AIIM

Association for Information and Image Management

1100 Wayne Avenue, Suite 1100
Silver Spring, Maryland 20910

301/587-8202

Centimeter

Inches

MANUFACTURED TO AIIM STANDARDS

BY APPLIED IMAGE, INC.

ORNL-6798
(Edition 14 of ORNL-5198)

Center for Transportation Analysis

Energy Division

TRANSPORTATION ENERGY DATA BOOK:

EDITION 14

Stacy C. Davis

May 1994

Prepared for
Office of Transportation Technologies
U.S. Department of Energy

Prepared by
OAK RIDGE NATIONAL LABORATORY
Oak Ridge, Tennessee 37831
managed by
MARTIN MARIETTA ENERGY SYSTEMS, INC.
for the
U.S. DEPARTMENT OF ENERGY
under Contract No. DE-AC05-84OR21400

Users of the Transportation Energy Data Book are encouraged to comment on errors, omissions, emphases, and organization of this report to one of the persons listed below. Requests for additional copies of this report, additional data, or information on an existing table should be referred to Ms. Stacy Davis, Oak Ridge National Laboratory.

Stacy C. Davis
Oak Ridge National Laboratory
P. O. Box 2008
Bldg. 5500A, MS 6366
Oak Ridge, Tennessee 37831-6366
Telephone: (615) 574-5957
FAX (615) 574-3851

Philip D. Patterson
Office of Transportation Technologies
Department of Energy, EE-30
Forrestal Building, Room 6B-094
1000 Independence Avenue, S.W.
Washington, D.C. 20585
Telephone: (202) 586-9121
FAX (202) 586-1637

TABLE OF CONTENTS

TABLE OF CONTENTS
(continued)

Page

TABLE OF CONTENTS
(continued)

TABLE OF CONTENTS
(continued)

TABLE OF CONTENTS
(continued)

TABLE OF CONTENTS
(continued)

TABLE OF CONTENTS
(continued)

Page

LIST OF FIGURES

Page

LIST OF FIGURES
(continued)

LIST OF FIGURES
(continued)

ACKNOWLEDGEMENTS

I wish to express my gratitude to the many individuals who assisted in the preparation of this document. First, I would like to thank Philip D. Patterson and the staff of the Office of Transportation Technologies for their continued support of the Transportation Energy Data Book. This document also benefits from the criticism and careful review of Phil Patterson of the U.S. Department of Energy, John Maples and Robert Gibson of the University of Tennessee, and Patricia Hu, Bruce Peterson, Frank Southworth, Jerry Hadder, and Mike Bronzini of Oak Ridge National Laboratory (ORNL). I would also like to thank An Lu of Oak Ridge Associated Universities for generating statistics from the ORNL MPG and Market Shares Data Base.

In addition, I would like to acknowledge the contributions of Sherry Campbell of the Health, Safety, Environment, and Accountability Division for the preparation of the title index and Daniel Pack of the Energy Division for the new cover design. Finally, I am **indebted** to Maggie Bruer for the preparation of the manuscript. Other contributors to manuscript preparation were Debbie Bain, Leigh Ann Daniel, and Karen Vogel.

ABSTRACT

The Transportation Energy Data Book: Edition 14 is a statistical compendium prepared and published by Oak Ridge National Laboratory (ORNL) under contract with the Office of Transportation Technologies in the Department of Energy (DOE). Designed for use as a desk-top reference, the data book represents an assembly and display of statistics and information that characterize transportation activity, and presents data on other factors that influence transportation energy use. The purpose of this document is to present relevant statistical data in the form of tables and graphs. Each of the major transportation modes is treated in separate chapters or sections. Chapter 1 compares U.S. transportation data with data from other countries. Aggregate energy use and energy supply data for all modes are presented in Chapter 2. The highway mode, which accounts for over three-fourths of total transportation energy consumption, is dealt with in Chapter 3. Topics in this chapter include automobiles, trucks, buses, fleet vehicles, federal standards, fuel economies, and high-occupancy vehicle lane data. Household travel behavior characteristics are displayed in Chapter 4. Chapter 5 contains information on alternative fuels and alternatively-fueled vehicles. Chapter 6 covers the major nonhighway modes: air, water, and rail. The last chapter, Chapter 7, presents data environmental issues relating to transportation.

INTRODUCTION

In January 1976, the Transportation Energy Conservation (TEC) Division of the Energy Research and Development Administration contracted with Oak Ridge National Laboratory (ORNL) to prepare a Transportation Energy Conservation Data Book to be used by TEC staff in their evaluation of current and proposed conservation strategies. The major purposes of the data book were to draw together, under one cover, transportation data from diverse sources, to resolve data conflicts and inconsistencies, and to produce a comprehensive document. The first edition of the TEC Data Book was published in October 1976. With the passage of the Department of Energy (DOE) Organization Act, the work being conducted by the former Transportation Energy Conservation Division fell under the purview of the DOE's Office of Transportation Programs (now the Office of Transportation Technologies). DOE, through the Office of Transportation Technologies, has supported the compilation of Editions 3 through 14.

Policymakers and analysts need to be well-informed about activity in the transportation sector. The organization and scope of the data book reflect the need for different kinds of information. For this reason, Edition 14 updates much of the same type of data that is found in previous editions.

Chapter 1 contains information which compares U.S. transportation data with data from selected countries in Asia, Europe, and North America. Chapter 2, Transportation Energy Characteristics, presents aggregate energy use data for each of the major transportation modes (i.e., highway, air, water, pipeline, and rail), as well as related statistics on the price and supply of transportation fuels. Chapter 3 covers detailed statistics on three major highway modes: automobiles, trucks, and buses. Also contained in this chapter is information on fleets, federal standards, fuel economies of highway vehicles, and high-occupancy vehicle lanes. Household travel behavior characteristics are displayed in Chapter 4. Chapter 5 presents data on alternative fuels and alternatively-fueled vehicles, and Chapter 6 consists of data for the major nonhighway modes: air, water, and rail. A new chapter to the data book series, Chapter 7, contains information on environmental issues which are pertinent to the transportation industry. Sources used represent the latest available data.

In any attempt to compile a comprehensive set of statistics on transportation activity, numerous instances of inadequacies and inaccuracies in the basic data are encountered. Where such problems occur, estimates are developed by ORNL. To minimize the misuse of these statistics, an appendix (Appendix A) is included in this edition to document the estimation procedures. The attempt is to provide sufficient information for the conscientious user to evaluate the estimates and to form his or her own opinions as to their utility. Clearly, the accuracy of the estimates cannot exceed the accuracy of the primary data, an accuracy which in most instances is unknown. In cases where data accuracy is known or substantial errors are strongly suspected in the data, the reader is alerted. In all cases it should be recognized that the estimates are not precise.

The majority of the statistics contained in the data book are taken directly from published sources, although these data may be reformatted for presentation by ORNL. Consequently, neither ORNL nor DOE endorses the validity of these data.

Edition 14 of the Transportation Energy Data Book includes over 200 pages of tables and figures. To facilitate use of this information, several aids in format and presentation techniques are included. Statistical highlights from the data book precede this introduction, and a synopsis of chapter contents is provided at the beginning of each chapter. Some of the average rates of change in the data book are calculated using 1982 as a base year. This is because an oil embargo was affecting the economy in 1982, and the year was chosen as a year of economic recession.

CHAPTER 1

INTERNATIONAL TRANSPORTATION STATISTICS

This chapter includes statistics related to the transportation sector of selected countries. Countries were included based on data availability, geographical distribution, and transportation fuel use as a percentage of total refined petroleum consumption. The statistics presented for the United States in this chapter are from international sources and are only for use in international comparisons. The numbers may differ slightly from data presented in other chapters of the book.

In 1950, 76% of the world's automobiles were registered in the United States; by 1991, that percentage had dropped to 31.3% (Table 1.1). The U.S. had a lower annual growth rate in automobile registrations from 1950 to 1990 than any of the other listed countries except Sweden, for which data are not available for the years 1950 to 1970. The U.S. also accounts for 32.6% of the world's truck and bus registrations. Japan has experienced the largest growth in truck and bus registrations since 1950, 12.5% annually (Table 1.2).

The data on gasoline prices indicate that Italy has had the highest gasoline prices since 1982, while the U.S. has had the lowest of the listed countries (Table 1.3). Italy's high gasoline prices in 1992 were mainly due to the gasoline tax (Figure 1.2). In 1990 over 50% of the diesel price could be attributed to tax in four countries - Italy, France, the United Kingdom, and West Germany (Figure 1.3).

Data from the Lawrence Berkeley Laboratory (LBL) are contained in Tables 1.5 through 1.10. These data are generated by LBL using sources from various countries:

Japan -	The Institute of Energy Economics, Japan;
France -	Agence Francaise pour la Matrise d'Energie, now Agence d'Environment et Matrise de L'Energie;
Italy -	Data provided by Agip Petroli, 1990 (private communication) and Italstat, National Accounts of Transportation;
Sweden -	Transport Raadet (Transportation Council), National Board of Industry, Energy Board, and Ministry of Communications and Transport;
UK -	Digest of Transport Statistics, Energy Technology Support Unit, D. Martin (private communication);

Germany - "Verkehr in Zahlen" ("Transportation in Figures," published by the Ministry of Transport) compiled by Deutsches Institut fuer Wirtschaft, Berlin;

US - Data from various tables and editions of the Transportation Energy Data Book, Oak Ridge National Laboratory;

Norway - Transport Oekonomisk Institut, various publications; Norsk Esso (private communication);

Denmark - Ministry of Traffic (formerly Ministry of Public Works) data books and Energistyrelsen (Danish Energy Agency).

