, (7) life cycle costing, and (8) building operation and maintenance. Checklists and detailed specifications are included to help with analysis. (DCK)
Availability: SMACNA, 8224 Old Courthouse Rd., Tysons Corner, Vienna, VA 22180 $7.50

Sheet Metal and Air Conditioning Contractors' National Association Inc.
Address: 1611 N. Kent Street, Suite 200, Arlington, VA 22209
Guidelines for Energy Conservation in Existing Buildings

12 p.
1974
Abstract: A 33% reduction of energy consumption in existing buildings is the goal of these guidelines for contractors in sheet metal and air conditioning. Professional expertise is essential in following the evaluation procedures outlined, which include familiarization with terms, heating/ventilating/air-conditioning and electrical systems, evaluation of consumption data for the building, and investigation of available fuel sources. Major categories on the checklist are (1) design conditions, (2) building heat gain or loss, (3) internal loads, (4) heating and air conditioning, (5) equipment efficiency, (6) operation, and (7) maintenance. A sample evaluation is included. Human comfort specifications set temperature at 73 degrees to 77 degrees F., relative humidity at 20 to 60%, and air movement at 10 to 45 feet per minute. Basic energy conservation steps are given for managing energy consumption, modifying the structure or the system, and improving the maintenance program. (DCK)
Availability: SMACNA, 1611 N. Kent St., Suite 200, Arlington, VA 22209 $5.00

Singer Co.; Mueller Associates Inc.
Address: MA, Baltimore, MD
InterTechnology Corporation Proposed Test and Evaluation Plan, Commercial Buildings: National Solar Demonstration Program

Report No. COO/2688-76/9, ITC-280576, 258 p.
Sep 1976
Sponsor: Energy Research and Development Administration, Division of Solar Energy
Abstract: Testing and evaluation procedures are described which are needed to document the results of ERDA's National Demonstration Program on solar heating and cooling of non-residential buildings. This testing and evaluation plan encompasses technical, economic, social, and environmental factors that are important in demonstrating that solar energy is a viable economic option. The demonstration plan is directed to 200 sites to be used over a 3 year period. Automatic data collection subsystems will be used for technical aspects, and several manual systems will collect and initially process the economic, social, and environmental data. This report is organized into three parts: (1) Sections II through VI derive the requirements for the testing and evaluation plan; (2) Sections VII through X contain the proposed plan to fulfill these requirements and include hardware and software recommendations and procedures and management considerations; and (3) Sections XI and XII describe some pre-demonstration activities. (32 references) (DYB)
Availability: NTIS

Snell, J.B.; Achenbach, P.R.
U.S. Dept. of Commerce, National Bureau of Standards
Address: Washington, DC 20234
Total Energy Systems: A Review of Recent NBS Activities

Paper presented at the Effective Energy Utilization Symposium held at Drexel University, Philadelphia, PA, published in Proceedings, p. 209-233
Jun 1972
Sponsor: U.S. Dept. of Housing and Urban Development
Abstract: This paper briefly reviews and reports on the status of several NBS activities in the area of total energy systems as they relate to the theme of the Drexel Symposium on Effective Energy Utilization. A recent review of the state of the art in total energy systems applications indicated the need for good, concise, operating and performance data on total energy systems to serve as a basis for more effective utilization of this concept to save energy. The Department of Housing and Urban Development requested NBS to assist in the development of a total energy system on the BREAKTHROUGH housing site at Jersey City and to conduct a full-scale field study with appropriate instrumentation to obtain engineering, cost and maintenance data. In a related effort, NBS, AEC, EPA, and NASA are supporting HUD in a new effort entitled The Modular-Sized Integrated Utility System (MIUS) program. The premise of this 3-phase effort is to demonstrate the potential energy, resource, and cost economies of combining energy-generating facilities and waste disposal facilities on a modular-basis to keep pace with changing patterns and rates of urban growth. (Auth)
Availability: Drexel University ($15.00 for entire proceedings)

Socolow, R.H.
Princeton Univ., Center for Environmental Studies
Address: Princeton, NJ 08540
The Twin Rivers Program on Energy Conservation in Housing: A Summary for Policymakers

Report No. PU/CES 51, ENG 77/19, 78 p.
Jun 1977
Sponsor: Energy Research and Development Administration
Abstract: Key results and conclusions of a five-year field study of residential energy use are reviewed. This multidisciplinary research is being undertaken in a set of nominally identical townhouses in Twin Rivers, New Jersey, a recently built community of standard construction with gas space heating, electric central air conditioning, and a full set of appliances. Average levels of energy consumption and their dependence on weather and building type have been established, thereby permitting detailed quantitative studies of the sources of remaining variability. Starting from this baseline, the level of change in energy consumption that followed the "energy crisis" in the autumn of 1973 has been established, and two kinds of controlled experiments have been performed: (1) experiments where a set of modifications (retrofits) are made to the building structure; and (2) experiments where "feedback" is provided to residents, on a regular basis, reporting their level of consumption of energy. Conclusions drawn from modeling and experimentation are presented, with emphasis given to those results bearing directly on the character of progress to retrofit the national housing stock. Photographs of the site, of building defects, and of the retrofits are included, as well as a selection of graphical displays of data, each a snapshot of a kind of analysis found useful and recommended to others who wish to help develop an understanding of how houses work. Lists are included both of the program's reports and publications and of the people who have contributed to the Twin Rivers program since its inception. (49 references) (auth, abstract modified)

Socolow, R.H.; Sonderegger, R.C.
Princeton University, Center for Environmental Studies
Address: Princeton, NJ 08540
The Twin Rivers Program on Energy Conservation in Housing: Four-Year Summary Report

Draft, Report No. CES-32, v.p.
Aug 1976
Sponsor: Energy Research and Development Administration; U.S. Dept. of Commerce; National Science Foundation, RANN Program
Abstract: In this draft document a four year study on energy conservation in housing is described in which the amount of energy used in townhouses in Twin Rivers, New Jersey, is documented, modeled, and modified. Main consideration was placed on space heating, but hot water heating, air conditioning, and appliances were also studied. The first part of this report covers studies made using only data from gas and electric meters and data from a nearby weather station. A quantitative description is presented of the voluntary conservation which followed the 1973 "energy crisis" and of the results of deliberate retrofitting of the townhouses during the time period December 1975 through January 1976. Part Two reports on studies made within the townhouses, particularly using instruments (e.g., electric meters to separate usage of different appliances, infrared equipment, and thermistors). Appendices provide additional data on the Twin Rivers Townhouse, the local weather, energy prices, chronology of the building of Twin Rivers and land use at Twin Rivers, instrumentation, and the retrofit packages. (BYB)

Spielvogel, L.G.
Lawrence G. Spielvogel Inc.
Address: Wyncote House, Wyncote, PA 19095
Critical Analysis of FEA Office Lighting Study: HVAC Energy Relationships

Report No. PB-246555, 37 p.
Oct 1975
Abstract: The purpose of this report is to present a critical analysis of the heating and cooling energy relationships and conclusions in the Ross and Baruzzini study for FEA "Energy Conservation Applied to Office Lighting" dated April 15, 1975. This report should be obtained with the Ross and Baruzzini study (NTIS PB-244154/1WE; PC $8.75/MF $2.25) since frequent references are made to it in order to avoid duplication of material. Numerous errors and inconsistencies are identified and the computer energy analyses are critiqued. (GRA)
Availability: NTIS

Stanford Research Institute
Address: 333 Ravenswood Avenue, Menlo Park, CA 94025
Fuel and Energy Price Forecasts: Final Report. Volume II - Data Base

Report No. EPRI EA-433, Research Project 759-1, 289 p.
Feb 1977

Sponsor: Electric Power Research Institute
Abstract: This document describes the complete data base for the SRI (Stanford Research Institute) Energy Model as of August 1976. This data base and the resulting model output were used in developing fuel and energy price forecasts in a study for the Electric Power Research Institute, RP759-1, "Fuel and Energy Price Forecasts." These forecasts, Volume I, will be published a few months after this volume. Seven sections are contained in this volume. Section 1 is the Introduction. Section 2, the Energy Network, consists of a detailed discussion of the "network" used in the SRI Energy Model to describe the production, processing, transportation, and end-use consumption of energy materials. Section 3, Process Economics, contains the basis for consistent estimation of process economics. The focus is on the economics of energy conversion processes (processes that require at least one fuel as a primary feedstock and produce at least one primary energy product), and on end-use conversion, including the basis for consistent estimation of end-use conversion processes. These processes convert energy into things desired by the user: heat, light, transportation, etc. Section 4, Primary Resource Supply, contains a description of how the relationship between the marginal cost of primary resources (excluding economic rent) and cumulative production of these resources are developed. The major emphasis is on coal and domestic crude oil and natural gas. Imported oil and gas, nuclear fuel, shale oil, geothermal, biomass, and hydropower are also covered. Section 5, Initial Energy Balances, describes a complete energy balance which is required by the SRI Energy Model for the initial year (1975). This balance is a specification of the flow at each node of the network. Section 6, End-Use Demand, describes a model used to project usable energy (end-use) demand as a function of usable energy prices (marginal costs) and other variables such as GNP or economic activity by sector, population growth, and mandatory or technologically induced changes in energy use. Section 7, Additional Model Features, includes six features of the SRI National Energy Model pertaining to the dynamics of the energy market. They are: (1) pricing using present value, (2) shutdown and expansion (inertial), (3) economic rent, (4) market share, (5) behavioral lags, and (6) secondary materials. (auth, abstract modified)
Availability: Electric Power Research Institute, 3412 Hillview Ave., Palo Alto, CA 94304

Stoecker, W.F. (ed.)
American Society of Heating, Refrigerating and Air-Conditioning Engineers Inc., Task Group on Energy Requirements for Heating and Cooling of Buildings
Address: 345 E 47th St., New York, NY 10017
Procedures for Simulating the Performance of Components and Systems for Energy Calculations

Third Edition, Energy Calculations 2, 103 p.
1975
Abstract: Equations for simulating the performance of individual components of air conditioning systems are given in this report, and a method to simulate the performance of any system is described. The purposes of this publication are to provide a guide to those preparing energy calculation programs for accommodating systems and equipment, and to facilitate the standardization of procedures and equations used to represent component and system performance. The report is organized into these sections: Principles of System Simulation; Procedures in System Simulation; Expressing Performance Data in Equation Form; Component Simulation (for boilers and furnaces, centrifugal and absorption water chillers, heating coils, cooling and dehumidifying coils, reciprocating compressors, water-cooled and air-cooled condensers, cooling towers, water-chilling evaporators, pumps, fans, condensing units, engines, controls, heat transfer to pipes and ducts, and part-load performance of unitary air conditioners); Refined vs. Streamlined Procedures for Simulating Systems; and Simulation of Selected Systems and Subsystems (i.e., outdoor air control, terminal reheat system, dual-duct or multizone system, variable-air-volume system, air-water induction units, decentralized heat pump, internal-source heat pump, and combined air system and perimeter convectors). (BYB)
Availability: American Society of Heating, Refrigerating and Air-Conditioning Engineers Inc., 345 East 47th St., New York, NY 10017
$10.50

Stucker, J.P.
Rand Corp.
Address: Santa Monica, CA 90406
The Impact of Energy Price Increases on Households: An Illustration

Report No. P-5585, 31 p.
1976
Sponsor: Federal Energy Administration
Abstract: Estimates of the impact of energy prices on household consumption indicate: (1) that direct energy expenditures are regressive (i.e., as income increases, the proportion spent for energy declines); (2) that indirect energy expenditures, which represent over half of all energy transactions, are regressive; and (3) energy taxes are also regressive, especially utility gas taxes. Estimates were made by input-output analysis using 1960 and 1961 data, which was updated to reflect current prices. Tables analyze both direct and indirect expenditures by income level and percent of total budget. Food and fuel comparisons show that in 1972 and 1973 the average household income before taxes was $10,185, of which nearly 16% went for food and 10% for energy. The implications for public policy of the results of this study are discussed. (DCK)

Sweeney, J.L.
Federal Energy Administration, Office of Policy Analysis, Office of Energy Systems Modeling and Forecasting
Address: Washington, DC 20461
Economics of Depletable Resources: Market Forces and Intertemporal Bias

Report No. PB-255623, FEA/B-76/028, 46 p.
30 Jun 1976
Abstract: This paper examines optimal and market-determined extraction patterns for a depletable resource available (at a cost) from many reserves of various grades. It is shown that under a general set of conditions optimal allocations of a depletable resource can be supported by a purely competitive market. The concept of a time-varying Market Imperfection Function is introduced. Properties of this function are shown to be sufficient to determine whether specific market form will overextract or underextract the resource (in comparison to a competitive allocation). Finally, the intertemporal biases associated with depletion allowances, monopolism, externalities, vulnerability costs, and price regulations are analyzed by making use of the Market Imperfection Functions associated with each market structure. (16 references) (auth)

Availability: NTIS

Syska & Hennessy; Tishman Research Corp.
Address: S&H, 110 West 50 Street, New York, NY 10020; TRC, 666 Fifth Avenue, New York, NY 10019
Energy Conservation in Existing Office Buildings. Volume 1. Report/Phase I. Volume 2. Appendices to Report/Phase I

v.p.
1977
Sponsor: Energy Research and Development Administration, Division of Buildings and Industry
Abstract: Activities completed during Phase I of this study are detailed, including: (1) a description of office buildings in New York City in terms of physical and operating characteristics and energy consumption; (2) an analysis of the inter-relationships between these characteristics and energy consumption; (3) the development of a statistical methodology for representative sample selection; and (4) an analysis of energy consumption patterns prior to and after the 1973 oil embargo. A preliminary evaluation indicates that, despite owners' and managers' lack of knowledge on energy consumption in their buildings, energy savings of 12% have occurred in New York City office buildings between 1971/1972 and 1974/1975. This study illustrates that there exists a wide spread in physical characteristics, operating practices, and energy consumption patterns in office buildings; therefore, a variety of retrofit measures may be necessary. These building characteristics seem to be related to energy consumption: age, hours of lighting, hours of perimeter heating and cooling, and types of perimeter system. The Phase I research suggests the following needs: the need for a uniform building energy information form to be adopted by the private and public sectors; the need for a nationally accepted system of normalization of energy consumption for occupancy/utilization and weather conditions; the need for a rational representative sample which can be used to gauge energy consumption patterns and practices; the need for a major effort to educate building owners on the importance of tracking consumption, comparing patterns with others, and evaluating potential and on-going conservation methods; and the need for a large-scale effort to correlate computer simulation design programs with actual operating results. (BYB)