Details on the methodology for compiling these data can be found in "Energy Efficiency and Human Activity," by Lee Schipper, Steve Meyers, et. al., Cambridge University Press, Cambridge, MA, 1992, the "Proceedings of the ACEEE Conference on Automobiles and the Greenhouse Effect," and "New Car Test and Actual Fuel Economy: Yet Another Gap?" by Lee Schipper and Wienke Tax, 1993.

Table 1.1
Automobile Registrations for Selected Countries, 1950-91
(thousands)

	Asia	Europe					North America		U.S.		
Year	Japan	France	Italy	Sweden	United Kingdom	West Germany	Canada	United States	percentage of world	All other countries[a]	World total
1950	43	[b]	342	[b]	2,307	[b]	1,913	40,339	76.0%	8,107	53,051
1955	153	[b]	861	[b]	3,609	1,821	2,961	52,145	71.4%	11,486	73,036
1960	457	4,950	1,976	[b]	5,650	4,559	4,104	61,671	62.7%	14,938	98,305
1965	2,181	8,320	5,473	[b]	9,131	9,043	5,279	75,258	53.8%	25,091	139,776
1970	8,779	11,860	10,181	[b]	11,802	13,299	6,602	89,244	46.1%	41,712	193,479
1975	17,236	15,180	15,060	2,760	14,061	16,764	8,870	106,706	41.0%	63,564	260,201
1980	23,660	18,440	17,686	2,883	15,438	21,455	10,256	121,601	38.0%	88,971	320,390
1981	24,612	19,130	18,603	2,893	15,633	21,812	10,199	123,098	37.2%	94,819	330,799
1982	25,539	19,750	19,616	2,936	17,644	22,086	10,530	123,702	36.4%	98,463	340,266
1983	26,385	20,300	20,389	3,007	18,108	22,624	10,732	126,444	35.9%	104,043	352,032
1984	27,114	20,600	20,888	3,081	18,532	23,193	10,781	128,158	35.1%	112,758	365,105
1985	27,845	20,800	22,495	3,151	18,953	23,777	11,118	131,864	35.2%	114,480	374,483
1986	28,654	21,090	23,495	3,253	19,415	24,700	11,586	135,431	35.1%	118,726	386,350
1987	29,478	21,500	24,320	3,367	20,108	25,558	11,686	137,324	34.9%	120,689	394,030
1988	30,776	21,970	25,290	3,483	20,977	26,228	12,086	141,252	34.2%	130,845	412,907
1989	32,621	22,520	26,267	3,578	21,919	26,914	12,380	143,081	33.7%	135,086	424,366
1990	34,924	23,010	27,300	3,601	22,528	27,218	12,622	143,550	32.3%	150,147	444,900
1991	37,076	23,550	28,200	3,619	22,744	27,484	13,061	142,956	31.3%	157,343	456,033
					Average annual percentage change						
1950-91	17.9%	3.9%[c]	11.4%	[b]	5.7%	6.8%[d]	4.8%	3.1%		7.5%	5.4%
1970-91	7.1%	3.3%	5.0%	1.3%[e]	3.2%	3.5%	3.3%	2.3%		6.5%	4.2%
1982-91	4.2%	2.0%	4.1%	2.4%	2.9%	2.5%	2.4%	1.6%		5.3%	3.3%

Source:
Motor Vehicle Manufacturers Association, World Motor Vehicle Data, 1993 Edition, Detroit, MI, 1993, pp. 23, 75, 136, 159, 181, 224, 250, 307,335, and annual.

[a]Automobile registrations for all other countries were calculated by subtracting listed countries' registrations from the world total.
[b]Data are not available.
[c]Average annual percentage change is for 1960-91.
[d]Average annual percentage change is for 1955-91.
[e]Average annual percentage change is for 1975-91.

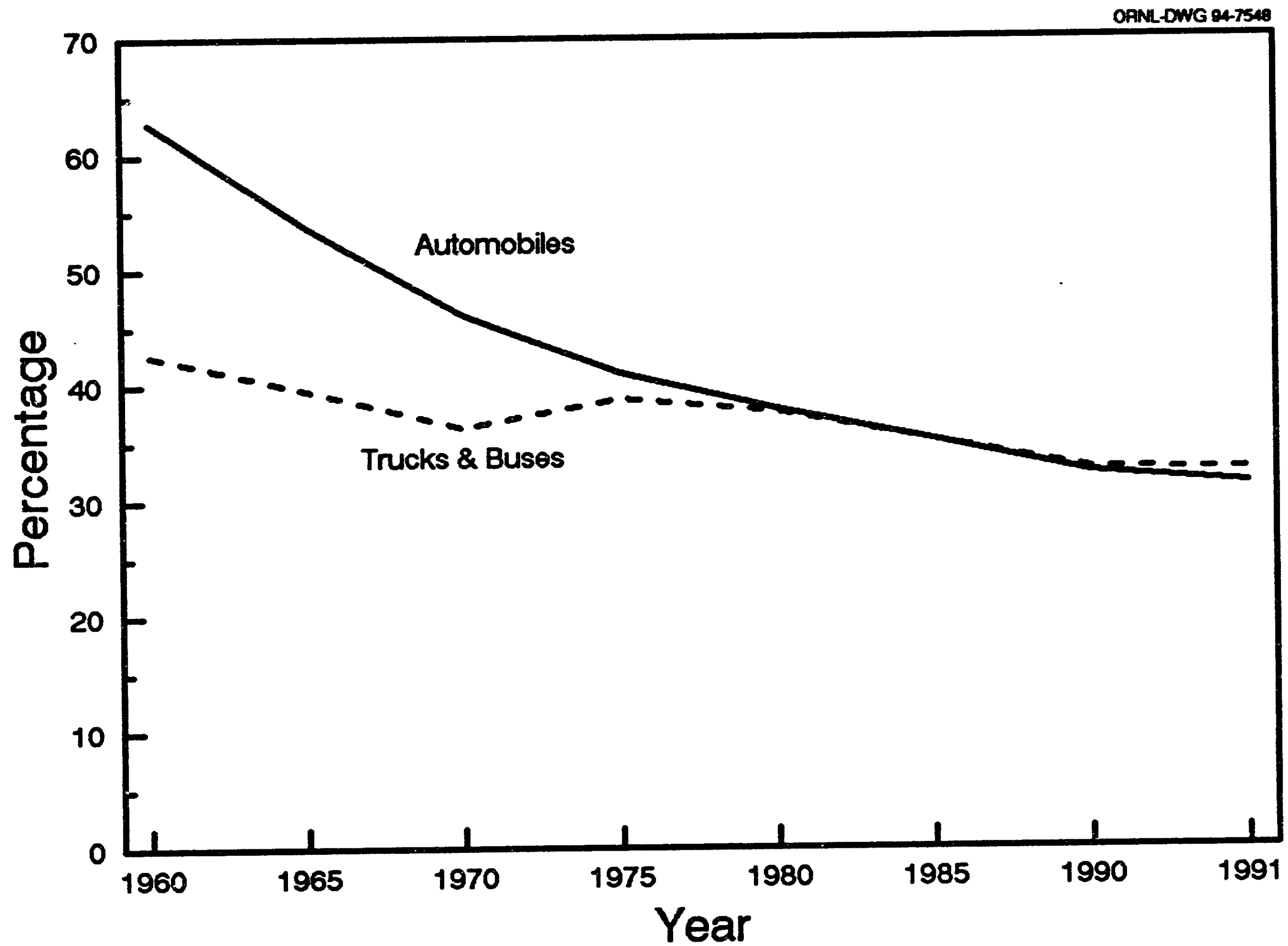
Table 1.2
Truck and Bus Registrations for Selected Countries, 1950-91
(thousands)

Year	Asia	Europe					North America		U. S. percentage of world	All other countries[a]	World total
	Japan	France	Italy	Sweden	United Kingdom	West Germany	Canada	United States			
1950	170	[b]	235	[b]	1,060	[b]	643	8,823	50.9%	6,418	17,349
1955	285	[b]	335	[b]	1,244	760	952	10,544	46.1%	8,740	22,860
1960	832	1,540	455	[b]	1,534	1,079	1,056	12,186	42.6%	9,901	28,583
1965	3,968	1,770	664	[b]	1,748	1,690	1,232	15,100	39.6%	11,946	38,118
1970	8,470	1,850	929	[b]	1,769	2,298	1,481	19,175	36.2%	16,927	52,899
1975	10,270	2,210	1,193	171	1,934	2,725	2,158	26,243	38.8%	20,794	67,698
1980	13,407	2,550	1,429	194	1,920	3,385	2,955	34,195	37.7%	30,557	90,592
1981	14,187	2,575	1,547	199	1,890	3,501	3,192	35,188	36.5%	34,126	96,405
1982	14,947	2,716	1,642	207	3,022	3,584	3,293	35,941	36.4%	33,435	98,787
1983	15,667	2,890	1,764	215	3,106	3,725	3,363	37,306	35.9%	35,852	103,888
1984	16,471	3,230	1,792	224	3,230	3,878	3,099	38,091	35.3%	37,910	107,925
1985	17,371	3,310	1,910	231	3,278	4,032	3,149	39,790	35.2%	39,953	113,024
1986	18,341	3,980	2,008	244	3,336	4,270	3,213	40,760	35.9%	37,284	113,436
1987	19,397	4,200	2,069	260	3,452	4,534	3,576	41,714	34.4%	41,974	121,176
1988	20,588	4,370	2,191	281	3,621	4,795	3,766	43,145	34.0%	44,125	126,882
1989	21,326	4,570	2,311	309	3,754	5,140	3,889	44,179	33.3%	47,088	132,566
1990	21,567	4,748	2,427	324	3,774	5,453	3,931	45,106	32.7%	50,752	138,082
1991	21,572	4,910	2,521	324	3,685	5,926	3,744	45,416	32.6%	51,176	139,274
					Average annual percentage change						
1950-91	12.5%	2.9%[c]	6.0%	[b]	3.1%	5.1%[d]	4.4%	4.1%		5.2%	5.2%
1970-91	4.6%	4.8%	4.9%	3.1%[e]	3.6%	4.6%	4.5%	4.2%		5.4%	4.7%
1982-91	4.2%	6.8%	4.9%	5.1%	2.2%	5.7%	1.4%	2.6%		4.8%	3.9%

Source:
Individual countries - Motor Vehicle Manufacturers Association, World Motor Vehicle Data, 1993 Edition, Detroit, MI, 1993, pp 23, 75, 136, 159, 181, 224, 250, 307, 335, and annual.

[a]Truck and bus registrations for all other countries were calculated by subtracting listed countries' registrations from the world total.
[b]Data are not available.
[c]Average annual percentage change is for 1960-91.
[d]Average annual percentage change is for 1955-91.
[e]Average annual percentage change is for 1975-91.

Figure 1.1. United States Automobile and Truck & Bus Registrations as a Percent of World Registrations, 1960-91



Source: See Tables 1.1 and 1.2.

Table 1.3
Gasoline Prices for Selected Countries[a], 1978-92

	Current dollars per gallon									Average annual percentage change	
	1978	1980	1982	1984	1986	1988	1990[b]	1991[b]	1992[b]	1978-92	1982-92
Japan[c]	2.00	2.58	2.60	2.31	2.79	3.43	3.05	3.90	3.78	4.7%	3.8%
France	2.15	3.03	2.56	2.24	2.58	3.06	3.40	3.86	3.69	3.9%	3.7%
Italy	2.23	3.10	2.88	2.79	3.26	3.95	4.27	5.10	4.81	5.6%	5.3%
Sweden	1.56	2.64	2.40	1.93	2.20	2.76	3.23	4.45	4.28	7.5%	6.0%
United Kingdom	1.22	2.50	2.42	2.05	2.07	2.51	2.55	2.55	3.28	7.3%	3.1%
West Germany	1.75	2.43	2.17	1.87	1.88	2.20	2.72	2.87	3.84	5.8%	5.9%
Canada[c]	0.69	0.85	1.37	1.48	1.31	1.54	1.92	2.06	2.11	8.3%	4.4%
United States[d]	0.66	1.23	1.32	1.22	0.93	0.95	1.04	1.43	1.07	3.5%	-2.1%
	Constant 1990 dollars[e] per gallon									**Average annual percentage change**	
	1978	1980	1982	1984	1986	1988	1990[b]	1991[b]	1992[b]	1978-92	1982-92
Japan[c]	4.01	4.09	3.52	2.91	3.33	3.79	3.05	3.74	3.52	-0.9%	0.0%
France	4.31	4.81	3.47	2.82	3.07	3.38	3.40	3.70	3.44	-1.6%	-0.1%
Italy	4.47	4.92	3.90	3.51	3.89	4.36	4.27	4.89	4.48	0.0%	1.4%
Sweden	3.12	4.19	3.25	2.43	2.62	3.05	3.23	4.27	3.98	1.8%	2.0%
United Kingdom	2.44	3.96	3.28	2.58	2.47	2.77	2.55	2.45	3.05	1.6%	-0.7%
West Germany	3.51	3.85	2.94	2.35	2.24	2.43	2.72	2.75	3.58	0.1%	2.0%
Canada[c]	1.38	1.35	1.85	1.86	1.56	1.70	1.92	1.98	1.96	2.5%	0.6%
United States[d]	1.32	1.95	1.79	1.53	1.11	1.05	1.04	1.37	1.00	-2.0%	-5.7%

Source:
U.S. Department of Energy, Energy Information Administration, International Energy Annual 1991, Washington, DC, December 1992, pp. 153, 154, and annual.

[a]Prices represent the retail prices (including taxes) for premium leaded gasoline unless otherwise noted. Prices are representative for each country based on quarterly data averaged for the year.

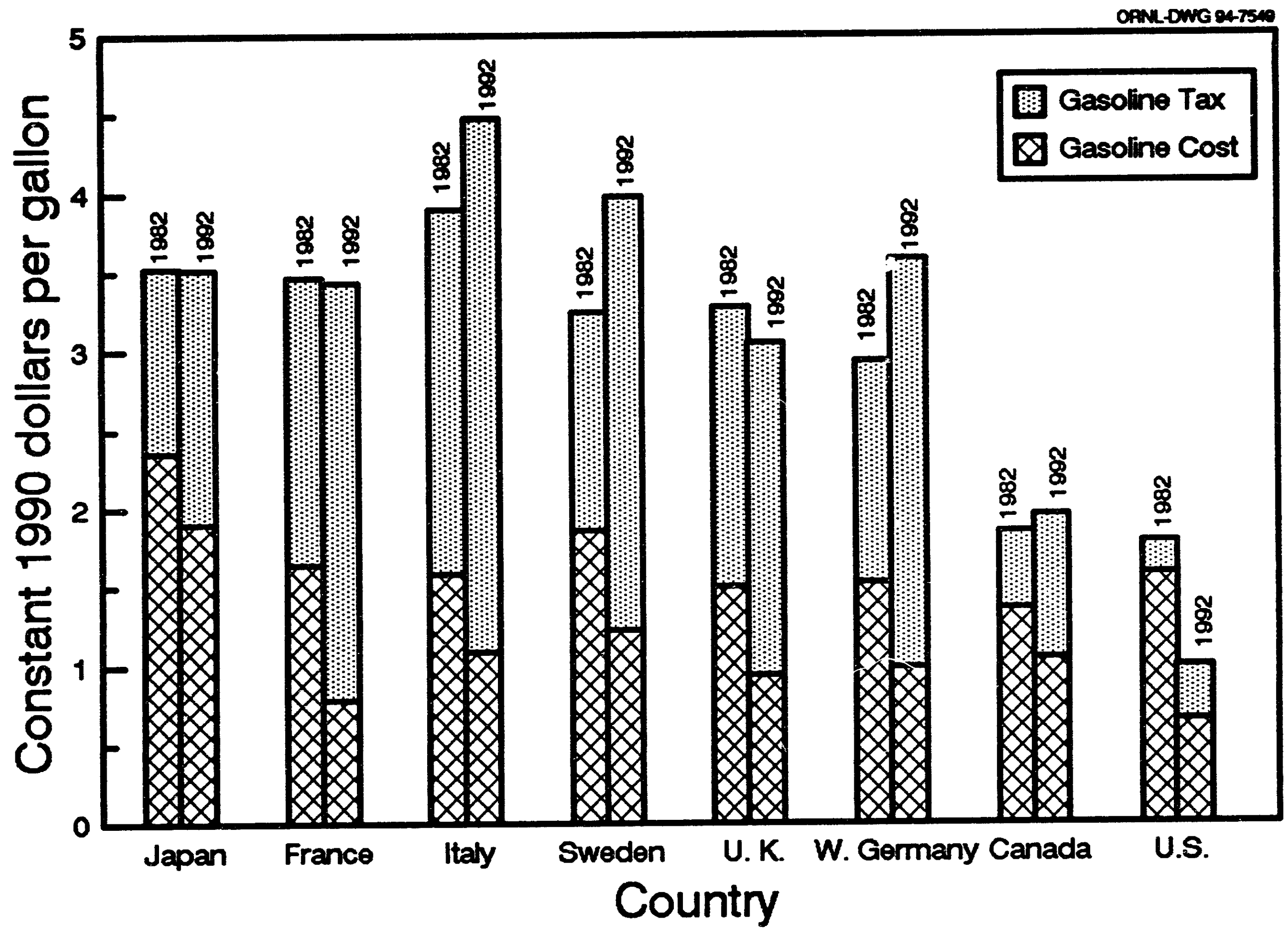
[b]Prices represent the retail prices (including taxes) for premium leaded gasoline on January 1 of the year.

[c]All prices for Japan and Canada are unleaded regular gasoline.

[d]All prices for the United States are unleaded regular gasoline. These estimates are for international comparisons only and do not necessarily correspond to gasoline price estimates in other sections of the book.

[e]Adjusted by the U.S Consumer Price Inflation Index.

Figure 1.2. Gasoline Prices for Selected Countries, 1982 and 1992



Source:
International Energy Agency, Energy Prices and Taxes, Fourth Quarter, 1992 Edition, Paris, France, 1993, p. 282; and Table 1.3.