Systems Consultants Inc.
Address: 3255 Wing St., San Diego, CA
The Application of Near-Term Fossil Technologies to the Energy Supply/Demand Profiles of U.S. States and Regions

88 p.
Jan 1977
Sponsor: Energy Research and Development Administration, Office of Fossil Energy
Abstract: Several conclusions emerge from an analysis of the supply, demand and utilization profiles of the U.S. Census Regions and the states and the evaluation of near-term fossil fuel and associated technologies. Based on energy supplies and utilization, the five regions with the most critical energy problems, in order of severity, are: the North Central, the West South Central, the Middle Atlantic, the South Atlantic and New England. The following near-term technologies appear to offer the widest application and are most likely to have a major impact on the supply/demand energy characteristics of the regions: direct combustion of coal in atmospheric fluidized beds; low-btu gas from coal for power generation and combined cycles; power plant technology; high-btu gasification in entrained and fluidized beds; improved railroad coal-handling facilities; direct combustion by fuel substitution; low-btu gas for process heat; improved underground and surface coal extraction techniques; coal slurry and coal-gas pipeline transport systems; and conservation in the residential/commercial and vehicular transportation sectors. Transportation systems (e.g., railways, pipelines, ships) are the vital linkages between the fossil energy supply centers and the fossil energy demand facilities. ERDA's programs should consider energy in a total systems sense, including transportation systems as well as supply and demand technologies. ... Further analysis of the economics of coal conversion is necessary. ... Considering the current mood of deregulated and/or increased prices at the well-head for natural gas, the elasticity of the price of both natural gas and petroleum products should be studied. ... The delineation of new regional divisions with compatible energy supply, demand and utilization characteristics would enable the formulation of RD&D strategies applicable to each region. Many of the states have detailed professional reports on energy supply and demand, with data and recommendations that would provide valuable inputs to ERDA's RD&D planning. Increased contact and direct working relationships between ERDA representatives and state energy officials are suggested. (29 references) (from Conclusions)

Tansil, J.
Oak Ridge National Laboratory, ORNL-NSF Environmental Program
Address: P.O. Box X, Oak Ridge, TN 37830
Residential Consumption of Electricity, 1950-1970

Report No. ORNL-NSF-EP-51, 33 p.
Jul 1973
Sponsor: National Science Foundation, RANN Program
Abstract: The growth of residential electricity use between 1950 and 1970 is examined on the basis of increases in the number of households, number of appliances, and the average annual electricity consumption per appliance. Increased electricity use per household accounted for 73% of the growth of residential electricity consumption, while 27% of the growth was due to an increase in the number of households. Consumption patterns are defined which illustrate the factors accounting for the increase from 1800 kWh per household in 1950 to 7000 kWh per household in 1970. The greatest potential for more efficient energy use occurs through insulating houses better, shifting from electric resistance heating to heat pumps, using more efficient air conditioners, substituting fluorescent for incandescent lighting, and improving insulation for refrigerators, freezers, and water heaters. Immediate implementation of these energy conservation measures would result in a 30 to 40% reduction in residential electricity consumption. The number of households, number of appliances, and average annual electricity use per appliance are projected to 1990 to obtain the total electricity consumption per appliance. The sum of the disaggregated projections is compared to other independent projections based on extrapolation and econometric methods. (Auth)
Availability: NTIS

Tansil, J.; Moyers, J.C.
Oak Ridge National Laboratory, ORNL-NSF
Environmental Program
Address: P.O. Box X, Oak Ridge, TN 37830
Residential Demand for Electricity

Paper presented at NSF-MIT Conference on Energy: Demand, Conservation, and Institutional Problems Held at M.I.T., February 12-14, 1973, 15p., proceedings published by MIT Press, M.S. Macrakis (ed.), 1974, 556 p.
Feb 1973
Sponsor: National Science Foundation, Rann Program
Abstract: The growth of residential electricity use for the period 1950 to 1970 is examined from the standpoint of increases in the number of households, appliance saturations, and the average annual electricity consumption per appliance. Growth patterns are defined which illustrate the factors accounting for the increase from 1800 kwhr per household in 1950 to 7000 kwhr per household in 1970. Space heating, water heating, and air conditioning have small saturations, large average annual consumptions, and the greatest growth potentials for contributing to the residential load. Energy conservation is stressed through (1) the importance of housing insulation, (2) more efficient room air conditioners, and (3) the substitution of heat pumps for electric resistance heating. The number of households, appliance saturations, and average annual electricity use per appliance are projected to 1990 to obtain the total electricity consumption per appliance. The sum of the disaggregated projections is compared to other independent projections based on extrapolation and econometric methods. (Auth)
Availability: MIT Press $25.00 for entire proceedings

Taw, D.J.
National Petroleum Council, Committee on Energy Conservation, Residential/Commercial Task Group.
Address: 1625 K Street NW, Washington, DC 20006
Potential for Energy Conservation in the United States: 1974-1978. Residential/Commercial

This report served as the basis for Chapter 3 of NPC's report "Potential for Energy Conservation in the United States: 1974-1978," published on Sept. 10, 1974, 151 p.
1974
Abstract: Energy conservation measures are studied that could provide significant reduction in actual or projected energy consumption levels in residential and commercial markets during the period 1974-1978. The following energy conservation measures offer the greatest potential savings in the residential sector, by order of rank,: setting thermostats back to 68 degrees during heating season; insulating ceilings; setting water heaters back to 120 degrees; weatherstripping and caulking; tuning-up furnaces; and installing storm doors and windows. It is estimated that these six conservation actions could result in energy savings of 1.6 quadrillion Btu's per year, or 13.2% of the total residential demand. Energy conservation measures in the commercial sector include: establishing 68 degrees maximum occupied thermostat setting in apartments, hotels, and motels during heating season; establishing 5 degrees night thermostat reduction below day levels in apartments and 10 degrees reduction for commercial buildings during unoccupied hours; weatherstripping and caulking; providing for scheduled maintenance of equipment and systems; and insulating ceilings. Other important savings methods that require no capital investment are as follows: reducing lighting levels; establishing minimum ventilating-air requirements for occupancy periods; establishing a cooling comfort level of 78 degrees if basic energy is necessary; and ceasing cooling of building one hour before termination of occupancy. The conservation actions listed for commercial establishments could achieve savings of about 1.0 quadrillion Btu's per year, or 8.3% of the total commercial energy consumption. (33 references) (EYE)
Availability: National Petroleum Council, 1625 K St. NW, Washington, DC 20006 $5.00

Taylor, L.D.
Arizona Univ.
Address: Tucson, AZ
Decreasing Block Pricing and the Residential Demand for Electricity

Published in "Proceedings of the Workshop on Energy Demand," W.D. Nordhaus, ed., International Institute for Applied Systems Analysis, Laxenburg, Austria, Report No. CP-76-1, CONF-7505110, pp. 43-67
1976
Abstract: Decreasing block pricing creates both theoretical and econometric problems in analyzing electricity demand. It is difficult to assess the relationship of demand and price, for instance, because the consumer faces, not a single price, but a price schedule from which he purchases blocks at a decreasing marginal price. Model results show that, in the short run, it is better to relate average price to actual rate schedule in order to avoid problems of simultaneity and identification. Residential consumption, in the short run, is constrained by electrical appliance stocks, but in the long run, the stock can vary and be kept in equilibrium with the amount of utility demanded. (19 references) (DCK)

Taylor, L.D.; Blattenberger, G.R.; Verleger, P.K., Jr.
Arizona Univ.; Data Resources Inc.
Address: DRI, 29 Hartwell Ave., Lexington, MA 02173
The Residential Demand for Energy. Volume I

Final Report, Report No. EPRI EA-235, Research Project 431, 148 p.
Jan 1977
Sponsor: Electric Power Research Institute
Abstract: This study focuses on the residential demand for energy over the period 1956 to 1972, with principal emphasis on the residential demand for electricity. The study has as its primary goal to deal with decreasing block pricing in the sale of electricity in a manner that is appropriate theoretically and econometrically sound. To this end, a completely new price data set was constructed that is derived from actual residential rate schedules published in the National Electric Rate Book. The price of electricity is represented in the econometric demand functions as the marginal price plus a measure of intramarginal expenditure. The basic unit of observation is the state, and the models are estimated using the variance-components technique pioneered by Balestra and Nerlove. Two types of dynamic models are estimated, logarithmic flow-adjustment models in which appliance stocks do not appear explicitly, and stock-adjustment models in which they do. The latter models employ annual estimates for the years 1960 to 1972 of 11 types of electrical appliances that were constructed by Data Resources, Inc. specifically for the project. The results of the study: (1) bury once-and-for-all any notion that the price of

electricity is not an important determinant of the amount of electricity that households consume; .... (2) establish the practical importance of proper modeling of decreasing-block tariffs; ... and (3) suggest that the long-run price elasticity for the residential demand for electricity may not be as large as previous studies have indicated. (68 references) (auth, abstract modified)
Availability: Electric Power Research Institute, 3412 Hillview Ave., Palo Alto, CA 94304

Tennessee Energy Office
Address: 250 Capitol Hill Building, Nashville, TN 37219
Recommendations for Greater Energy Efficiency in Large Buildings

Report No. NP-20678, 7 p.
1975
Abstract: A detailed list of energy saving suggestions, these recommendations concentrate on "idea-joggers" to lower demand rather than a higher standards approach. Suggestions cover lighting, air conditioning, heating, air circulation, electrical equipment, water, insulation, and maintenance in large buildings. Emphasis is on turning things on only when they are needed and keeping buildings and equipment at peak performance. (14 references) (ECK)
Availability: TIC

Tennessee Valley Authority, Power Marketing Division
Address: Chattanooga, TN
Guide for Calculations of Electric Space Heating and Cooling

20 p.
Mar 1972
Abstract: This report reviews the fundamentals of calculating heating requirements in residences and other buildings. A general discussion of insulation, weather stripping, storm sashes, fireplace dampers, and window sweating is presented first. Types of electric heating are described, followed by an explanation of estimating kwh consumption. Tables of heat loss calculations for a sample residence, heat pump performance data, wire sizes for heater circuits, heat loss coefficients, and normal degree days for heating season for cities in the TVA area are included. Instructions for estimating the cooling load and cooling load tables are also presented. (MPG)

Tree, D.R.; Hamilton, J.F.
Purdue Univ., Dept. of Mechanical Engineering, Ray W. Herrick Laboratories
Address: West Lafayette, IN 47906
Energy Requirements of Residential Homes

Paper presented at the Conference on Improving Efficiency in HVAC Equipment and Components for Residential and Small Commercial Buildings held October 7-8, 1974 at Purdue University, pp. 202-213
1974
Abstract: In order to effectively size and use the heating and air-conditioning equipment for a residential home, all energy inputs into that house should be known. It is difficult to find or predict values of many of these energy inputs. In a study conducted by the staff of the Ray W. Herrick Laboratories, four houses were designed, built and instrumented to study the comfort provided by and the operating characteristics of four different heating and air-conditioning plants (a split-type, gas operated heating and cooling unit; gas furnace and electric split-type air conditioner; packaged, air-to-air heat pump; baseboard resistance electrical heaters and electric air conditioning). As part of this study the energy input to each house, the energy input to the heating and cooling equipment, and the energy input to some of the major appliances were measured. This paper will discuss and give values of these energy inputs. (5 references) (auth, Introduction modified)

Tyrrell, T.J.; Chern, W.S.
Oak Ridge National Laboratory, Energy Division, Dept. of Analysis and Evaluation
Address: Oak Ridge, Tennessee 37830
Forecasting Electricity Demand: A Range of Alternative Futures

To be published in the proceedings on Systems Thinking and the Quality of Life, The Society for General Systems Research - AAAS Annual Meeting, New York City, January 27-30, 1975, 12 p., 20 references
1975
Sponsor: National Science Foundation, RANN Program
Abstract: Many government and utility forecasters regard the sharp decline in electricity sales during 1973-1974 as a temporary phenomenon resulting primarily from stringent energy conservation efforts. Little has been attributed to the impacts of higher electricity prices and interfuel substitution. This explanation is in sharp contrast to our econometric analyses under which significant price-demand relationships were estimated. The paper forecasts future electricity demand based on econometric models, which specify the relationship between electricity sales and major causal factors for residential, commercial, and industrial sectors. We conclude that if future prices of electricity and other substitutes fall into our assumed range, the total electricity demand in the U.S. will increase by 5.0 percent to 5.6 percent per year during 1973 to 1985. (20 references) (auth)

U.S. Congress
Energy Policy and Conservation Act, Public Law 94-163

94th Congress, S.622, 99 p.
22 Dec 1975
Abstract: The purposes of the Act are: (1) to grant standby authority to the President to impose rationing, to reduce energy demand through conservation plans, and to fulfill obligations under the international energy program; (2) to create a Strategic Petroleum Reserve capable of reducing the impact of severe energy supply interruptions; (3) to increase domestic fossil fuel supplies through price incentives and production requirements; (4) to conserve energy supplies through conservation programs and through regulations, where necessary; (5) to improve energy efficiency of vehicles, major appliances, and certain other consumer commodities; (6) to decrease demand for petroleum products and natural gas by providing for greater use of coal resources; and (7) to assure reliability of energy data. (BYB)
Availability: GPO $1.20