Table 1.4
Diesel Fuel Prices for Selected Countries[a], 1978-92

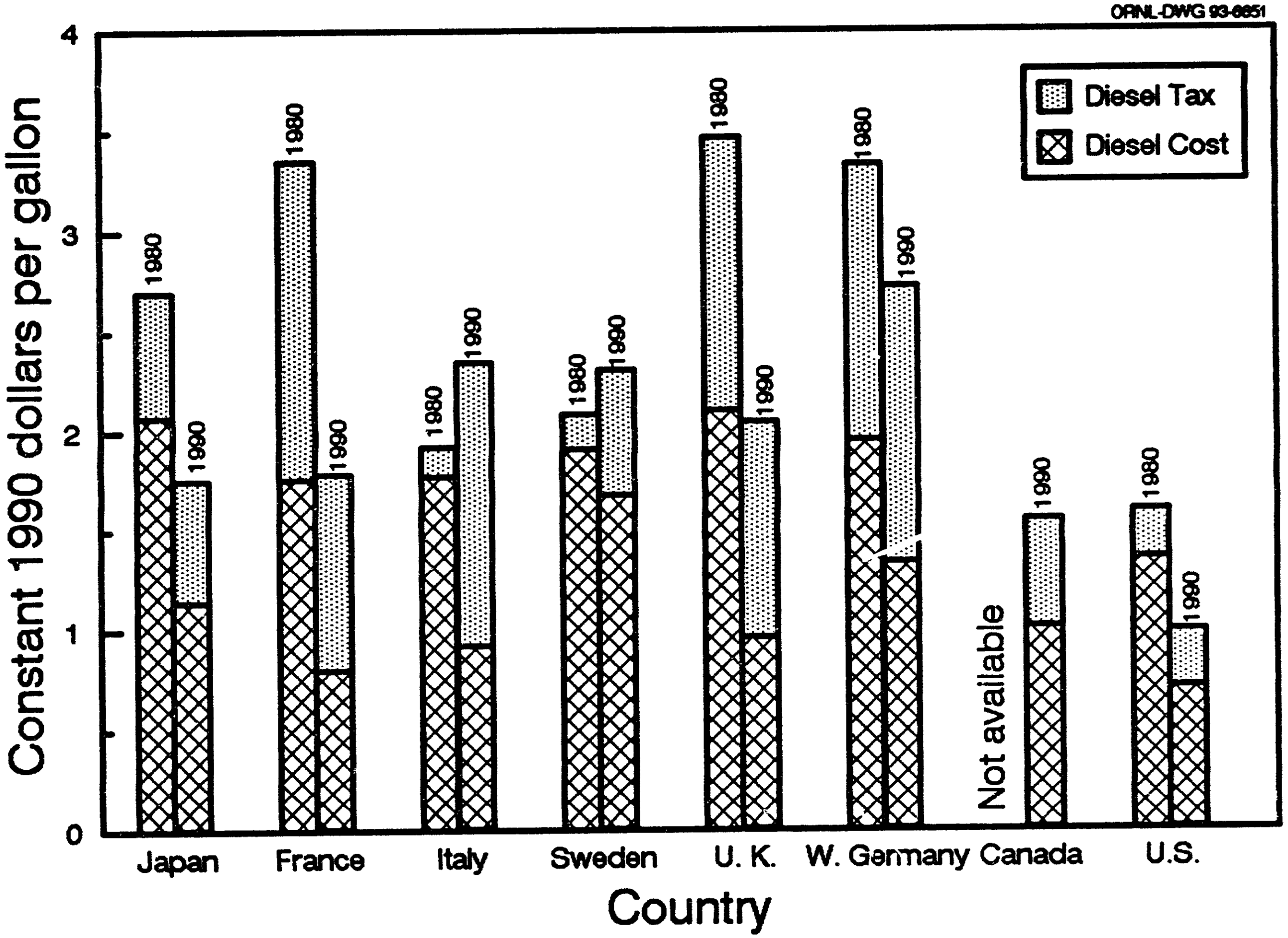
	Current dollars per gallon									Average annual percentage change	
	1978	1980	1982	1984	1986	1988	1990[b]	1991[b]	1992[b]	1978-92	1982-92
Japan	[c]	1.70	1.78	1.66	1.90	26.02	1.75	2.40	[c]	5.7[d]	3.4[f]
France	1.30	2.11	1.88	1.63	1.69	1.84	1.78	[c]	[c]	2.7[e]	-0.7[e]
Italy	0.64	1.21	1.19	1.20	1.31	1.78	2.34	3.77	[c]	14.6[f]	13.7[f]
Sweden	0.62	1.31	1.41	1.32	1.24	1.64	2.30	3.58	[c]	14.4[f]	10.9[f]
United Kingdom	1.24	2.19	2.05	1.68	1.71	1.99	2.04	[c]	[c]	4.2[e]	-0.1[e]
West Germany	1.48	2.10	1.81	1.53	1.51	1.66	2.72	2.69	2.81	4.7	4.5
Canada	[c]	[c]	1.27	1.30	1.27	1.45	1.55	1.98	1.78	[c]	3.4
United States[g]	0.54	1.01	1.16	1.22	0.94	0.95	0.99	0.91	1.06	4.9	-0.9

	Constant 1990 dollars[h] per gallon									Average annual percentage change	
	1978	1980	1982	1984	1986	1988	1990[b]	1991[b]	1992[b]	1978-92	1982-92
Japan	[c]	2.70	2.41	2.09	2.26	2.23	1.75	2.30	[c]	0.3[d]	-0.5[f]
France	2.60	3.35	2.55	2.05	2.01	2.03	1.78	[c]	[c]	-3.1[e]	-4.4[e]
Italy	1.28	1.92	1.61	1.51	1.56	1.97	2.34	3.62	[c]	8.3[f]	9.4[f]
Sweden	1.24	2.08	1.91	1.66	1.48	1.81	2.30	3.43	[c]	8.1[f]	6.7[f]
United Kingdom	2.48	3.47	2.78	2.11	2.04	2.20	2.04	[c]	[c]	-1.6[e]	-3.8[e]
West Germany	2.96	3.33	2.45	1.92	1.80	1.83	2.72	2.58	2.62	-0.9	0.7
Canada	[c]	[c]	1.72	1.64	1.51	1.60	1.55	1.90	1.66	[c]	-0.4
United States	1.08	1.60	1.57	1.53	1.12	1.05	0.99	0.87	0.99	-0.6	-4.5

Source:
U.S. Department of Energy, Energy Information Administration, International Energy Annual 1991, Washington, DC, December 1992, pp. 153, 154, and annual.

[a]Prices represent the retail prices (including taxes) for diesel fuel unless otherwise noted. Prices are representative for each country based on quarterly data averaged for the year.
[b]Prices represent the retail prices (including taxes) for diesel fuel on January 1 of the year.
[c]Data are not available.
[d]Average annual percentage change is for 1979-91.
[e]Average annual percentage changes are for 1978-90 and 1982-90.
[f]Average annual percentage changes are for 1978-91 and 1982-91.
[g]These estimates are for international comparisons only and do not necessarily correspond to diesel price estimates in other sections of the book.
[h]Adjusted by the U.S. Consumer Price Inflation Index.

Figure 1.3. Diesel Fuel Prices for Selected Countries, 1980 and 1990



Source:
International Energy Agency, Energy Prices and Taxes, 1991 Edition, Paris, France, 1992, pp. 82, 115, 126, 156, 168, 229, 257, and 268; and Table 1.4.

According to the best available data, new cars in France have the highest fuel economy of the listed countries. Caution should be used, however, when comparing fuel economy data between countries because each country may use different methods of calculating new car fuel economy. The data, therefore, may not be directly comparable.