U.S. Congress, Congressional Budget Office
Address: Washington, DC

President Carter's Energy Proposals: A
Perspective

Staff Working Paper, 154 p.
Jun 1977
Abstract: This working paper is intended to assist in the Congressional debate by offering an independent evaluation of the proposed energy program. ... The report focuses on the major energy initiatives of coal conversion, the crude oil equalization tax, natural gas pricing, home insulation and solar equipment tax credits, and the two automobile-related proposals. Secondary proposals, such as standards on new appliances and buildings, which altogether the Administration estimates account for less than 30 percent of the potential savings, are not addressed in this report. Essentially, the paper has five major objectives: to give an overview of the general strategy, to provide analysis of the major initiatives, to convey information about the incentive mechanisms, to indicate short-run macroeconomic impacts, and to specify possible changes in the distribution of income. Chapter II offers a general orientation, describing the overall philosophy of the President's approach and its critical features, and placing it in the spectrum of possible alternatives. Perhaps more important, however, it specifies a framework for evaluating the individual proposals that is used throughout the subsequent chapters. Chapters III through VII evaluate and analyze the major energy initiatives within the package. Chapters VIII through X attempt to assess the general costs and benefits of the major proposals. Budget costs, macroeconomic effects, and distributional impacts are addressed in these final three chapters. (from Scope of the Report)
Availability: GPO, Stock No. 052-070-04044-1

U.S. Congress, Office of Technology Assessment
Address: Washington, DC 20510
Analysis of the Proposed National Energy Plan

Report No. OTA-E-51, 248 p.
Aug 1977
Sponsor: U.S. House of Representatives, Committee on Science and Technology; U.S. House of Representatives, Committe on Interior and Insular Affairs
Abstract: The National Energy Plan, which was presented to Congress on April 20, 1977, prescribes goals and principles to guide the nation's energy future. The Administration also submitted legislation to implement the Plan. The purpose of this study was to provide Congress with an independent evaluation of the Administration's proposals and their social and economic effects. Task groups were assembled to assess the Plan's likely impacts on energy supply, energy demand, and society as a whole. An additional task group examined the overall policy implications of the Plan. ... The report begins with an executive summary, including the major conclusions on supply, demand, and societal impacts. Chapter II provides an overall perspective on the Plan and its policy implications. There follow chapters for each of the three impact areas and the issues that need to be considered. Finally, there are two appendixes: the first measures the magnitude of the energy problem; the second analyzes the effect of energy price changes on the supply of fossil fuels. (27 references) (from Foreword)
Availability: GPO $4.00, Stock No.
052-003-00420-8

U.S. Dept. of Commerce; U.S. Dept. of Housing and Urban Development
Address: Washington, DC
Annual Housing Survey: United States and Regions. Part A - General Housing Characteristics

Annual publication, Current Housing Reports Series H-150-73A for 1973 data, v.p.; Series H-150-74A for 1974 data, v.p.; Series H-150-75A for 1975 data, v.p.
Jul 1975; Aug 1976; Apr 1977
Abstract: Statistics are presented on general housing characteristics from the Annual Housing Survey for the U.S. by inside and outside standard metropolitan statistical areas and each of the four geographical areas (Northeast, North Central, South, and West). Information is provided on the size and composition of the housing inventory, the characteristics of its occupants, and changes in the inventory resulting from new construction and from losses. Statistics are based on information from a sample of housing units, collected by personal interview. Contained in this publication are an introduction; a summary of findings with text tables; Appendix A, which describes the geographic area classifications and provides definitions and explanations of the subjects covered in this report; and Appendix B, which presents information on sample design, estimation, and accuracy of the data. (BYE)
Availability: GPO $4.00, Stock No.
003-024-01368-1 for 1975 Survey

U.S. Dept. of Commerce, Bureau of Economic Analysis
Address: Washington, DC
Survey of Current Business

v.p.
Monthly
Abstract: Each monthly report provides comprehensive coverage of business and economic conditions including national income and balance of payment statements. In-depth articles on various economic subjects are also included. Weekly supplements provide advance information on selected data. (EBH)
Availability: GPO $48.30 annual subscription including weekly supplements

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U.S. Dept. of Commerce, Bureau of Economic Analysis
Address: Washington, DC
1975 Business Statistics. Twentieth Biennial Edition

Biennial supplement to the Survey of Current Business, v.p.
May 1976
Abstract: This publication presents the historical data for approximately 2,500 series that appear in the S-pages of the Survey of Current Business, published monthly by the Bureau of Economic Analysis. Data for the national income and product accounts reflect the recently completed benchmark revisions. Data are shown annually for the years 1947-74, quarterly for the years 1964-74, and monthly for the years 1971-74. Explanatory notes are provided for each of the series in a separate section. ... The appendix to this volume provides monthly or quarterly data for earlier periods for almost 400 of the more important series. (from Foreword)
Availability: GPO $5.10

U.S. Dept. of Commerce, Bureau of the Census
Address: Washington, DC 20233
Households with Television Sets in the United States, January 1969

Current Housing Reports, Housing Characteristics, Series H-121, No. 15, 8 p.
Jun 1969
Abstract: Data are presented on households equipped with television sets. Information is presented on the percentage of households with one or more than one set in the U.S. and various regions of the U.S., characteristics of households and heads of households by number of sets and by type of sets, and other related data. (HHG)
Availability: GPO

U.S. Dept. of Commerce, Bureau of the Census
Address: Washington, DC
Statistical Abstract of the United States, 1975; 1976

Annual publication, National Data Book and Guide to Sources, 96th Annuel Edition, 1050 p. for 1975 Abstract; 97th Annual Edition, 1049 p. for 1976 Abstract
1975; 1976
Abstract: Statistical data are included in the following categories: population; vital statistics, health, and nutrition; immigration and naturalization; education; law enforcement, federal courts, and prisons; area, geography, and climate; public lands, parks, recreation, and travel; labor force, employment, and earnings; national defense and veterans affairs; social insurance and welfare services; income, expenditures, and wealth; prices; elections; federal government finances and employment; state and local government finances and employment; banking, finance, and insurance; business enterprise; communications; power; science; transportation - land; transportation - air and water; agriculture; forests and forest products; fisheries; mining and mineral products; construction and housing; manufactures; distribution and services; foreign commerce and aid; outlying areas under the jurisdiction of the United States; comparative international statistics; and metropolitan area statistics. (DCM)
Availability: GPO $10.50 (cloth), Stock No. 0324-01049-6; $8.00 (paper), Stock No. 0324-01050-0 for 1975 Edition; $10.50 (cloth), Stock No. 003-024-01173-5; $8.00 (paper), Stock No. 003-024-01174-3 for 1976 Edition

U.S. Dept. of Commerce, Bureau of the Census
1970 Census of Housing, Detailed Housing Characteristics, United States Summary

HC(1)-B1, 480 p.
Jul 1972
Abstract: This report presents statistics on detailed characteristics of housing units for the United States, regions, divisions, states, and certain other areas. Tables are presented on the following subjects: summary characteristics; total housing units; total population; occupancy characteristics; vacancy characteristics; utilization characteristics; plumbing characteristics; structural characteristics; equipment, fuels and appliances; and financial characteristics. The subjects covered in this report are all drawn from the 15% and 5% questionnaires. (MPG)
Availability: GPO

U.S. Dept. of Commerce, Bureau of the Census
Address: Washington, DC
** Selected Data from the 1973 and 1974 Surveys of Purchases and Ownership

62 p.
Jul 1976
Abstract: The Surveys of Purchases and Ownership were conducted in the fall of 1973 and 1974 as supplements to the Annual Housing Survey. Data are presented on consumer ownership, availability, and purchases of automobiles and major household items. Socio-economic factors affecting ownership and purchases of cars and appliances are surveyed (e.g., income, age of head of household, race and Spanish origin, location of residence, and tenure of housing unit). Data collected from the 1973 and 1974 Surveys of Purchases and Ownership are to be published in an issue of "Consumer Buying Indicators," Series P-65 in the Current Population Report Series. (BYB)

U.S. Dept. of Commerce, Bureau of the Census
Address: Washington, DC
Current Population Reports*

Publication Series P-20, P-23, P-25, P-26, P-27, P-28, P-60, and P-65
Abstract: Current Population Reports, which consist of eight separate report series, present data derived from the Current Population Survey, a monthly sample survey of about 47,000 households. These Current Population Reports present data on household relationship, age, race, and sex; marital status; number, presence, and age of children; number of children ever born; first marriage; level of educational attainment; occupational group; labor force status; family income; veterans' status; and mobility. The eight series are as follows: P-20, Population Characteristics, with 15 reports issued per year on school enrollment, educational attainment, characteristics of persons, families, and households, fertility, and mobility status of civilian population; P-23, Special Studies, issued several times per year on varying subjects (e.g., reports on black population, American youth, the aging, survival rates, population in metropolitan and nonmetropolitan areas, fertility indicators, and female family heads); P-25, Population Estimates and Projections, a monthly and annual series; P-26, Federal-State Cooperative Program for Population Estimates, a periodic publication which covers population estimates by county, percent change for estimates from previous year, and components of change--births, deaths, net migration--by county; P-27, Farm Population, an annual report on the size of farm population and selected population characteristics; P-28, Special Censuses, a semi-annual publication covering the age, sex, race, and change in population in specified areas; P-60, Consumer Income, which is published several times each year and includes data on the money income of families and persons, household money income and selected social and economic characteristics of households, and characteristics of the low-income population; and P-65, Consumer Buying Indicators, covering household expenditures on cars (new and used), appliances, and selected other durables, and expenditures by age and race of household head and by income. (BYB)
Availability: GPO; Population Series Reports sold as a single consolidated subscription, $56 per yr.

U.S. Dept. of Commerce, Bureau of the Census
Address: Washington, DC

1967 Census of Construction Industries. Area Statistics: United States Summary, Statistics for Construction Establishments With and Without Payroll

Report No. CC67-A-1, 27 p.
Dec 1970

Abstract: This report summarizes 1967 Census of Construction Industries data derived from the final reports already published for each of the States. During 1967, there were a total of 794,838 establishments in the United States operating primarily as general contractors, special trade contractors, operative builders, or subdividers or developers. These establishments had total receipts of $101.7 billion. In tables 1 and 2 of this report, summary statistics are provided for all establishments and also separately for the employer group (those establishments with payroll) and for the nonemployer group (those establishments with no payroll). There were 426,067 establishments, or 54 percent of all construction establishments in the United States, ~~that were "nonemployers."~~ They accounted for only about 6 percent of the total receipts of all construction establishments. There were 368,771 establishments, or 46 percent of all construction establishments, that were "employers" and they accounted for 94 percent of total receipts. California ranked first among the States on the basis of the greatest number of construction establishments (with and without payroll) and on the basis of total receipts of all establishments. New York ranked second. Tables 3 through 9 provide considerably more detailed information for the employer group. Total receipts for these establishments in 1967 amounted to $95.9 billion, of which $92.6 billion were receipts for construction work. These establishments made payments for construction work subcontracted to others amounting to $23.1 billion, leaving net construction receipts of about $69.5 billion. The construction establishments with payroll in the United States made payments for purchased materials, components, and supplies in the amount of $29.4 billion. ... Average employment for the year in these construction establishments in the United States totaled 3.4 million employees. Total payroll for 1967 amounted to $24.2 billion. ... Construction establishments with 10 or more employees, while representing only 18 percent of the total number of employer establishments in the United States, accounted for 75 percent of the total receipts of all employer establishments. (from Special Text)

Availability: GPO $0.35

U.S. Dept. of Commerce, Bureau of the Census
Address: Washington, DC
Construction Reports

Periodic Reports, Series Nos. C20, C21, C22, C25, C27, C30, C40, and C41, v.p.

Abstract: This series of Census reports on the construction industry consists of these periodic publications: C20, Housing Starts, a monthly report which provides estimates of total housing starts and number of new housing units started by private and public ownership; C21, New Residential Construction in Selected Standard Metropolitan Statistical Areas, a quarterly publication; C22, Housing Completions, a monthly report which provides both unadjusted and seasonally adjusted data on the number of new privately owned and publicly owned housing units completed each month; C25, a monthly publication, entitled "New One-Family Houses Sold and For Sale" (formerly "Sales of New One-Family Homes"), and an annual publication, entitled "Characteristics of New Housing" (formerly "Characteristics of New One-Family Homes"), which provide information on new privately owned, one-family homes (expanded to multi-family housing in 1976 annual report, C25-76-13) sold during the month and for sale at the end of the month, together with related annual data and figures for previous months; C27, Price Index of New One-Family Houses Sold, a quarterly report; C30, Value of New Construction Put in Place, a monthly report; C40, Housing Authorized by Building Permits and Public Contracts, a monthly and annual publication; C41, Authorized Construction, a monthly report; C45-1975, Housing Units Authorized for Demolition in Permit-Issuing Places: 1975, an annual report presenting data on housing authorized for demolition in 326 cities with a population of 50,000 or more, all SMSA's, and Census regions and divisions; and C50, Residential Alterations and Repairs, a quarterly and annual report. (BYB)

Availability: GPO

U.S. Dept. of Commerce, Bureau of the Census
Address: Washington, DC 20233
1972 Census of Selected Service Industries. Subject Series

Report Nos. SC72-S-1 to SC72-S-8, v.p.
Dec 1975

Abstract: Conducted in 1973 as part of the economic censuses, the 1972 Census of Selected Service Industries is an enumeration of selected service establishments in the U.S. This Subject Series consists of eight reports, including the following: SC72-S-2 (Hotels, Motels, Trailering Parks, and Camps) which presents statistics on major sources of receipts, number of guestrooms, weighted average percentage of occupancy, period establishments started operations, type of facilities available, and resorts by major source of receipts and by average length of stay; SC72-S-3, Motion Picture Industry, providing data on receipts by source, promotional expenditures, admissions and capacity, and period first operated as theater; SC72-S-4, Legal Services, with data on operating expenses, personnel and payroll by occupation, receipts by class of client, and primary fields of practice; SC72-S-5, Architectural, Engineering, and Land-Surveying Services; SC72-S-6, Arrangement of Passenger Transportation, which presents statistics for travel agencies, tour operators, and related services; SC72-S-7, Nonregulated Motor Carriers and Public Warehousing, which presents data on bus carriers, truck carriers, and public warehousing; and SC72-S-8, Miscellaneous Subjects, including statistics on laundry, cleaning, and other garment services; funeral service and crematories; advertising agencies; credit reporting and collection agencies; portrait photography; commercial photography, art, graphics, and related design; computer and data processing services; commercial research, development, and testing laboratories; automotive rental and leasing, without drivers; automobile parking; automotive services; performing arts; bowling establishments; commercial spectator sports and amusement parks; dental laboratories; central administrative offices and auxiliaries; and capital expenditures and other financial data. (BYB)

Availability: GPO

U.S. Dept. of Commerce, Bureau of the Census
Address: Washington, DC
Current Industrial Reports

Periodic Reports, v.p.
Abstract: This series of monthly, quarterly, and annual reports provides current statistics on commodity production and shipments. Included in this series are the following reports: M3-1, Manufacturers' Shipments, Inventories, and Orders, monthly reports with data on value of manufacturers' shipments, inventories, and orders, by industry group; market categories and supplementary series on capital goods, defense products, and household durables; and value of manufacturers' inventories by stage of fabrication, by industry group; M3-1.6, Manufacturers' Shipments, Inventories, and Orders: 1958-1976 (Revised), in which the monthly data in M3-1 have been revised; MA-34N, Selected Heating Equipment, an annual publication which presents statistics on the quantity and value of manufacturers' shipments and inventory of selected heating equipment; MA-35M, Air-Conditioning and Refrigeration Equipment, Including Warm Air Furnaces, an annual report providing statistics on the quantity and value of manufacturers' shipments of air-conditioning, refrigeration equipment, and nonelectric warm air furnaces; MA-35R, Office, Computing, and Accounting Machines, an annual report presenting data on the quantity and value of shipments of office, computing, and accounting machines and related equipment; MQ-36B, Electric Lamps, a quarterly report with an annual summary, including data on the quantity of production and end-of-quarter stocks, and the quantity and value of shipments of electric lamps each by product; MA-36E, Electric Housewares and Fans, an annual report which presents statistics on manufacturers' shipments of electric housewares and fans; MA-36F, Major Household Appliances, an annual publication with statistics on the value of shipments of major household appliances; MA-36L, Electric Lighting Fixtures, an annual publication; MA-36M, an annual publication entitled "Radio Receivers and Television Sets, Phonographs and Record Players, Speakers and Related Equipment." (BYB)
Availability: GPO $125.00 for yearly subscription; individual reports are available through Subscriber Services Section (Publications), Bureau of the Census, Washington, DC 20233

U.S. Dept. of Commerce, Bureau of the Census
Address: Washington, DC 20230
United States Department of Commerce News. Price Index of New One-Family Houses Sold

Quarterly report, approximately 4 p.
Abstract: Tables are provided with data back to 1963 on: the Price Index of New One-Family Houses Sold, Including Value of Lot for the U.S. and by Region; and Average Sales Prices of the Kinds of New One-Family Houses Sold in 1974 (1967 for old series) Compared with Houses Actually Sold During Each Period. Beginning with the second quarter 1977 report (released August 12, 1977), the price index table will be calculated with weights which reflect the quality characteristics of houses sold in 1974 rather than those sold in 1967 (as in previous reports) and the base year updated to 1972=100.0. However, the old series based on the kinds of houses sold in 1967 will also be published for the remainder of 1977. (BYB)

U.S. Dept. of Commerce, Bureau of the Census
Address: Washington, DC 20233
1972 Census of Wholesale Trade. Volume I. Summary and Subject Statistics

961 p.
Aug 1976
Abstract: This volume includes data previously issued in report WC72-A-52, series WC72-S-1 to 4, and report WC72-L. Summary statistics on such topics as number of establishments, sales, inventories, and payroll are presented by type of operation and kind of business for the United States, regions, divisions, States, selected standard metropolitan statistical areas, and counties. Subject statistics include reports on establishment size and firm size, along with legal form of organization; petroleum bulk stations and terminals; value produced, capital expenditures, fixed assets, rental payments, and supplemental labor costs of merchant wholesalers; sales by class of customer, credit sales, receivables, and bad-debt losses; warehouse space and miscellaneous subjects. These data are are primarily presented for the United States, but selected items include breakdowns for smaller areas. Commodity line sales provide data by kind of business for each type of operation (merchant wholesalers, manufacturer's sales branches and sales offices, and merchandise agents and brokers) on the number and total sales of establishments in a specified kind of business; on the number of establishments carrying the line, and total sales of the specified commodity line; on the percent of total sales accounted for by each commodity line carried; and, for establishments actually handling a specific line, the percent of their total sales represented by sales of that line. Data are shown for the United States, each geographic division, and selected standard metropolitan statistical areas. (from Bureau of Census Catalog: 1976)
Availability: GPO $17 (clothbound), Catalog No. C56.252/5:(Vol.)

U.S. Dept. of Commerce, Bureau of the Census
Address: Washington, DC 20233
1972 Census of Retail Trade. Volume I. Summary and Subject Statistics

420 p.
Jul 1976
Abstract: This volume includes data previously issued in series RC72-A and RC72-S. Summary statistics on such topics as number of establishments, sales, number of unincorporated businesses operated by sole proprietorships and partnerships, and payrolls are presented by kind of business for the United States, regions, divisions, and States. The 250 largest counties and cities are ranked by volume of sales. Subject statistics include reports on establishment and firm size, along with legal form of organization; capital expenditures, fixed assets, and rental payments; miscellaneous subjects; and merchandise line sales. These data are primarily presented for the United States, but some items among the miscellaneous subjects include breakdowns for smaller areas. (from Bureau of Census Catalog: 1976)
Availability: GPO $8.50, Catalog No. C56.251/6:(Vol.)

U.S. Dept. of Commerce, Bureau of the Census
Address: Washington, DC 20233
U.S. Exports--Schedule B--Commodity by Country

Monthly and annual reports, Report No. FT 410, v.p.
Abstract: Statistics on the quantity and value of individual commodities exported are presented by country of destination. Commodity detail shown is that of Schedule B, Statistical Classifications of Domestic and Foreign

Commodities Exported from the United States. The sampling procedure and its effect on the reliability of the data are discussed in each issue of this report. (from Bureau of the Census Catalog: 1976)
Availability: GPO, Catalog No. C3.164:410

U.S. Dept. of Commerce, Bureau of the Census
Address: Washington, DC 20233
1972 Census of Governments. Volume 1. Governmental Organization

477 p.
Jul 1973
Abstract: This volume provides information on the numbers and selected characteristics of governmental units and public school systems as of the beginning of 1972. An introductory text summarizes the data, reviews historical trends, explains criteria for classification, and describes procedures for assembling data. National data are shown, by States and standard metropolitan statistical areas, on the following: numbers of county, municipal, and township governments, and their 1970 population, by population-size classes; school districts and other public school systems by selected characteristics--type of system, enrollment, number of schools operated, area served, and grades provided; special districts, by function performed and area served; and numbers of local governments, by type, in each county area. A concluding textual section describes local governments and public school systems legally authorized in each State at the beginning of 1972, and identifies semiautonomous government agencies that are classed as parts of other governments rather than as separate government units. (from Bureau of Census Catalog: 1973)
Availability: GPO $4.55, Catalog No. C56.247/2:972/V.1

U.S. Dept. of Commerce, Bureau of the Census
Address: Washington, DC
Current Housing Reports: Housing Vacancies

Quarterly and annual publications, Series No. H-111, v.p.
Abstract: Data are shown on rental vacancy rates and homeowner vacancy rates for the United States, regions, and inside and outside standard metropolitan statistical areas, for the current quarter and for the same quarter one year ago. Vacancy rates for rental and homeowner housing with specific characteristics are also presented: Percent distribution of rental vacancies and homeowner vacancies, by housing characteristics; number of rooms, number of bedrooms, and number of housing units in structure; duration of vacancy; plumbing facilities; year built; monthly rent asked; and sale price asked. Also included are percent distribution of all vacant housing units by status, and figures on tenure. Annual average rates are published in a separate report issued in March. Quarterly reports are titled "Vacant Housing Units in the United States"; the annual report is titled "Vacancy Rates and Characteristics of Housing in the United States." (from Bureau of Census Catalog: 1976)
Availability: GPO $3.60 (annual subscription for Series H-111 and H-121, combined), single copy $0.35, Catalog No. C3.215:H111

U.S. Dept. of Commerce, Bureau of the Census;
U.S. Dept. of Housing and Urban Development
Address: Washington, DC
Current Housing Reports: Market Absorption of Apartments

Quarterly and annual publications, Series NO. H-130, v.p.
Abstract: This series presents data for the United States concerning the rate at which non-subsidized and unfurnished privately financed units in buildings with five or more units are rented (or absorbed), by quarter of completion, number and sampling error of total completed, percentage and sampling error for seasonally adjusted rented within 3 months, and percentage and sampling error for not seasonally adjusted, rented within 3 months, 6 months, 9 months, and 12 months. Data are shown on the characteristics of apartments completed in the current and previous quarter, by rent classes and number of bedrooms. Data are also provided on cooperative and condominium apartments by total completed, percent of all with five or more units, and those absorbed within 3 months. The annual report provides data for apartments completed during the year. Absorption rates for unfurnished apartments are shown by number of bedrooms, rent classes, and presence of air conditioning and swimming pool. Data are given for the United States, regions, and inside and outside standard metropolitan statistical areas. Statistics for furnished apartments are presented by absorption rates, rent classes, and number of bedrooms. Data for cooperative and condominium apartments are given by number of bedrooms and geographic regions. The charts show absorption rates by rent classes and the number and percent of apartments absorbed by months on the market. Text tables provide standard errors of estimated totals and percentages. The statistics in these publications are based on a survey conducted by the Bureau of the Census for the Department of Housing and Urban Development. (from Bureau of Census Catalog: 1976)
Availability: Bureau of the Census, Subscriber Services, Washington, DC 20233; annual subscription $2.50, single copy $0.50

U.S. Dept. of Commerce, Bureau of the Census;
U.S. Dept. of Housing and Urban Development
Address: Washington, DC
Current Housing Reports: Characteristics of Apartments Completed

Annual publication, Series No. H-131, v.p.
Abstract: This series, which began with the 1975 report, issued July 1976, presents statistics on the characteristics of apartments completed, based on preliminary figures from the Survey of Market Absorption Series H-130. Data are provided on unfurnished apartments completed and percent absorbed within 3 months by rent classes for the United States and regions; characteristics of unfurnished apartments completed by inside and outside standard metropolitan statistical areas and by regions; furnished apartments completed by rent classes and number of bedrooms; and cooperative and condominium apartments completed and percent absorbed within 3 months by number of bedrooms and regions. These data are for privately financed, nonsubsidized, unfurnished apartments in buildings with five units or more. (from Bureau of Census Catalog: 1976)
Availability: Bureau of the Census, Subscriber Services, Washington, DC 20233 $0.30

U.S. Dept. of Commerce, Bureau of the Census;
U.S. Dept. of Housing and Urban Development,
Office of Policy Development and Research
Address: Washington, DC

Annual Housing Survey: United States and Regions. Part B - Indicators of Housing and Neighborhood Quality

Annual publication, Current Housing Reports
Series H-150-74B, 158 p. for 1974 Survey;
Series H-150-75B, 188 p. for 1975 Survey
May 1976; Feb 1977

Abstract: These reports present final statistics on indicators of housing and neighborhood quality from the 1974 and 1975 Annual Housing Surveys for the United States by inside and outside standard metropolitan statistical areas (SMSA's) and each of the four geographic regions. ... Most of the data in this report are for items that were collected for the first time by the Bureau of the Census in the 1973 Annual Housing Survey. These items include such diverse indicators of housing quality as water leakage in basement and roof, the physical condition of interior ceilings, floors, and stairways, and breakdowns or failures in plumbing facilities and equipment as well as measures of neighborhood quality such as the presence of heavy street traffic and noise and the inadequacy of neighborhood services such as public transportation. ... The text consists of an introduction and appendixes A and B, which appear after the data tables. Appendix A describes the geographic area classifications and provides definitions and explanations of the subjects covered in this report. Appendix B presents information on sample design, estimation, and accuracy of the data. ... Tables 1 to 4 present characteristics for owner- and renter-occupied housing units, tables 5 to 8 present characteristics for owner- and renter-occupied housing units with Negro head of household, tables 9 to 12 present characteristics for owner- and renter-occupied housing units with household head of Spanish origin, and table 13 presents characteristics of year-round vacant housing units. (from Introduction)

Availability: GPO $3.15 for 1974 Survey; $2.50 for 1975 Survey

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U.S. Dept. of Commerce, Bureau of the Census, Industry Division
Address: Washington, DC
Annual Survey of Oil and Gas: 1973, 1974, 1975

Current Industrial Reports, Series MA-13K(73)-2, 37 p. for 1973 Survey; Series MA-13K(74)-1, 46 p. for 1974 Survey; Series MA-13K(75)-1, 65 p. for 1975 Survey
Annual

Abstract: These annual surveys present final statistics on the operations of the petroleum and natural gas industries, including oil and gas field exploration, development, and production activities. Results of the survey are summarized. Approximately 19 tables provide the following data: Selected Gross Operator Basis Statistics, Detailed Net Company Interest and Gross Operator Basis Statistics, Detailed Net Company Interest Basis Statistics, Input/Output Relationship, Expenditure Interrelationships, Product Specialization of Leases, Offshore Specialization, Selected Drilling Relationships, and Stripper Output Specialization. The 1975 Survey includes an appendix supplementing the 1973 report with tables on Detailed Net Company Interest Statistics Ranked by Total Lease Revenues: 1973. (BYB)

Availability: Subscriber Services Section (Publications), Bureau of Census, Washington, DC 20233 $0.25 for 1973 Survey; $0.25 for 1974 Survey; $0.70 for 1975 Survey

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U.S. Dept. of Commerce, Bureau of the Census, Industry Division
Address: Washington, DC 20233
Annual Survey of Manufactures

Annual series, Report No. M75(AS) for 1975 series, v.p.