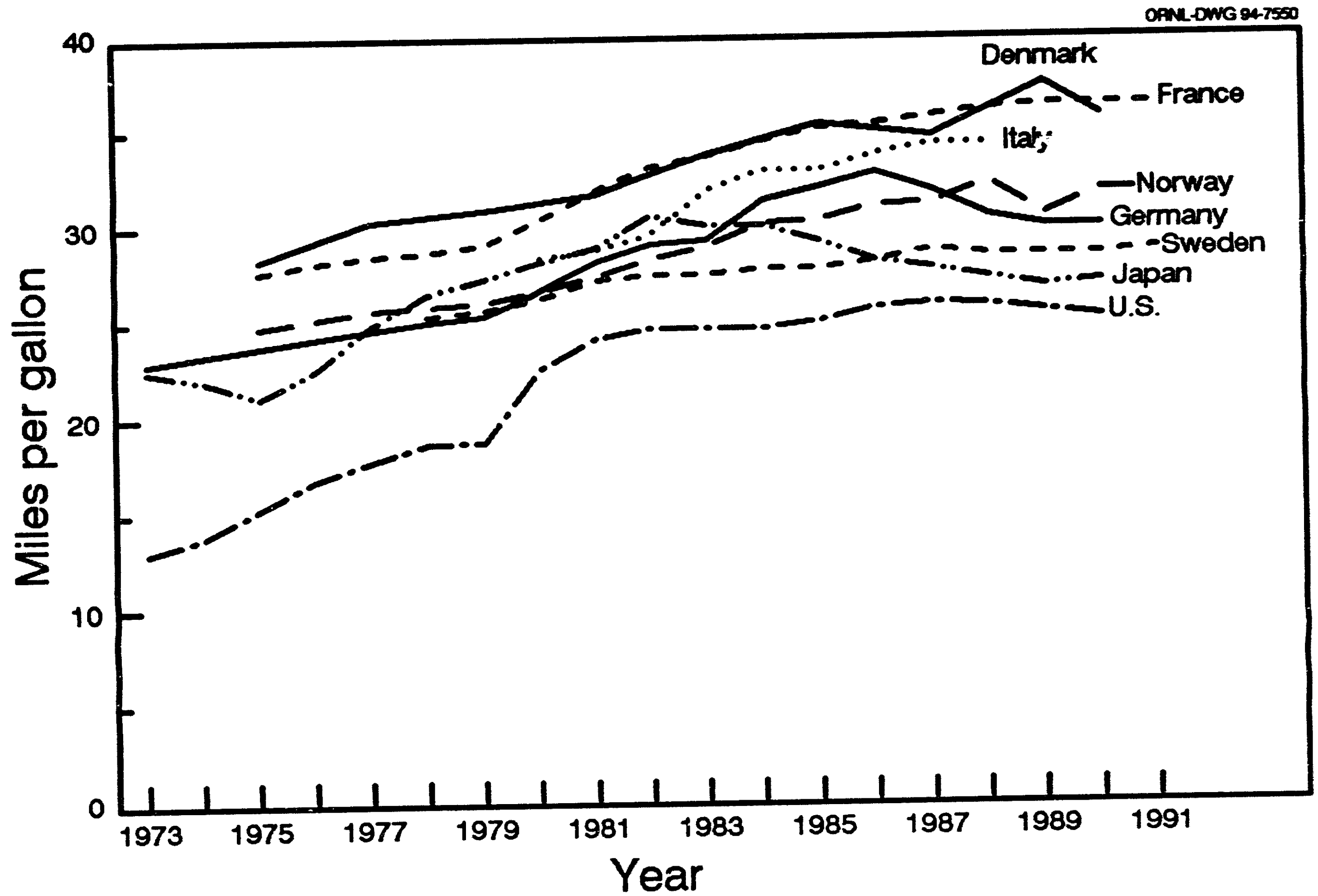
Table 1.5
New Gasoline Car Fuel Economy for Selected Countries, 1973-91
(miles per gallon)

Year	Japan	France	Italy	Sweden	Norway	Denmark	West Germany	United States
1973	22.6	[a]	[a]	[a]	[a]	[a]	23.0	13.1
1974	22.1	[a]	[a]	[a]	[a]	[a]	[a]	13.9
1975	21.2	27.7	[a]	[a]	24.8	28.3	[a]	15.4
1976	22.6	28.2	[a]	[a]	25.3	[a]	[a]	16.8
1977	24.9	28.5	[a]	[a]	25.6	30.3	[a]	17.8
1978	26.6	28.7	[a]	25.4	25.9	[a]	25.1	18.7
1979	27.3	29.1	[a]	25.7	26.1	30.9	25.4	18.8
1980	28.2	30.4	28.4	26.3	26.7	[a]	26.7	22.6
1981	28.9	31.9	28.8	27.2	27.4	31.7	28.2	24.2
1982	30.6	33.1	29.6	27.5	28.3	[a]	29.1	24.8
1983	30.1	33.7	31.9	27.5	29.0	33.8	29.3	24.7
1984	30.1	34.5	32.9	27.8	30.2	[a]	31.4	24.7
1985	29.2	35.1	32.9	27.8	30.3	35.3	32.0	25.1
1986	28.2	35.3	33.8	28.2	31.1	[a]	32.8	25.8
1987	27.8	35.7	34.3	28.8	31.2	34.7	31.8	26.0
1988	27.3	36.1	34.3	28.5	32.3	[a]	30.5	25.9
1989	26.8	36.3	[a]	28.5	30.6	37.4	30.0	25.6
1990	27.1	36.3	[a]	28.5	31.8	35.7	30.0	25.3
1991	[a]	36.3	[a]	28.8	31.8	[a]	[a]	[a]

Sources:
International Energy Studies, Energy Analysis Program, Lawrence Berkeley Laboratory, Berkeley, CA, 1993. Data were compiled from country sources, such as oil companies, energy economics institutes, and government ministries.

[a]Data are not available.

Figure 1.4. New Gasoline Car Fuel Economy for Selected Countries, 1973-91



Source: See Table 1.6.

Because each country may use different methods of calculating fuel economies, caution should be used when comparing fuel economy data among countries. The data for the United States were generated specifically for international comparisons and should be used only for that purpose; they are not consistent with other domestic fuel economy figures.

Table 1.6
Fuel Economy of the Gasoline Automobile Population for Selected Countries, 1970-91
(miles per gallon)

Year	Japan[a]	France	Italy	Sweden	Holland	Norway	Denmark	United Kingdom	West Germany	United States
1970	21.7	27.8	[b]	22.9	24.8	23.0	[b]	23.5	23.1	12.6
1971	20.7	27.8	[b]	22.6	24.8	23.0	[b]	23.4	22.1	12.6
1972	21.9	27.8	[b]	22.4	24.8	23.0	24.3	22.0	21.5	12.5
1973	21.3	27.0	27.9	22.2	24.8	23.0	24.0	21.8	22.0	12.4
1974	21.0	27.8	[b]	22.9	24.8	23.2	[b]	21.9	22.3	12.6
1975	21.4	27.4	[b]	22.3	24.8	23.2	26.5	22.6	22.0	12.7
1976	21.2	26.4	[b]	22.1	26.2	23.2	26.1	22.7	21.9	12.7
1977	21.0	26.6	[b]	21.9	26.3	23.2	26.5	22.5	21.7	12.9
1978	20.8	26.2	[b]	21.7	26.5	23.2	26.3	22.1	21.5	13.1
1979	20.4	26.6	27.9	21.7	26.5	23.4	27.2	21.6	21.8	13.4
1980	20.4	25.8	27.9	21.7	25.7	23.4	27.7	22.7	21.6	14.3
1981	20.8	25.6	28.1	21.8	25.7	23.7	28.0	23.6	21.7	14.7
1982	21.1	25.4	28.1	21.8	26.0	23.9	28.1	23.8	21.7	15.3
1983	21.1	25.4	28.4	21.9	26.3	24.4	28.2	23.8	21.7	15.7
1984	21.5	25.7	28.9	21.9	26.7	24.9	29.7	23.8	21.7	16.2
1985	21.9	25.9	29.1	22.1	27.0	25.4	28.8	24.2	21.7	16.5
1986	22.0	26.0	29.6	22.5	27.4	26.0	28.5	24.2	21.7	16.5
1987	22.4	26.3	30.0	23.0	27.7	26.0	28.0	24.5	21.9	17.1
1988	22.5	26.2	30.3	23.2	27.9	26.0	28.9	25.0	22.1	17.8
1989	22.5	26.6	30.1	23.4	28.2	26.0	29.6	25.8	22.5	18.2
1990	22.3	26.7	30.1	23.7	28.6	26.3	29.2	25.6	22.7	18.6
1991	21.8	26.7	29.9	23.9	[b]	26.6	[b]	25.8	23.0	19.1

Sources:
International Energy Studies, Energy Analysis Program, Lawrence Berkeley Laboratory, Berkeley, CA, 1993. Data were compiled from country sources, such as oil companies, energy economics institutes, and government ministries.

[a]Combined gasoline and diesel fuel economy.
[b]Data are not available.

FUEL ECONOMY GAP

Concerns about the difference between on-road fuel economy and tested fuel economy have resulted in related data collection and analysis. "There is a relatively consistent shortfall or gap between tested fuel economy and that actually achieved by consumers on the road ... a gap which changes over time."

The International Energy Studies Program at Lawrence Berkeley Laboratory (LBL) has studied this gap for six countries. They discovered in the study that "despite differences in test measurement methods and data collection and analysis techniques, significant similarities exist between countries on the gap problem."

"The gap arises for several reasons. The effects of these variations tend to cause test values to deviate further and further from actual conditions.

- The formulae used to construct the 'real' cycle from road test data typically underrepresent the proportion of city to urban highway driving;
- The actual conditions in all parts of the cycle, including hills, weather, road curvature, road surface, etc., are themselves worse than modelled, leading to increased actual fuel consumption. Generally these factors cannot be accounted for by adjusting the dynamometer tests, although road tests could be adjusted;
- Driver behavior, i.e., speed, acceleration, frequency of cold starts, reflects patterns that themselves are more fuel-intensive than the patterns used in tests. Lack of maintenance of the vehicle may also decrease fuel economy ;
- The tests do not reflect seasonal differences in fuel consumption; this was noted particularly in Sweden, Canada, and France; and
- The test values do not represent cars actually sold, either because the cars tested are somehow optimized for testing or because cars actually bought contain more fuel-intensive features (larger engines, turbocharging, more accessories) than is reflected in either the tests or the sales-weightings.

Additionally, the gap may be large if the vehicles counted in the weightings do not accurately represent the entire new-car fleet[a]."

The results of the LBL gap study are presented in Table 1.7.

---

[a]Schipper, Lee and Wienke Tax, "New Car Test and Actual Fuel Economy: Yet Another Gap?" Lawrence Berkeley Laboratory, Berkeley, CA, Fall 1993.

Table 1.7
Fuel Economy Gap for Selected Countries
(liters per 100 kilometers)

Country	Year	Test	Actual	Average Gap	Percent Gap	Comments
Canada	1988	8.0	10.0	2.0	20	Actual fuel efficiency from driver surveys. Test from laboratory test.
Individual car models	1985	8.6	10.7	2.1	19.6	
France	1988	6.5	8.4	1.9	23	Travel diaries compared to 1/3 city, 1/3 highway, 1/3 road test values.
Germany	1987	7.7	9.8	2.1	21.4	DIN (test) vs. DIW (actual)
Sweden	1987	8.2	8.5	0.3	3.5	KOV compared with consumer reported survey data.
U.S.	1985					
Cars		9.7	11.9	2.2	18.5	RTECS survey vs. EPA fleet average
Trucks		11.6	14.5	2.9	20	from dynamometer test.
U.K.	1989	7.2	9.3	2.1	22.6	Test value for registration-weighted average.

Sources:
Schipper, Lee and Wienke Tax, "New Car Test and Actual Fuel Economy: Yet Another Gap?" Lawrence Berkeley Laboratory, Berkeley, CA, Fall 1993.

Note: DIN = Deutsches Institut fur Normug
DIW = Deutsches Institut fur Wirtschaftsforschung
KOV = Kosumentverket
RTECS = Residential Transportation Consumption Survey
EPA = Environmental Protection Agency

Table 1.8
Annual Vehicle Miles per Vehicle Traveled by Personal Vehicles[a]
for Selected Countries, 1970-91

Year	Japan	France	Italy	Sweden	Holland	Norway	Denmark	United Kingdom	West Germany	United States
1970	9,290	8,357	7,344	8,852	9,366	7,730	8,343	8,431	8,903	11,097
1971	8,864	8,340	6,884	8,913	9,435	7,729	8,742	8,597	8,765	11,324
1972	7,948	8,358	6,187	9,110	9,037	7,729	9,209	8,635	8,519	11,527
1973	7,845	8,580	6,403	9,247	9,019	7,669	9,186	8,570	8,336	11,386
1974	6,973	8,074	5,848	8,580	8,739	7,672	8,555	8,277	8,086	10,657
1975	6,906	8,148	6,116	8,849	8,953	8,286	8,693	8,278	8,454	10,674
1976	6,748	8,080	5,925	8,745	8 896	8,532	8,895	8,505	8,321	10,846
1977	6,896	8,012	5,781	8,770	8,752	8,594	8,960	8,667	8,187	10,969
1978	6,828	7,981	6,089	8,924	9,060	8,410	8,977	9,034	8,127	11,039
1979	6,820	7,852	6,429	8,926	8,682	8,538	8,466	8,674	7.972	10,588
1980	6,714	8,037	6,377	9,085	8,384	8,232	8,196	8,974	7,917	10,532
1981	6,599	8,191	6,366	8,991	8,192	8,052	8,191	9,004	7,354	10,550
1982	6,589	7,796	6,430	9,047	8,390	7,994	8,413	9,088	7,538	10,747
1983	6,454	7,790	6,326	9,026	8,563	7,997	8,586	9,169	7,645	10,846
1984	6,403	7,926	6,401	9,097	8,739	8,185	8,830	9,196	7,685	10,893
1985	6,451	7,883	7,029	8,960	8,541	8,369	8,937	9,187	7,486	10,923
1986	6,481	8,105	7,186	9,258	8,849	8,493	9,130	9,387	7,710	11,033
1987	6,469	8,191	7,393	9,419	8,923	8,579	9,816	9,840	7,895	11,278
1988	6,505	8,321	7,584	9,380	9,172	8,674	10,033	9,981	8,049	11,696
1989	6,442	8,198	7,745	9,375	9,201	8,785	10,041	10,624	7,997	11,794
1990	6,464	8,235	[b]	8,969	8,963	8,892	9,814	10,502	8,079	12,172
1991	6,447	8,481	[b]	8,895	[b]	8,717	9,887	10,483	7,999	12,305

Sources:

International Energy Studies, Energy Analysis Program, Lawrence Berkeley Laboratory, Berkeley, CA, 1993. Data were compiled from country sources, such as oil companies, energy economics institutes, and government ministries.

[a]Calculated as total vehicle miles of travel divided by the number of vehicles in use. Includes privately owned automobiles and light trucks.

[b]Data are not available.

Table 1.9
Passenger Travel by Personal Vehicles[a] for Selected Countries, 1970-91
(billion passenger-miles)

Year	Japan	France	Italy	Sweden	Holland	Norway	Denmark	United Kingdom	West Germany	United States
1970	379	188	[b]	34	41	11	28	179	216	2,109
1971	401	198	[b]	35	45	13	30	190	229	2,194
1972	422	209	158	37	47	14	32	198	232	2,289
1973	438	235	170	38	49	15	32	208	240	2,320
1974	449	222	173	37	50	15	30	201	235	2,207
1975	458	231	186	40	55	17	32	199	249	2,238
1976	456	237	194	41	58	17	31	209	256	2,310
1977	457	246	205	42	61	18	33	217	265	2,354
1978	479	256	220	42	66	18	34	230	275	2,422
1979	497	263	227	42	65	18	33	230	285	2,344
1980	499	279	233	41	66	19	32	243	288	2,306
1981	504	289	241	41	66	19	32	247	272	2,314
1982	512	289	243	42	68	19	32	252	281	2,354
1983	524	295	248	42	70	20	33	254	289	2,400
1984	530	304	254	44	73	20	34	267	295	2,459
1985	546	305	260	45	73	22	35	271	294	2,513
1986	556	319	267	47	76	23	36	286	311	2,575
1987	574	329	275	49	79	24	37	307	325	2,668
1988	601	342	283	51	81	25	38	319	340	2,788
1989	628	356	290	54	85	25	37	343	348	2,854
1990	665	363	338	53	[b]	25	37	346	367	2,898
1991	693	370	332	54	[b]	25	37	344	367	2,903

Sources:
International Energy Studies, Energy Analysis Program, Lawrence Berkeley Laboratory, Berkeley, CA, 1993. Data were compiled from country sources, such as oil companies, energy economics institutes, and government ministries.

[a]Includes privately owned automobiles and light trucks.
[b]Data are not available.

Table 1.10
Energy Use by Personal Vehicles[a] for Selected Countries, 1970-91
(trillion Btu)

Year	Japan	France	Italy	Sweden	Holland	Norway	Denmark	United Kingdom	Germany	United States
1970	491	431	[b]	99	111	30	52	510	629	9,230
1971	589	454	[b]	104	123	32	55	541	701	9,777
1972	594	480	[b]	111	126	34	60	612	742	10,509
1973	676	534	379	117	133	36	[b]	652	753	10,936
1974	672	511	[b]	110	135	35	[b]	635	737	10,491
1975	706	540	[b]	122	146	40	59	621	803	10,759
1976	747	573	[b]	126	146	45	62	648	839	11,332
1977	825	593	[b]	130	153	49	62	666	882	11,555
1978	887	627	[b]	133	165	49	65	706	935	11,880
1979	959	636	473	133	167	51	63	720	961	11,403
1980	982	688	493	133	174	51	58	733	991	10,667
1981	984	704	512	132	172	51	56	719	933	10,588
1982	1,005	720	536	134	176	53	56	740	968	10,509
1983	1,017	732	538	135	182	54	58	752	1,000	10,604
1984	1,015	743	550	140	186	56	58	793	1,029	10,659
1985	1,035	739	574	140	183	59	60	801	1,022	10,825
1986	1,062	766	594	146	187	62	63	845	1,089	11,191
1987	1,077	780	620	151	194	63	64	896	1,142	11,319
1988	1,118	808	654	154	202	64	66	944	1,195	11,505
1989	1,189	818	671	157	207	64	66	992	1,204	11,660
1990	1,286	831	723	153	201	65	69	1,014	1,246	11,700
1991	1,391	842	723	[b]	[b]	63	70	1,002	1,246	11,594

Sources:
International Energy Studies, Energy Analysis Program, Lawrence Berkeley Laboratory, Berkeley, CA, 1993. Data were compiled from country sources, such as oil companies, energy economics institutes, and government ministries.

---

[a]Includes privately owned automobiles and light trucks.
[b]Data are not available.

CHAPTER 2

TRANSPORTATION ENERGY CHARACTERISTICS

The U.S. was responsible for more than one-quarter of the world's petroleum consumption in 1992. Domestic crude oil production, which had been declining every year from 1985 to 1990 rose in 1991, then fell to a new all-time low 7.15 million barrels per day in 1992. While domestic crude oil production has declined 20.3% from 1985 to 1992, the amount of crude oil imported has increased 89% in that time period to meet the domestic demand. Imports in 1992 accounted for 46.1% of U.S. petroleum consumption, down from a high of 47.2% in 1990 (Table 2.2).

Most of the petroleum consumed in the U.S. was in the transportation sector, 65.1% (on a crude oil equivalent energy basis) (Table 2.3). This accounted for 27.4% of total energy use in 1992 (Table 2.5). While the transportation sector depended primarily on petroleum, the residential and commercial sector depended heavily on electricity (Table 2.4).