Abstract: This series of reports provides data for industry groups, individual industries, geographic divisions, States, standard metropolitan statistical areas, large industrial counties, and selected cities. Included in the series are these reports: (1) General Statistics for Industry Groups and Industries (Including Supplemental Labor Costs), which presents final manufacturing establishment statistics for industry groups and industries, including data on employment, payrolls, man-hours, value added by manufacture, capital expenditures, cost of materials, and value of industry shipments; (2) Value of Product Shipments, which lists estimates of the value of product shipments; (3) Value of Manufacturers' Inventories, providing data on the value of manufacturers' inventories for industry groups and industries; (4.1) Fuels and Electric Energy Consumed, presenting quantity and cost statistics for the major fuels consumed for power and heat by manufacturing establishments; (4.2) Fuels and Electric Energy Consumed: States, by Industry Group, and United States, by Industry, a report presenting statistics on quantity and cost of specified fuels used for heat and power, quantity and cost of electric energy purchased, and quantity of electric energy generated (less quantity sold) by manufacturing plants; and (6) Statistics for States, Standard Metropolitan Statistical Areas, Large Industrial Counties, and Selected Cities, a report with statistics on employment, payroll, man-hours, value added by manufacture, cost of materials, value of industry shipments, and new capital expenditures. (BYB)

Availability: Bureau of the Census, Subscriber Services Section, Washington, DC 20233

U.S. Dept. of Commerce, Bureau of the Census, Social and Economic Statistics Administration
Address: Washington, DC
County Business Patterns: 1974

Annual publication, Report No. CBP-74, v.p.
1975

Abstract: This series includes a report for each state, the District of Columbia, and a U.S. Summary. Data are presented for 1974 on employment, number and employment size of establishments, and payrolls. This series of reports includes data covering most of the economic divisions of the economy; i.e., agricultural services, mining, construction, manufacturing, transportation, public utilities, wholesale trade, retail trade, finance, insurance, and real estate and services. The use of the Census Bureau's Company Organization Survey covering multilocation companies now permits the revised program to include data on total payroll for the entire year on an establishment basis rather than a reporting unit basis. Data for 1974 are presented on the number of employees as of the mid-March pay period; the first quarter total payroll; total annual payroll; and the number of establishments, by employment size class, by the revised 1972 Standard Industrial Classification (SIC) 4-digit industries for the United States and each state. Data are shown for each county at the 4-digit SIC level. Summary data, provided for the principal data items, are tabulated for approximately 800 detailed kinds of businesses based on the SIC designations. Geographic areas tabulated include the total

U.S. level, individual states, and counties. Appendixes provide Federal employment and payroll data by county for most states. (from Bureau of the Census Catalog: 1976)
Availability: GPO, Catalog No. C3.204:CBP-74(No.)

U.S. Dept. of Commerce, Bureau of the Census, Social and Economic Statistics Administration
Address: Washington, DC 20233
1970 Census of Housing. Subject Reports.

Final Report, Report No. HC(7)-1 to 9, v.p.
May 1973
Abstract: Volume VII of the 1970 Census of Housing consists of this series of nine reports, with each report focusing on a particular subject. The reports in this series are: HC(7)-1, Housing Characteristics by Household Composition, with data on cross-tabulations of housing and household characteristics for the U.S., inside central cities, balance of standard metropolitan statistical areas (SMSA's) outside central cities, and total for all areas outside SMSA's; HC(7)-2, Housing of Senior Citizens, presenting data on senior citizens cross-classified by various housing and household characteristics; HC(7)-3, Space Utilization of the Housing Inventory, covering such indicators as persons per room, rooms per person, income in 1969, units in structure, value, and gross rent; HC(7)-4, Structural Characteristics of the Housing Inventory, which supplies detailed tables presenting statistics for owner-occupied and renter occupied housing units, for housing units with Negro head of household, and units with Spanish-speaking head of household cross-classified by such indicators as number of rooms, persons per room, persons by income in 1969, bedrooms, units in structure, etc.; HC(7)-5, Mover Households, presenting data for household heads who moved into their present housing units within 5 years of the 1970 Census; HC(7)-6, Mobile Homes, with information on the location by state of mobile homes, model year of mobile homes, household composition, family income in 1969, plumbing facilities, and rooms; HC(7)-7, Geographic Aspects of the Housing Inventory, providing tables with data for urban and rural residence by various categories of place size; HC(7)-8, Cooperative and Condominium Housing, a report containing information on owner-occupied cooperative and condominium housing units, including data on household composition, persons in such units, income, children under 18 and persons 65 years old and over, units in structure, and year structure was built; and HC(7)-9, Housing of Selected Racial Groups, a report which contains data for units with household head of selected racial groups (i.e., American Indian, Japanese, Chinese, Filipino, Korean, and races other than white and Negro). (BYB)
Availability: GPO, Catalog No. C3.224/10:970/1-9

U.S. Dept. of Commerce, National Bureau of Standards
Address: Washington, DC 20234
Energy Efficiency in Room Air Conditioners

LC 1053, 5 p.
1974
Abstract: Some facts that potential buyers of room air conditioners need to consider relating to energy efficiency of the unit are discussed in this publication. The differences between window and through-wall models are discussed. Household wiring and cooling capacity are briefly discussed. A method is presented for estimating cooling capacity needed for a particular situation. Determination of the energy efficiency of a room air conditioner, cost of electricity to operate the unit being considered in a given location, and relation of the cost of electricity to operate the unit and purchase price are all discussed briefly. (ELH)

U.S. Dept. of Commerce, Office of Energy Programs; Federal Energy Administration, Office of National Energy Conservation Programs
Address: Washington, DC
Voluntary Industrial Energy Conservation. Progress Report 5

129 p.
Jul 1977
Abstract: This publication is the fifth in a series (with two additional updating issues) of reports showing progress in energy conservation made by industry. The report contains information on industry's achievements in conserving energy and provides new data on energy use and savings for the full year 1976. Also listed are those industries which are developing industrial energy efficiency reporting systems, and the industries which have been contacted by the Department of Commerce regarding participation in the Voluntary Industrial Energy Conservation Program. The principal information presented in each industry report are: progress towards industrial energy efficiency targets, recent energy trends, and brief background information. Also, most reports show percentage breakout and description of energy use. Included for the first time are bar graphs showing basic energy use patterns for 1976 compared to the base year when such information is included in the industry group's report. The basic information for this report is that submitted by the industry representatives. Fifty industry groups (including the Air-Conditioning and Refrigeration Institute, the Grocery Manufacturers of America, Inc., and the Motor Vehicle Manufacturers Association) have provided data for this report. The following groups submitted information for the first time: Aerospace Industries Association of America, American Boiler Manufacturers Association, Building Owners and Managers Association International, Commercial Refrigerator Manufacturers Association, Construction Industry Manufacturers Association, Copper & Brass Fabricators Council, Fans and Industrial Equipment Institute, Ferroalloys Association, General Aviation Manufacturers Association, National Soft Drink Association, and the U.S. Brewers Association. ... Based upon the information contained in this report, most of the industries continue to show energy efficiency improvements. (from Summary)

U.S. Dept. of Health, Education, and Welfare, Office of the Assistant Secretary for Planning and Evaluation, Office of Income Security Policy
Address: Washington, DC
The Impact of Rising Residential Energy Prices on the Low-Income Population: An Analysis of the Home-Heating Problem and Policy Alternatives

Report No. PB-245206, FEA/E-74/569, 107 p.
Dec 1974
Sponsor: Federal Energy Administration, Office of Intergovernmental, Regional and Special Programs, Office of Consumer Affairs and Special Impact
Abstract: The effect of rapidly rising residential energy prices, specifically for

home-heating fuels, on the lower income population is explored, and various policy alternatives to ameliorate this impact are analyzed. The study is also a response to a Congressional request to study the feasibility of a "fuel stamp" program. The introductory section provides a summary of the findings of the paper. The second section analyzes the costs of home-heating and the particular needs of the low income population. In Section III, the responses to rising energy prices of programs such as Food Stamps, Aid to Families with Dependent Children, Emergency Assistance, Supplemental Security Income, and State and local assistance programs are reviewed. Section IV examines a number of policy alternatives designed either to provide additional purchasing power to low income households to meet necessary utility costs or to encourage the reduced consumption of home heating fuels through improvements in the thermal efficiency of living quarters. Section V examines certain proposed new programs, including a number of "fuel stamp" proposals motivated by the rise in residential energy prices. (GBA)
Availability: NTIS

U.S. Dept. of Housing and Urban Development
Address: Washington, DC
The Home Buyer's Estimator of Monthly Housing Cost

Report No. HUD-419-(b)-HM
Feb 1976
Abstract: The purpose of this pamphlet is to help individuals make wise financial decisions when purchasing a home. Information is provided to allow the home buyer to estimate the total monthly cost of owning a home, compare the monthly costs of different homes, and determine whether the buyer can afford a particular home. (BYB)
Availability: GPO $1.75, Stock No. 023-000-00319-8

U.S. Dept. of Housing and Urban Development; Executive Office of the President, Domestic Council, Committee on Community Development
Address: Washington, DC
1976 Report on National Growth and Development: The Changing Issues for National Growth

Report No. HUD-386-2-CPD, Third Biennial Report to the Congress, submitted pursuant to Section 703 (a) of Title VII, Housing and Urban Development Act of 1970, 151 p.
Feb 1976
Abstract: As have the two previous reports, the 1976 report addresses not only urban growth, but also national growth in a broader sense. The report considers regional and local impacts of economic and social change, and shifting patterns of physical development. Patterns of population growth are described, particularly trends that have not changed. The U.S. continues to be mainly an urban nation. Large concentrations of poor live in the central cities and in certain rural areas. Children of the postwar baby boom are now forming households, ensuring continued growth pressures despite a decline in the birth rate. According to Census estimates, nonmetropolitan areas are growing faster than metropolitan areas. Shifts in the geography of population and economic growth affect public policy, especially state and local economic development policy. Development of domestic energy resources is considered one of the most important factors in shaping the pattern of growth for the next 10 years. Limitations on the availability of energy have made people become aware of constraints on other resources, especially land. Although older Eastern cities seem to be losing economic bases and population, the report emphasizes that the capital investment in existing urban areas should be preserved. Due to higher interest rates and increased uncertainties about future capital availability, the planning period required for both the private and public sectors has shortened. The first four chapters detail the changes that are occurring in the national economy and society (i.e., (1) The Changing Context of Resource Use; (2) Shifting Patterns of Growth; (3) Family Needs and Resources; and (4) New Pressures on Government). Chapters five through thirteen discuss current trends and the choices that can be made in national growth (i.e., (5) Accommodating Energy Imperatives; (6) Growth Consequences of Environmental Regulations; (7) Hard Choices in Natural Resources; (8) A Period of Adjustment in Transportation Policy; (9) Expansion of Telecommunications Capabilities; (10) Improving America's Housing and Neighborhoods; (11) Toward Balanced Economic Growth; (12) Guiding and Controlling Land Development; and (13) Strengthening the Fiscal and Management Capacity of State and Local Governments). The final chapter examines the role of government. (EYE)

U.S. Dept. of Housing and Urban Development, Federal Housing Administration, Management Information Systems Division, Single Family Insured Branch
Address: Washington, DC 20410
Series Data Handbook: A Supplement to FHA Trends. Covering Section 203b Home Mortgage Characteristics

Report No. BR:251, 67 p.
1976
Abstract: All characteristics dealing with the structure or mortgage are presented for one-family homes. Characteristics dealing with the mortgage, for example, income, payments, housing expense, etc., are presented for owner occupant transactions, while characteristics such as sale price, acquisition cost, closing costs, and the like are presented for purchase transactions. (from Technical Notes)

U.S. Dept. of Housing and Urban Development, Federal Housing Administration, Management Information Systems Division, Single Family Insured Branch
Address: 451 Seventh Street SW, Washington, DC 20410
Characteristics of FHA Single-Family Mortgages. Selected Sections of National Housing Act, Calendar Year 1976

Annual publication, Recurring Report No. RR:255, 41 p.
1977
Abstract: This report, published for the first time, depicts Federal Housing Administration single family insured-home characteristics of the following major Sections of the National Housing Act: Section 203(b), mortgage insurance for homes - regular program; Section 221(d)(2), low cost housing for families displaced by urban renewal or other governmental action as well as other low and moderate income families; Section 223(3), housing, located in older declining areas, in which the conditions are such that one or more of the eligibility requirements applicable to the Section of the Title under which insurance is sought could not be met; Section 244, coinsurance, a program providing for the sharing of losses between HUD and originators or certain investing mortgagees

which have assumed the liability of the coinsurance contract; and Section 265(i) (235(i) Rev.), homeownership assistance for lower income families. (auth, abstract modified)

U.S. Dept. of Housing and Urban Development,
Federal Housing Administration, Office of Management, Management Information Systems Division, Single Family Insured Branch.
Address: Washington, DC 20411
FHA Homes, 1976: Data for States and Selected Areas on Characteristics of FHA Operations under Section 203

Annual publication, SR:250, HUD SCS-3, v.p.
1976
Abstract: This annual publication describes characteristics of the Federal Housing Administration's insuring operations under Section 203(b), by state and by selected housing areas. The document presents data derived from processing all proposed and existing one-family home cases insured under Section 203(b). Statistics are included on: volume of FHA-insured home mortgages; ratio of loan to value; property value; construction costs; description of houses; market price of site; water supply and sewage disposal systems; type of heat by type of fuel; term of mortgage; race, age, marital status, and income of mortgagor; FHA estimate of monthly cost of heating and utilities; etc. (BYB)

U.S. Dept. of Housing and Urban Development,
Office of Policy Development Research
The Applicability of the Residential Energy Consumption Analyses to Various Geographic Areas

Report No. HUD-HAI-6, 13 p.
Nov 1973
Abstract: Hittman Associates, under the sponsorship of the Department of Housing and Urban Development, has performed a study of innovations and modifications whereby residential energy consumption could be minimized. The study was performed for typical single- and multi-family residences in the Baltimore/Washington area. ... The products of this study were an improved method for computation of residential heating and cooling requirements and a quantitative evaluation of innovations directed toward minimizing residential energy consumption. Whereas the above study was specific for the construction trends and the weather and solar conditions for the Baltimore/Washington area, the methods of analyses and the general conclusions would be expected to be applicable to other geographical regions in the United States. It is the purpose of this paper to discuss the applicability of the methods of analyses and of the energy-conservative innovations to other geographic areas in the United States. In this discussion, the following geographically-related factors were considered: climatology (dry and wet bulb temperatures, wind velocity and direction, cloud cover and type, and barometric pressure); solar angle and solar flux; structural design; construction materials; availability and costs of gas, oil, and electricity; and regional trends or bias. (6 references) (from Introduction)
Availability: GPO $.55 Stock No. 2300-00256

U.S. Dept. of Interior, Bureau of Mines
Address: Washington, DC 20241
Sales of Fuel Oil and Kerosine in 1975

Mineral Industry Surveys, annual report, 19 p.
17 Sep 1976
Abstract: Data on domestic sales of distillate fuel oils, residual fuel oils, and kerosene are presented in tables and graphs, including information on sales from 1971 to 1975; sales by P.A.D Districts, States; and sales by end use (e.g., heating, industrial, oil company use, electric utility companies, railroads, vessels, military, on-highway diesel, and off-highway diesel). Sales of fuel oil and kerosene decreased 5.3% from 2,109 million barrels in 1974 to 1,997 million barrels in 1975. The decline occurred mainly in the heating, electric utility, and transportation use categories. (BYB)

U.S. Dept. of Interior, Bureau of Mines
Address: Washington, DC 20241
Minerals & Materials: A Monthly Survey

Monthly report, approximately 50 p.
Abstract: These monthly publications present statistics on up to 17 commodities (crude petroleum, petroleum, and natural gas liquids; natural gas; bituminous coal and lignite; anthracite; iron; nickel; manganese; chromium; cobalt; aluminum; copper; tin; zinc; lead; platinum-group metals; gold; and silver). Charts and tables are also provided on Significant U.S. Mineral Imports; U.S. Imports and Exports of Raw and Processed Minerals; and Fossil Fuels, Production-Consumption Index. Detailed descriptions of the data are presented in the Technical Notes on each commodity. (BYB)
Availability: Harold R. Millie, Editor, Bureau of Mines, U.S. Dept. of the Interior, Washington, DC 20241 Free

U.S. Dept. of Interior, Bureau of Mines
Address: Washington, DC
Commodity Data Summaries, 1977: An Up-to-Date Summary of 95 Mineral Commodities

Annual publication, 199 p.
1977
Abstract: Coordinated estimates covering 1976 mineral industry data are provided in this publication. Information is included on the domestic industry structure, government programs, tariffs, and salient statistics for 95 individual minerals, metals, and fuels. For each commodity, data are also furnished on domestic production and use; recycling; import sources; events, trends, and issues; world plant production and capacity; world resources; and substitutes and alternates. A chart describes the role of minerals in the U.S. economy. (BYB)

U.S. Dept. of Interior, Bureau of Mines
Address: Washington, DC
Mineral Facts and Problems, 1975 Edition

Bureau of Mines Bulletin 667, 1264 p.
1976
Abstract: During the last quarter of a century "Mineral Facts and Problems" has become a standard reference document on mineral commodities in the U.S. and internationally. This fifth edition looks at trends in recent decades, current developments, and projections to 1985 and 2000. An Introduction discusses the role of minerals in the U.S. economy, 1776 through 1976, and covers the organization, definitions, and methodology of the rest of the publication. Separate chapters are provided on 88 commodities, including information on

industry structure, reserves and resources, uses, technology, supply-demand relationships, byproducts and coproducts, strategic considerations, economic factors and problems, operating factors and problems, demand and supply outlook, and sources of current information. (BYB)
Availability: GPO $17.00, Stock No. 024-004-01893-3

U.S. Dept. of Interior, Bureau of Mines, Division of Fuels Data
Address: Washington, DC 20241
Crude Petroleum, Petroleum Products, and Natural Gas Liquids: September 1976

Mineral Industry Surveys, monthly reports, 28 p.
29 Dec 1976
Abstract: Monthly data on the production and stocks of crude petroleum, petroleum products, and natural gas liquids are provided in these periodic reports. Over 23 tables present statistics on supply, demand, stocks, production, refining, transportation, imports, and exports of these fuels. (BYB)

U.S. Dept. of Interior, Bureau of Mines, Division of Fuels Data
Address: Washington, DC 20241
Sales of Liquefied Petroleum Gases and Ethane in 1975

Mineral Industry Surveys, annual report, 12 p.
2 Oct 1976
Abstract: Total sales of liquid petroleum gases (propane, normal and other butanes, isobutane, and butane-propane mixtures) and ethane in the U.S. declined in 1975 to 24,395 million gallons, 2.7% less than the 1974 level. Tables provide statistics on: Sales of Liquefied Petroleum Gases and Ethane in the U.S., 1971-75; Sales of Liquefied Petroleum Gases and Ethane by Use, Excluding Use in Gasoline Production, by P.A.D. District and State--1975 and 1974; Sales of Liquid Petroleum Gases by Use (residential and commercial use, internal-combustion engine fuel, industrial use, utility gas, and miscellaneous use), by Type, by P.A.D. Districts and States--1975 and 1974; Sales of Liquefied Petroleum Gases and Ethane for Chemical and Synthetic Rubber Manufacture; Sales of Liquefied Petroleum Gases and Ethane, by Type, by P.A.D. District and State--1975 and 1974; and Liquefied Petroleum Gases Exported from the U.S. by Countries, 1975-74. (BYB)

U.S. Dept. of Interior, Bureau of Mines, Division of Fuels Data
Address: Washington, DC 20241
Natural Gas Production and Consumption: 1975

Mineral Industry Surveys, annual report, 13 p.
4 Oct 1976
Abstract: Statistics on natural gas production, consumption, disposition, storage, and reserves are provided in this annual report. In 1975 marketed production of natural gas decreased 6.9% from the 1974 level to 20,109 billion cubic feet. Consumption was 20,410 billion cubic feet in 1975, down 7.7% from the previous year. Imports of natural gas totaled 953 billion cubic feet, a drop from 1974 of 0.6%, while storage of gas increased by 344 billion cubic feet. The following tables are provided: Salient Statistics of Natural Gas in the U.S.; Gross Withdrawals and Disposition of Natural Gas in the U.S.; Quantity and Value of Marketed Production of Natural Gas in the U.S.; Market Production, Interstate Shipments, and Total Consumption of Natural Gas in the U.S., 1975; Production of Natural Gas Liquids at Natural Gas Processing Plants, and Disposition of Residual Gas in the U.S. in 1974-75, by State; Consumption of Natural Gas by Use and By State, 1975; Quantity and Value of Natural Gas Delivered to Consumers in 1975, by Type of Consumer and by State; Net Interstate Movements of Natural Gas in the U.S.; Natural Gas Stored in and Withdrawal Statistics; Underground Storage Statistics; Producing Gas and Condensate Wells in the U.S.; and Estimated Total Proved Reserves of Natural Gas in the U.S. (BYB)

U.S. Dept. of Labor, Bureau of Labor Statistics
Address: Washington, DC 20212
Consumer Expenditure Survey Series: Diary Survey

Report series 448
1975; 1976
Abstract: The latest Consumer Expenditures Survey, completed in June 1974, covered the civilian noninstitutional population over a period of 2 years (1972 and 1973). This Survey is a comprehensive source of detailed information on family expenditures and income that can be classified by socio-economic and demographic characteristics of U.S. families. The Survey is comprised of two separate components: (1) a diary or recordkeeping survey, completed by respondents for two 1-week periods and (2) an interview panel survey. The sample for the survey included about 10,000 families. These Diary Survey reports present selected weekly expenditure data for July 1972 through June 1973 and for July 1973 through June 1974 for U.S. families classified by income, age of family head, race of family head, education of family head, family size, region, occupation of family head, housing tenure, family composition, and type of area. Expenditure data are listed for food for home consumption, food consumed away from home, housekeeping supplies, personal care products, personal care services, non-prescription drugs and medical supplies, gasoline, gas and electricity, and other fuels. (BYB)
Availability: Bureau of Labor Statistics, Washington, DC 20212

U.S. Dept. of Labor, Bureau of Labor Statistics
Address: Washington, DC 20212
Retail Prices and Indexes of Fuels and Utilities, Residential Usage

Monthly publication, 9 p.
Abstract: These periodic reports provide data on retail prices and indexes of fuels and utilities for residential use. Indexes reported in this publication are components of the Consumer Price Index, which measures price changes for commodities and services bought by wage earners and clerical workers in the urban U.S. These tables are included: Indexes of Retail Prices, Fuels and Utilities, by Component, U.S. Averages; Average Retail Prices for Fuel Oil No. 2 and Residential Heating Gas, U.S. Averages; Indexes of Retail Prices of All Fuels and Utilities, and Fuel Oil and Coal, by Area; Indexes of Retail Prices of Gas and Electricity Combined, Gas, Electricity, by Area; Net Monthly Bills for Specified Kilowatt Hours of Electricity by Area; Net Monthly Bills to Residential Customers for Specified Amounts of Gas, by Area; Average Price of 100 Therms of Residential Heating Gas, and 100 Gallons of Fuel Oil No. 2 by Area; and Leaded Regular, Unleaded Regular, and Premium Gasoline Indexes for the U.S. and

Selected Areas. (BYB)

U.S. Dept. of Transportation, Interagency Task
Force; U.S. Dept. of Interior; U.S. Dept. of
Commerce; Federal Energy Administration;
Energy Research and Development
Administration; U.S. Environmental Protection
Agency
Address: Washington, DC
Alaska Natural Gas Transportation System: Safety
and Design

84 p.
1 Jul 1977

Abstract: The safety and design issues in the Alaska natural gas transportation system relate primarily to how a recommended system should be designed, constructed, and operated, and to a lesser degree, where such a system should be located. This report discusses the relative safety and design merits of the three alternatives considered in the Federal Power Commission (FPC) Recommendation to the President, May 1, 1977. Each of the three systems proposed for transportation of natural gas from Alaska presents new challenges in design, construction, and planned operation. Information in the record detailing the applicants' approaches to meeting these challenges is exhaustive, and much of it has been tested for accuracy by examination, rebuttal, and argument before the FPC and by its staff. In this report, the interagency participants who analyzed the FPC Recommendation and other relevant material discuss the principal concerns which remain to be decided relative to the safety and design of an Alaska gas transportation system and make their own recommendations on these matters. ... The safety and design issue interagency task group concludes, as did the FPC, that each of the systems, assuming proper design and construction, can operate safely and reliably. Although there are special technical problems peculiar to each of the systems which cannot be resolved at this time, it is incumbent on those Federal officers or agencies who are responsible for assuring pipeline safety to do all that is necessary to ensure, before initial operation, that the selected gas transportation system is designed and constructed in a manner consistent with Federal safety standards. Additional attention will need to be devoted especially to potential problems which may arise from the operation of the pipelines at high pressures and transporting chilled gas in discontinuous permafrost as well as the specific technical innovations present in liquefied natural gas (LNG) processing and storage in an active seismic area. (from Summary)

U.S. General Accounting Office
Address: Washington, DC 20548
Improvements Still Needed in Federal Energy Data
Collection, Analysis, and Reporting. Report
to the Congress by the Comptroller General of
the United States

Report No. OSP-76-21, 55 p.
15 Jun 1976

Abstract: This document reviews recent actions affecting Federal energy data collection, analysis, and reporting, and identifies major energy data problems. On February 6, 1974, the General Accounting Office (GAO) testified before the Senate Committee on Interior and Insular Affairs on "Actions Needed to Improve Federal Efforts in Collecting, Analyzing, and Reporting Energy Data." That report concluded that legislation was needed to establish a comprehensive energy data system to be placed where it would not be influenced by energy policy analysis and formulation. This document is based on GAO's testimony before the Senate Interior Committee on March 9, 1976, which updated its earlier testimony. Included is the Statement of Assistant Comptroller General Hughes and five attachments: an Overview of GAO's February 6, 1974 Study on Energy Data; an Overview of Actions Affecting Federal Energy Data Collection and Analysis Since February 1974; a Discussion of Energy Data Problem Areas Identified in GAO's February 6, 1974 Energy Data Study; a Listing of Principal Energy Data-Related Recommendations in GAO Reports Issued since February 1974; and Specific Comments on S. 1864--Energy Information Act--with February 26, 1976, Proposed Amendment. Many basic problems identified by GAO in the 1974 report have not been resolved, and the volume of data has increased. The report recommends the establishment of a Department of Energy and Natural Resources, with an independent energy data collection component, as the best organizational solution to energy problems, including energy data problems. (BYB)