The fuels used in the transportation sector include gasoline, distillate fuel oil (diesel fuel), jet fuel, residual fuel oil, natural gas, and electricity. Gasoline, however, accounted for the majority of transportation energy consumption in 1992 (61.4%) (Figure 2.6). Of total transportation energy use in 1992, 73.6% was consumed by the highway mode while the nonhighway mode (which includes water, air, pipeline, and rail transportation) accounted for 21.5%. The remaining 4.9% of transportation energy use was consumed by the off-highway mode and military activities (Table 2.9).

The average price for all types of gasoline jumped 10 cents from 1989 to 1990 (in constant 1990 cents), but has fallen 11 cents from 1990 to 1992. Unleaded regular gasoline prices (in constant 1990 cents) experienced an average decline of 5% annually from 1982 to 1992 (Table 2.16). The refiner sales prices for other transportation fuels such as propane, aviation gasoline and jet fuel also increased from 1989 to 1990 and declined in 1991 and 1992 (Table 2.17). Crude oil price changes contribute to fuel price fluctuations. The price per barrel of crude went from $18.94 in 1989 to $22.22 in 1990, then back down to $17.16 in 1992 (constant 1990 dollars) (Table 2.18).

Transportation's share of the gross national product (GNP) fell below 17% for the first time in 1991. GNP has been growing at an average rate of 2.8% from 1982 to 1992, while transportation outlays have grown an average of 1.8% annually (Table 2.19). Personal consumption expenditures (PCE) have nearly doubled from 1970 to 1992. Transportation PCE have grown 77.2% in that same time period. Transportation PCE was approximately 11.3% of total PCE in 1992 (Table 2.20).

Consumers in 1992 spent almost four times more for a used car than they would have in 1970 (Table 2.21). The average price of a new car in 1992 reached $17,784 (in current dollars). The average price for an import car has been more than the average price for a domestic car since 1982. Before then, imports were priced less than domestics, on average (Table 2.22). The cost of operating a car rose to 42.61 cents per mile in 1992. Gas and oil, once as much as one-quarter of the total cost to operate a car, accounted for only 13.1% of the total cost in 1992 (Table 2.23).

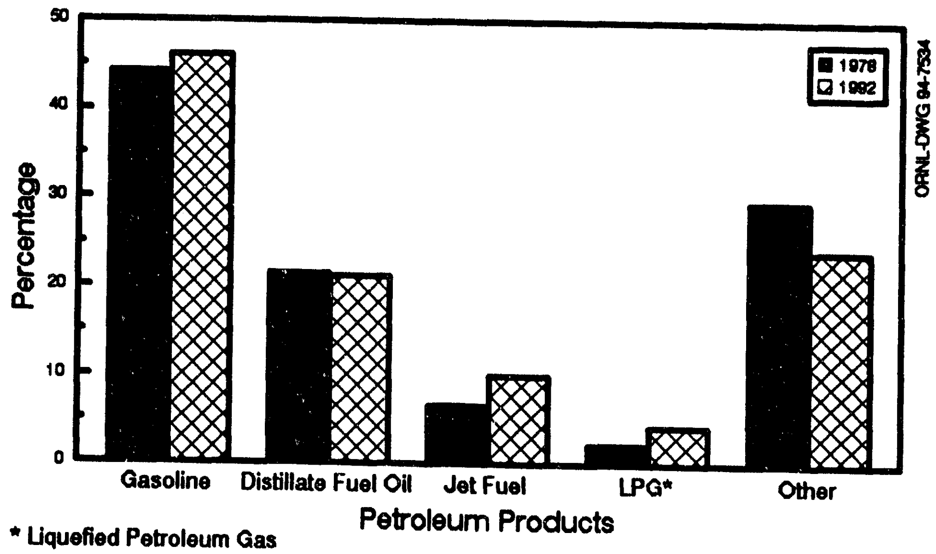
Section 2.1.
Energy Consumption and Supply

Table 2.1
Refinery Yield of Petroleum Products from a Barrel of Crude Oil, 1978-92[a]
(percentage)

Year	Motor Gasoline	Distillate fuel oil	Jet fuel	Liquefied petroleum gas	Other[b]
1978	44.1	21.4	6.6	2.3	29.6
1979	43.0	21.5	6.9	2.3	30.3
1980	44.5	19.7	7.4	2.4	30.0
1981	44.8	20.5	7.6	2.4	28.7
1982	46.4	21.5	8.1	2.2	26.2
1983	47.6	20.5	8.5	2.7	24.8
1984	46.7	21.5	9.1	2.9	24.2
1985	45.6	21.6	9.6	3.1	24.6
1986	45.7	21.2	9.8	3.2	24.8
1987	46.4	20.5	10.0	3.4	24.5
1988	46.0	20.8	10.0	3.6	24.4
1989	45.7	20.8	10.1	4.0	24.2
1990	45.6	20.9	10.7	3.6	24.1
1991	45.7	21.3	10.3	3.8	24.1
1992	46.0	21.2	9.9	4.3	24.0

Source:
Department of Energy, Energy Information Administration, Petroleum Supply Annual 1992, Vol. 1, May 1993, Table 19, p. 52, and annual.

Figure 2.1. Refinery Yield of Petroleum Products from a Barrel of Crude Oil, 1978 and 1992



Source: See Table 2.1.

[a]Products sum greater than 100% due to processing gain. The processing gain for years 1978 to 1980 is assumed to be 4%.

[b]Includes aviation gasoline, kerosene, naphtha and other oils for petrochemical feedstock use, special naphthas, lubricants, waxes, petroleum coke, asphalt and road oil, still gas, and miscellaneous products.

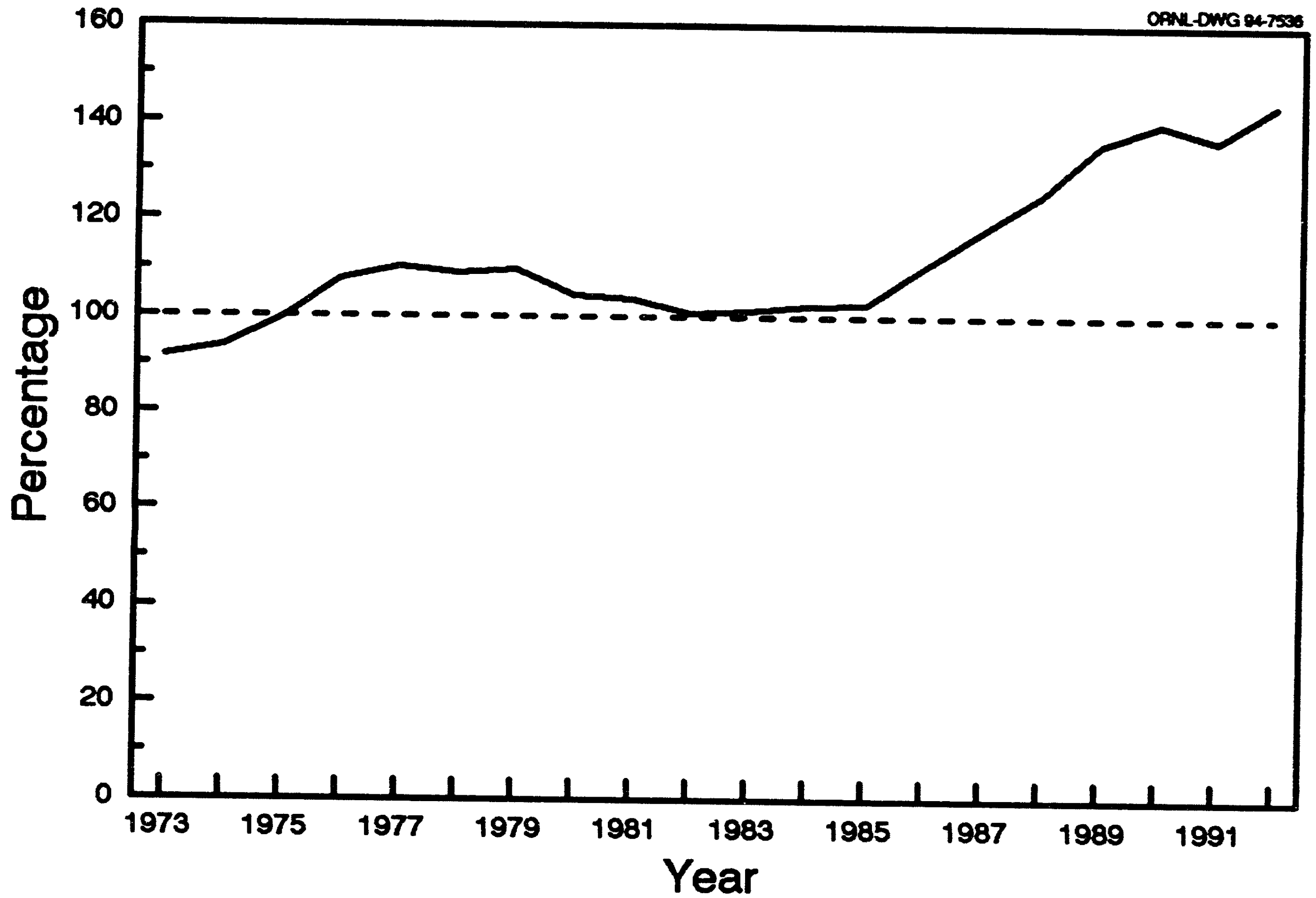
Table 2.2
United States Petroleum Production and Consumption, 1970-92
(million barrels per day)