Availability: U.S. General Accounting Office,
Distribution Section, Room 4522, 441 G St.
NW, Washington, DC 20548 $1.00

U.S. General Accounting Office
Address: Washington, DC 20548
Actions Needed to Improve Federal Efforts in
Collecting, Analyzing, and Reporting Energy
Data

Report No. B-178205, 68 p.
6 Feb 1974
Sponsor: U.S. Senate, Committee on Interior and
Insular Affairs

Abstract: Upon request of the Senate Committee on Interior and Insular Affairs, the General Accounting Office undertook this study on energy data collection in the Federal government. The state of Federal energy data collection is described as "fragmented and uncoordinated." This study reports on the magnitude of the data collection efforts. At least 17 Federal agencies, comprising 45 bureaus, offices, divisions, and administrations were collectors or users of energy data. These problem areas are discussed: voluntary vs. mandatory reporting of data, credibility of data, confidentiality of data, timely reporting of data, data definitions, adequacy and completeness of data, and analysis of data. It is concluded that legislation is needed to establish a comprehensive Federal Energy Information System (within the Department of Energy and Natural Resources, if created). A first step to improving the energy data system would be to develop a single reference source or directory describing existing energy data collection efforts. (BYB)

U.S. House of Representatives, Committee on
Interior and Insular Affairs, Subcommittee on
the Environment
National Energy Conservation Policy Act of 1974,
Hearings Before the Subcommittee on the
Environment of the Committee on Interior and
Insular Affairs, House of Representatives,
Ninety-Third Congress, Second Session on
H.R. 11343

Committee Print Serial No. 93-55, hearings held
in Washington, DC, June 4, 6 and 10 and July
19 and 26, 1974, 292 p.
1974

Abstract: The testimony of 20 witnesses is presented concerning the National Energy

Conservation Policy Act of 1974, which proposes to limit the growth of energy demands to 2% per year by legislated conservation measures. The statements were unanimous in their approval of conservation as a way to help meet the energy shortage, but the ways suggested for achieving conservation differed widely. The witnesses represented industry, university economics departments, the Department of Commerce, environmental groups, fuel economy consultant groups, the Council on Environmental Quality, the Environmental Protection Agency, and consumer concern groups. Some portions of the testimony were concerned with development of alternative sources of energy that might logically result from stringent conservation measures imposed on currently used energy sources. (BLM)

U.S. House of Representatives, Committee on Ways and Means; Library of Congress, Congressional Research Service
Address: Washington, DC
Background Readings on Energy Policy. Selected Materials Compiled by the Staff of the Committee on Ways and Means with the Assistance of the Congressional Research Service

892 p.
1975
Abstract: This selection of recent articles and reports was compiled to present the House Committee on Ways and Means with information on energy issues as background for formulating a national energy program. Basic information is provided on the potential for expanding alternative energy sources and on energy conservation. The readings are organized under these categories: Energy Needs and Alternatives; Natural Gas: Supply and Policy; Tax Policy in the Energy Sector; Energy Conservation: Potentials, Policies, and Impact (including the industrial, agricultural, electrical generation, transportation, and residential/commercial buildings sectors; recycling of waste materials; alternative fuels; overall national programs; and gasoline); and International Implications. (EYP)

U.S. Senate, Committee on Energy and Natural Resources; Federal Energy Administration
Address: Washington, DC
Regulation of Domestic Crude Oil Prices

Publication No. 95-8, 95th Congress, 1st Session, 233 p.
Mar 1977
Abstract: As required by the Energy Policy and Conservation Act (EPCA), Part I of this report describes the economic and supply impacts of the President's crude oil pricing policies in effect since December 1975. Part II presents the President's Energy Action No. 11, a production incentive proposal to establish the post-ECPA rate of escalation at 10% per year as a minimum rate of increase for the remaining two years of mandatory controls (as specified under the Energy Conservation and Production Act). Impacts in 1976 of EPCA/ECPA controls include: (1) measurable savings through reductions in the price of domestic crude oil; (2) a small offset against these savings due to higher levels of demand, and, therefore, increased imports; (3) minor favorable impacts on most economic indicators; and (4) a significant adverse impact on the balance of trade. (BYB)
Availability: U.S. Senate Committee on Energy and Natural Resources

U.S. Senate, Committee on Finance
Address: Washington, DC
Energy Conservation and Conversion Act of 1975. Hearings Before the Committee on Finance, United States Senate, Ninety-Fourth Congress, First Session on H.R. 6860. Part 2 of 2 Parts

Hearings held July 15, 16, 17, and 18, 1975, pp. 461-1002
1975
Abstract: Testimony was recorded from legislators and from organizations who represented practically all phases of energy production, use, and conservation. With the exception of the sponsoring legislators, the consensus of the testimony seemed to be that restrictions on expenditure of energy imposed by H.R. 6860 are not stringent enough, and that the Bill deals inadequately with the problems of increasing energy supplies. The proposals of the Bill relating to allocations, import tariffs, and import quotas provoked much comment--often criticism. The gas and petroleum industries presented strong arguments for deregulation of prices as an energy production incentive. The inadequacy of provision for domestic energy resources was a concern of many witnesses. A panel of witnesses presented reforms of electric rate structure that would encourage energy conservation. Also, the removal of the recycling tax incentive from H.R. 6860 by the Senate was considered to be an anti-conservative action. The testimony also pointed out that conservation alone cannot solve the energy shortage, but that at best conservation could reduce energy growth to 2% annually. Communications received by the Committee expressing an interest in these hearings are appended. (BLM)
Availability: GPO $4.60

U.S. Senate, Committee on Government Operations
Address: Washington, DC
Establish a Department of Energy and Natural Resources. Hearings Before the Committee on Government Operations, U.S. Senate, Ninety-Third Congress, First Session on S. 2135

Hearings held July 31, August 1, and September 13, 1973, 233 p.
1974
Abstract: These hearings were held to consider S. 2135, President Nixon's proposal to establish a Department of Energy and Natural Resources and an independent Energy Research and Development Administration. The Department would have consisted of units from five departments and two agencies and would have had a budget of $5.3 billion and more than 90,000 employees. ERDA would have contained units from one department and one agency, and would have had a budget of $2.3 billion and 6,500 employees. This reorganization was proposed to do away with the conflict, duplication, and overlap in energy and natural resources programs. Witnesses included the following: Roy L. Ash, Director of the Office of Management and Budget; John A. Love, Director of the Energy Policy Office; and John C. Whittaker, Under Secretary of the Interior Department; Dixy Lee Ray, Chairman of the Atomic Energy Commission; Dr. Robert White, Administrator of the National Oceanic and Atmospheric Administration; Charles R. Ford, Chief of Civil Functions of the Army Department; J. Phil Campbell, Under Secretary of the Agriculture Department; Donald B. Craft, Vice President of Wyatt, Inc.; and John A. Kaneb, President of Northeast Petroleum Industry, Inc. In addition to testimony, the hearings include several exhibits, e.g., the text of

S. 2135, statements, letters, etc. (BYB)
Availability: GPO $1.80, Stock No. 5270-02215

U.S. Senate, Committee on Governmental Affairs
Address: Washington, DC
Department of Energy Organization Act. Report of the Committee on Governmental Affairs, United States Senate, to Accompany S. 826

Report No. 95-164, 55th Congress, 1st Session, 125 p.
1977

Abstract: The primary aim of S. 826 is to establish a permanent, Cabinet-level Department of Energy in the executive branch and to merge all the major Federal energy programs in the DOE. DOE would include these major components: the Federal Energy Administration; the Energy Research and Development Administration; the Federal Power Commission; certain programs and functions from the Department of Interior; statutory authority for the development and promulgation of new building energy conservation standards and authority to undertake a national energy conservation demonstration program now vested in the Secretary of Housing and Urban Development; Commerce Department programs to promote voluntary industrial energy conservation; jurisdiction over the administration of the three naval petroleum reserves in California and Wyoming, and three naval oil shale reserves in Colorado and Utah, now administered by the Defense Department; and authority now vested in the Interstate Commerce Commission to regulate oil pipelines. The Department of Transportation would continue to have primary responsibility for the promulgation of automobile efficiency standards. The internal structure of DOE would include these Presidentially appointed officers (subject to the advice and consent of the Senate): a Secretary, a Deputy Secretary, two Under Secretaries, and eight Assistant Secretaries. S. 826 also establishes an Economic Regulatory Administration, an Energy Information Administration, and an Energy Regulatory Board. (BYB)
Availability: GPO

U.S. Senate, Committee on Governmental Affairs
Address: Washington, DC
Department of Energy Organization Act. Hearings Before the Committee on Governmental Affairs, United States Senate, Ninety-Fifth Congress, First Session on S. 826 and S. 591

Hearings held March 7, 9, 15, 16, 17, 18, 22, 24, 25, 29, 31 and April 8, 1977, 1322 p.
1977

Abstract: These hearings focus on two bills that would reorganize the Federal government's energy functions: S. 826, President Carter's proposal to establish a Department of Energy in the executive branch; and S. 591, introduced by Senator Percy, which would create a Department of Energy Supply and Natural Resources. S. 826 would merge the primary energy agencies (the Energy Research and Development Administration, the Federal Energy Administration, and the Federal Power Commission) and energy functions of the Interior Department and other departments and agencies in the executive branch. Witnesses included: James R. Schlesinger; John F. O'Leary, Administrator of FEA; Cecil D. Andrus, Secretary of the Interior; Richard L. Dunham, Chairman of the Federal Power Commission; Stewart L. Udall, former Secretary of the Interior; Elmer B. Staats, Comptroller General of the U.S.; Robert W. Fri, Acting Administrator of ERDA; Orcutt P. Drury, Acting Director of the Office of Energy Programs of the Commerce Department; John J. Bennett, Assistant Secretary for Naval Installations and Logistics of the Navy Department; and George M. Stafford, Chairman of the Interstate Commerce Commission. Testimony was also heard from two former FPC Chairmen, three governors, representatives of citizen's groups, and representatives of energy industries and energy-related industry associations. (BYB)
Availability: GPO

U.S. Senate, Committee on Interior and Insular Affairs
Address: Washington, DC
Home Heating Oil. Hearing Before the Committee on Interior and Insular Affairs, United States Senate, Ninety-Fifth Congress, First Session

Publication No. 95-12, 95th Congress, 1st Session, hearing held February 10, 1977, 265 p.
1977

Abstract: The purpose of this hearing was to review a proposed Federal Energy Administration ruling which would grant entitlements to importers of No. 2 fuel oil (home heating oil). This entitlement program would transfer money from firms using U.S. oil to firms importing foreign No. 2 fuel oil, in order to equalize the cost of fuel oil among all domestic refiners. Witnesses included representatives of the New England Congressional Caucus, the southern caucus, oil companies, refiners, the Federal Energy Administration, and the Petroleum Industry Research Foundation. (BYB)
Availability: GPO

U.S. Senate, Committee on Interior and Insular Affairs, Special Subcommittee on Integrated Oil Operations; Cornell Univ., Energy Industry Study Group
The Structure of the U.S. Petroleum Industry: A Summary of Survey Data. Prepared for the Chairman, Special Subcommittee on Integrated Oil Operations of the Committee on Interior and Insular Affairs, United States Senate, Pursuant to S. Res. 45

Committee Print Serial No. 94-37 (92-127), Ninety-Fourth Congress, Second Session, 460 p.
1976

Sponsor: National Science Foundation, RANN Program; Library of Congress, Congressional Research Service

Abstract: This report summarizes the results of a survey of 63 petroleum companies, including the 20 largest, and provides a basic description of the structure of the petroleum industry. The survey requested information on directorate affiliations; acquisitions and mergers; ownership; subsidiary holdings; association with legal, accounting, and financial groups; joint activities in oil and gas exploration, production, refining, and transportation; marketing; and operations in coal and uranium. The 63 responding companies included 12 vertically integrated firms, 38 independents, and 19 subsidiaries; 46 of these companies have foreign operations, and 17 have an interest in coal, uranium, or geothermal operations. Major findings of this study include the following: (1) although mergers and acquisitions since 1954 have been significant in magnitude and number, the 20 largest companies have remained unchanged; (2) direct directorate affiliations between competing petroleum companies were infrequent, but many indirect affiliations exist; (3) because ownership data are generally in a nominee form, the recording of actual or beneficial ownership is precluded; (4) sharing of debt holders among the 20 largest oil companies is high; (5) subsidiary data are insufficient to describe interactions; (6) multiple affiliations by accounting firms are common, but almost nonexistent with law firms; (7) due to insufficient financial data, the impact of Federal tax subsidies on industry production and investment can not be determined; (8) joint ownership of oil production and wells is common for both large and small companies; (9) state concentration in refinery ownership is much greater than national concentration; (10) the measure of concentration normally used for the petroleum industry results in lesser concentration and cooperation than any other possible measure; (11) petroleum companies control a significant amount of coal production and reserves, and 7 of the 15 largest coal companies are owned by petroleum companies; and (12) 95% of uranium milling capacity is affiliated with petroleum companies. (BYB)

Availability: GPO $3.95

Ultrasystems Inc.
Address: 500 Newport Center Drive, Newport Beach, CA 92660
A Market Study of Energy-Related Equipments for the Commercial Buildings Sector: Decision-Makers, Buying Process, and Marketing Strategies

Report No. PB-248618, FEA/D-76/010, 154 p.
19 Sep 1975
Sponsor: Federal Energy Administration, Office of Energy Conservation and Environment, Office of Buildings Programs

Abstract: The report provides detailed information about the market for conservation practices in the commercial buildings sector that may be stimulated or supported by Federal government actions and initiatives. The first section describes, within the limits of available data, the commercial building sector, both existing and projected through 1980, and lists levels of energy consumption in each segment of the commercial buildings sector. Section 2 describes key decision-makers involved in the buying and adoption process used for energy-related equipment, both new and retrofit. The final section uses the study's findings to describe existing market approaches, decision processes, and areas of concentration for energy conservation, and then makes recommendations for Federal strategies to encourage energy conservation practices. (26 references) (GRA)

Availability: NTIS

United Nations Secretariat, Dept. of Economic and Social Affairs, Population Division
Selected World Demographic Indicators by Countries, 1950-2000

Report No. ESA/P/WP.55
28 May 1975

Abstract: This is the second of a series of working papers which gives the results of revised population projections as assessed in 1973. This report presents 26 selected demographic indicators for the 187 countries, regions, major geographical areas, more and less developed regions, and the world, which would have the broadest use for Governments, institutions, and individuals interested in population data. The period covered in this report is 1950-2000. Figures for the period 1950-1970 have been drawn from various official and non-official sources. They have been adjusted by the United Nations Population Division in order that they may be presented in a uniform manner. The figures for the period 1970-2000 include the assumptions used in the revised population projections and measures derived from the projected populations. For each country and region, three variants of projections, namely "medium", "high" and "low" are shown. It should be noted that only one variant has been prepared for 1950-1970, and the figures given for the three different variants in this period are, therefore, the same. Each country or area is given in a single page. No data have been given separately for the small countries or areas which had 250,000 population or less in mid-1970. (from introduction)

Vachon, R.I.; Long, R.E.; Humphries, W.R.; O'Brien, J.F.
Auburn Univ., School of Engineering
Address: Auburn, AL
ECASTAR - Energy Conservation: An Assessment of Systems, Technologies and Requirements

Report No. FEA/D-76/341, 779 p.
Sep 1975
Sponsor: National Aeronautics and Space Administration; Federal Energy Administration, Office of Energy Conservation and Environment, Office of Planning, Analysis and Evaluation; American Society for Engineering Education

Abstract: ECASTAR presents a methodology for a systems approach display and assessment of the potential for energy conservation actions and the impacts of those actions. The U.S. economy is divided into four sectors--energy industry, industry, residential/commercial, and transportation. Each sector is assessed with respect to energy conservation actions and impacts. The four sectors are combined and three strategies for energy conservation actions for the combined sectors are assessed. The three strategies (national energy conservation, electrification, and diversification) represent energy conservation actions for the near term (now to 1985), the mid term (1985 to 2000), and the far term (2000 and beyond). A feature of the assessment methodology is the identification of targets of opportunity for large net energy savings and the application of technology to achieve these savings. In addition, citizen's actions for energy conservation are discussed. (280 references) (GRA)

Availability: NTIS

Verleger, P.K., Jr.
Data Resources Inc.; Ford Foundation, Energy Policy Project
An Econometric Analysis of the Relationship Between Macro Economic Activity and U.S. Energy Consumption

Paper presented for a Seminar on Energy Modeling, January 25-26, 1973, Washington, DC, Sponsored by Resources for the Future, Inc., p. 62-102
Mar 1973
Sponsor: Resources for the Future Inc.

Abstract: In this paper, we have sketched the outline of a macro econometric model of the U.S. economy specified to incorporate the changing relationships between labor, capital and resources. Further, a link between this long term model and other short term econometric forecasting models through an energy balance model was discussed. Two sectors of this model, which in total encompass energy consumption and production of all sectors, were discussed in detail. The estimates of the consumption functions indicated that models which exclude the

relative price of energy in consumption and production do so incorrectly, at least in some sectors, and that relative price increases may ease some of the energy crisis. (Auth Conclusion)
Availability: Resources for the Future, Inc., 1755 Massachusetts Ave. NW, Washington, DC 20036 ($5.00 for entire proceedings)

Verleger, P.K., Jr.
Data Resources Inc.
Address: 29 Hartwell Ave., Lexington, MA 02173
The Residential Demand for Energy: Estimates of Residential Stocks of Energy Using Capital. Volume II

Report No. EPRI EA-235, Research Project 431-1, 123 p.
Jan 1977
Sponsor: Electric Power Research Institute
Abstract: A program of research into the demand for residential energy requires the construction of an adequate data base on the stock of energy using capital. This report details the procedures used to assemble such a data base. The development of data on housing stocks was the most important element of this analysis. Bureau of the Census figures were available for 1960 and 1970. Two methods were used to obtain annual estimates of the stock. In the first, data on housing permits authorized were used as investment and a constant rate of depreciation was assumed. The second employed an adjusted annual change in the number of residential electric customers as a proxy for investment and depreciation. These methods yielded substantially similar results. Stocks of refrigerators, home freezers, room air conditioners, electric ranges, water heaters, automatic washers, conventional washers and electric dryers were estimated by benchmarking annual state saturation rates obtained from Merchandising Week to decennial saturation rates obtained from the Census and multiplying these saturation rates by the stock of houses. This study was hampered by a lack of information on the number of appliances held by consumers, and on the age distribution, size distribution, and historical utilization rates of these appliances. Fortunately, enough data were collected to allow for the construction of a reasonable data set on appliance stocks. However, we were unable to gather adequate data to construct estimates of the age, size, or usage types of capital. To correct this deficiency, it would be necessary for some agency to undertake the development of periodic systematic censuses of consumer holdings of capital. (auth)
Availability: Electric Power Research Institute, 3412 Hillview Ave., Palo Alto, CA 94304

Villecco, M. (ed.)
American Institute of Architects; AIA Research Corp.
Address: AIA, 1735 New York Avenue NW, Washington, DC 20006
Energy Conservation in Building Design

156 p.
1974
Sponsor: Ford Foundation
Abstract: Measures that architects can use to conserve energy are presented. Building systems are responsible for over one-third of the nation's total energy consumption, with residential buildings using 19.2% and commercial buildings using 14.4%. Recent legislative proposals that have suggested prescriptive building practices to conserve energy are criticized, because they do not consider overall building system performance criteria. Under a section entitled "Physical Design Alternatives," areas of the building process in which energy savings can be achieved are outlined, and trade-offs to be considered in choosing one measure over another are described. Specific physical design alternatives are discussed for site analysis, building orientation, configuration, envelope, space planning, transportation, ventilation, heating, cooling, electric power, lighting, domestic hot water, and waste management. Alternate power sources, particularly solar energy and wind power, are examined. The Appendix contains information on energy consumption in the United States, energy conservation in the built environment: a gap in current strategies, energy flow diagrams, and selected projects. (33 references) (BTB)
Availability: American Institute of Architects, 1735 New York Avenue NW, Washington, DC 20006 $5.00

Vogely, W.A.
U.S. Dept. of Interior, Bureau of Mines
Pattern of Energy Consumption in the United States

Paper presented at 149th National Meeting of the American Chemical Society; American Chemical Society Preprints, 9(2), 205-221
1965
Abstract: The pattern of flows of energy through the economy of the United States is an ever changing one. Major shifts in sources of energy and in the uses to which energy is put have occurred since the beginning of our industrial economy. This paper is limited to an examination of the post-war period. Within this decade and a half (1947-1962) there were factors which created a very different set of energy flows for 1962 from that of 1947. These changes will be examined, hypotheses concerning them will be presented, and projections to 1980 of the pattern will be made. Such an analysis should serve as a useful frame of reference for papers dealing with specific energy sources. Two views of the energy economy are presented in tables. The first shows total energy resource consumption by consuming sector by source. The second shows energy resource consumption by consuming sector by function. Projections to 1980 are given for each view. The concluding portion of this paper presents a tentative hypothesis concerning competition among energy sources and energy trends. (auth)

Vogely, W.A.; Morrison, W.E.
U.S. Dept. of Interior, Bureau of Mines
Patterns of U.S. Energy Consumption to 1980

IEEE Spectrum, 4(9), pp. 61-86 (Sept. 1967)
Sep 1967
Abstract: Total energy consumption in the United States is presented for 1947 and 1965, together with extrapolation to 1980. Data are tabulated by type of user and by source of energy. Use by electric utilities is growing faster than any other type. (JMC)

Watson, D.
Sunworks Inc.
Address: 669 Boston Post Rd., Guilford, CT 06437
Energy Conservation in Architecture. Part 1: Adapting Design to Climate

Reprinted from the March-April issue of the Connecticut Architect, adapted from remarks to the Joint Producers Council-CSA Chapter Meeting in March 1974, 5 p.

1974
Abstract: A review of climate conditions and both traditional and new architectural designs to deal with these conditions is presented. The suggestions focus on individual housing, but the architectural suggestions are just as applicable to multi-family housing or commercial buildings. Some of the designs are fairly simple. The object of all suggestions is to aid in design and construction of buildings for long-term use, for user comfort, and for total resource conservation--particularly energy conservation. Some of the devices discussed are insulation (interior insulating panels for windows as well as walls), fireplace designs, solar heating and cooling, natural ventilation, window placement, and even earth berm or underground houses. (15 references) (BLM)
Availability: Sunworks, Inc., 669 Boston Post Rd., Guilford, CT 06437 $0.50

West, J.A.
U.S. Dept. of Interior
Address: Washington, DC 20240
Techniques Used in Developing the U.S. Department of the Interior Energy Forecast, United States Energy Through the Year 2000

Paper presented for a Seminar on Energy Modeling, January 25-26, 1973, Washington, DC, sponsored by Resources for the Future Inc., pp. 294-303
Mar 1973
Sponsor: Resources for the Future Inc.
Abstract: The main purpose of this report was to assess and forecast future United States energy demand and supply as accurately as possible in order to assist in the development of policies and programs to assure that national energy requirements are most efficiently met. The methodology employed was to quantify the principal components of energy demand by major consuming sectors, by primary fuels and energy sources, and by secondary form on an historical basis. These components were correlated with major economic indicators, such as Gross National Product, and other available determinants of sectorial energy demand. Projections and integrated energy balances were then prepared for each of the time periods using separate forecasts for gross and net energy, for the four major consuming sectors and an expected synthetic gas sector, for the forms of energy finally consumed, and for each of the energy sources. Assessments of potential supply constraints were made and the projections were adjusted and revised to reconcile supply-demand differences. (Auth)
Availability: Resources for the Future, Inc., 1755 Massachusetts Ave. NW, Washington, DC 20036 ($5.0C for entire proceedings)

Wheeler, J.; Graubard, M.; Acton, J.P.
Rand Corp.
Address: Santa Monica, CA
How Business in Los Angeles Cut Energy Use by 20 Percent, Preliminary Research Results of a Rand Study

Report No. WN-8866-2-FEA, 20 p.; also published as P-5417 in April 1975
Jan 1975
Sponsor: Federal Energy Administration, Office of Energy Conservation and Environment
Abstract: The plan used by Los Angeles during the winter of 1973-74 to reduce electrical consumption by approximately 20% is outlined. The plan included a two-phase cutback with severe penalties: a 50% surcharge on the entire bill for the first over usage, a two-day power shut-off for the second violation, and a five-day power shut-off for the third violation. Certain prohibitions or restrictions, such as decorative outdoor lighting and motors for fountains and moving signs, in addition to the percentage reduction in consumption were also set forth in the plan. As a whole, the commercial sector produced most of the total curtailment in usage as compared to the residential and industrial sectors of the city. Specific plans for how eight different classes of commercial buildings curtailed usage are included in the report. (BLM)
Availability: GPO $.65, Stock No. 041-018-00042

Wilder, R.P.; Willenborg, J.F.
South Carolina Univ.
Address: Columbia
Residential Demand for Electricity: A Consumer Panel Approach

Southern Economic Journal, 42(2), pp. 212-217 (Oct. 1975)
Oct 1975
Abstract: Estimates of price elasticity based on a metropolitan household model suggest that, contrary to utility company views, electricity could be effectively rationed by raising the price. Relationships between size of residence, numbers of appliances, electricity demand, and electricity price indicate that the size of a residence and its stock of appliances correlate with family size, income, and race. Comparisons with past elasticity estimates suggest that electricity demand is determined more by income than by number of persons in a household. Energy consciousness and rising prices could result in middle and upper income families choosing smaller, more efficient residences. (DCK)

Williams, J.S., Jr.; Murray, R.S.
MetroStudy Corp.
Address: 1012 14th Street NW, Washington, DC 20005
Commercial Floor Space: An Analysis of the Methodologies Used to Estimate the National Inventory

Report No. PB-248900, 75 p.
Sep 1975
Sponsor: Federal Energy Administration, Office of Energy Conservation and Environment, Office of Buildings Programs
Abstract: The report presents a technical survey of the methods used to prepare commercial space inventories in the United States. The document includes a comprehensive collection of published inventories of commercial space, along with evaluations of the methodologies used in each, and appraisals of their reliability. In addition, the authors have made recommendations for further commercial space inventory studies. (GRA)
Availability: NTIS

Woroniak, A.; Murphy, J.J.
Infodyne Systems Corp.
Address: 1000 Falls Road, Potomac, MD 20854
Economic Impact Study of the Appliance Efficiency Program

Report No. PB-251665, FEA/D-76/077, 281 p.
30 Jun 1975
Sponsor: Federal Energy Administration, Office of Energy Conservation and Environment, Office of Appliance Programs
Abstract: The objective of this report is to analyze the economic impact of the technical

improvements that would have to be incorporated into major household appliances to make 1980 models of such appliances provide the same level of performance as 1972 models, but require on the average 20% less energy to operate. One consequence foreseen from such an improvement in energy efficiency was the saving by 1985 of over one half million barrels of oil per day. The appliances covered by the efficiency program are: room air conditioners; electric and gas water heaters; refrigerators and refrigerator/freezers; freezers; electric and gas ranges; electric and gas dryers; washers; dishwashers; and black and white and color televisions. Specific energy efficiency goals for 1980 are listed for each type of appliance. (40 references) (from Executive Summary)

Availability: NTIS

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