Year	Domestic crude oil production	Gross imports: Crude oil	Gross imports: Petroleum products	Gross imports: Total	U.S. petroleum consumption[a]	World petroleum consumption	Imports as a percentage of U.S. petroleum consumption	Petroleum products as a percentage of gross imports	U.S. petroleum consumption as a percentage of world consumption	Transportation petroleum use as a percentage of domestic production[b]
1970	9.64	1.32	2.10	3.42	14.70	46.38	23.3	61.4	31.7	[c]
1971	9.46	1.68	2.25	3.93	15.21	50.00	25.8	57.3	30.4	[c]
1972	9.44	2.22	2.53	4.75	16.37	52.42	29.0	53.3	31.2	[c]
1973	9.21	3.24	3.01	6.25	17.31	56.39	36.1	48.2	30.7	91.5
1974	8.77	3.48	2.64	6.12	16.65	55.91	36.8	43.1	29.8	93.7
1975	8.37	4.10	1.95	6.05	16.32	55.48	37.1	32.2	29.4	99.4
1976	8.13	5.29	2.03	7.32	17.46	58.74	41.9	27.7	29.7	107.6
1977	8.25	6.61	2.19	8.80	18.43	61.63	47.7	24.9	29.9	110.2
1978	8.71	6.36	2.01	8.37	18.85	63.30	44.4	24.0	29.8	108.7
1979	8.55	6.52	1.94	8.46	18.51	65.17	45.7	22.9	28.4	109.6
1980	8.60	5.26	1.65	6.91	17.06	63.07	40.5	23.9	27.0	104.4
1981	8.57	4.40	1.60	6.00	16.06	60.87	37.4	26.7	26.4	103.7
1982	8.65	3.49	1.63	5.12	15.30	59.50	33.5	31.8	25.7	100.6
1983	8.69	3.33	1.72	5.05	15.23	58.74	33.2	34.1	25.9	101.1
1984	8.88	3.43	2.01	5.44	15.73	59.84	34.6	36.9	26.3	102.3
1985	8.97	3.20	1.87	5.07	15.73	60.10	32.2	36.9	26.2	102.6
1986	8.68	4.18	2.05	6.23	16.28	61.76	38.3	32.9	26.4	110.3
1987	8.35	4.67	2.00	6.68	16.67	63.01	40.0	30.0	26.5	118.1
1988	8.14	5.11	2.30	7.40	17.28	64.83	42.8	31.1	26.7	125.4
1989	7.61	5.84	2.22	8.06	17.33	66.03	46.5	27.5	26.2	135.7
1990	7.36	5.89	2.12	8.02	16.99	66.16	47.2	26.4	25.7	140.0
1991	7.42	5.78	1.84	7.63	16.71	66.60	45.7	24.1	25.5	136.6
1992	7.15	6.05	1.79	7.84	17.01	[c]	46.1	22.8	[c]	143.9
					Average annual percentage change					
1970-92	-1.3%	7.2%	-0.7%	3.8%	0.7%	1.7%[d]				
1982-92	-1.9%	5.7%	0.9%	4.4%	1.1%	1.3%[d]				

Sources:
U.S. Department of Energy, Energy Information Administration, Monthly Energy Review, March 1993, pp. 40-41.
World petroleum consumption - U.S. Department of Energy, Energy Information Administration, International Energy Annual 1991, December 1992, p. 24.

[a]Best estimate for U.S. petroleum consumption is the amount of petroleum products supplied to the U.S. in a given year.
[b]Transportation petroleum use can be found on Table 2.3.
[c]Data are not available.
[d]Average annual percentage change for years 1970-91 and 1982-91.

Figure 2.2. Transportation Petroleum Consumption as a Percentage of Total United States Crude Oil Production, 1973-92



Source: See Table 2.2.

Each year since 1990, the transportation sector has consumed at least 65% of the petroleum used in the U.S. Petroleum use in all sectors declined slightly from 1990 to 1991, but rose in 1992 to 33.48 quads.

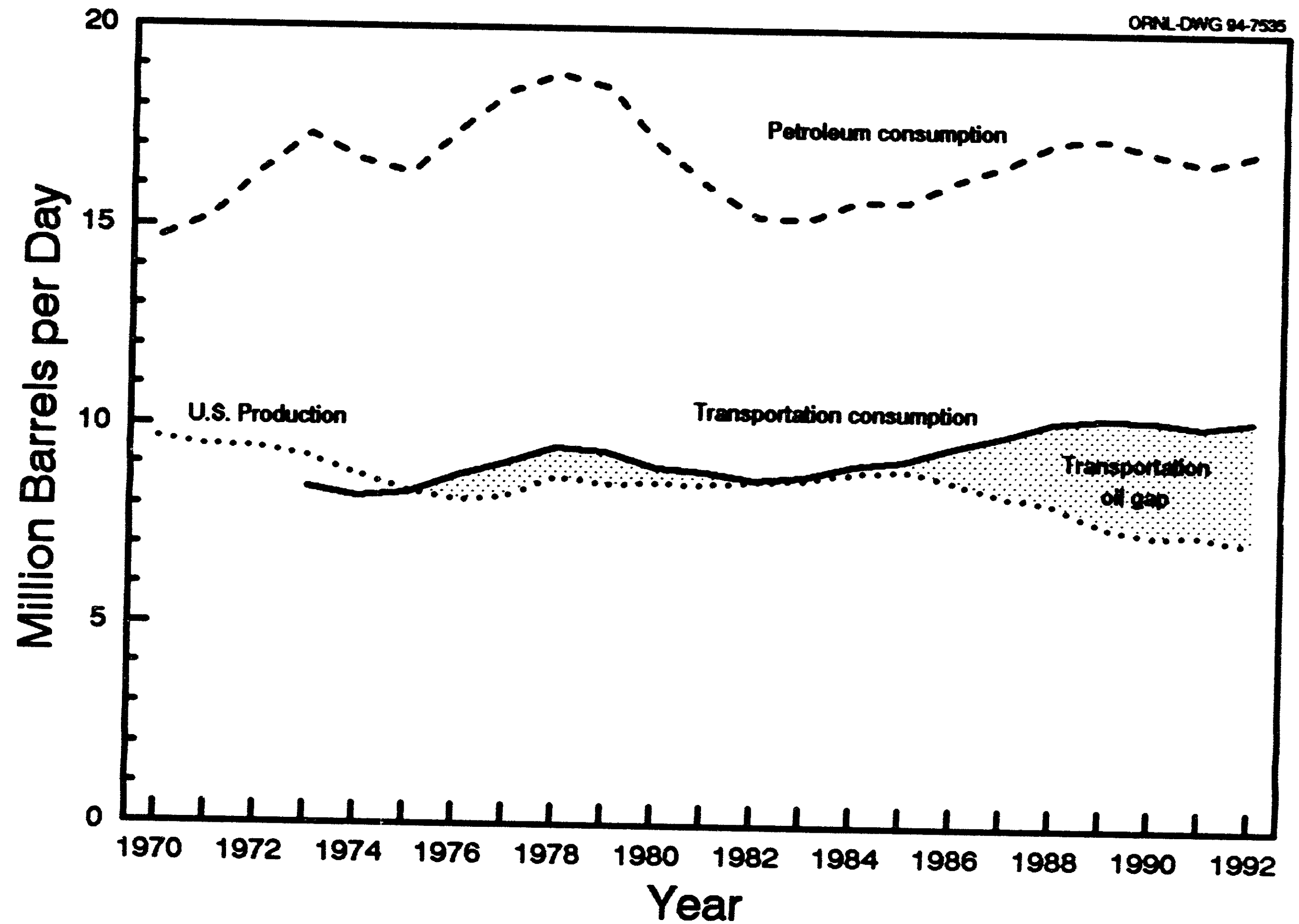
Table 2.3
Consumption of Petroleum by End-Use Sector, 1973-92
(quadrillion Btu)

Year	Transportation	Percentage transportation of total	Residential and commercial	Industrial	Electric utilities	Total	Total in million barrels per day[a]
1973	17.83	51.2%	4.39	9.10	3.52	34.84	16.46
1974	17.40	52.0%	4.00	8.69	3.37	33.46	15.81
1975	17.61	53.8%	3.81	8.15	3.17	32.74	15.47
1976	18.51	52.6%	4.18	9.01	3.48	35.18	16.62
1977	19.24	51.8%	4.21	9.77	3.90	37.12	17.53
1978	20.04	52.8%	4.07	9.87	3.99	37.97	17.94
1979	19.83	53.4%	3.45	10.57	3.28	37.13	17.54
1980	19.01	55.6%	3.04	9.53	2.63	34.21	16.16
1981	18.81	58.9%	2.63	8.29	2.20	31.93	15.08
1982	18.42	60.9%	2.45	7.79	1.57	30.23	14.28
1983	18.59	61.9%	2.50	7.42	1.54	30.05	14.19
1984	19.22	61.9%	2.54	8.01	1.29	31.06	14.67
1985	19.50	63.1%	2.52	7.81	1.09	30.92	14.61
1986	20.27	63.0%	2.56	7.92	1.45	32.20	15.21
1987	20.87	63.5%	2.59	8.15	1.26	32.87	15.53
1988	21.63	62.2%	2.60	8.43	1.56	34.22	16.16
1989	21.87	63.9%	2.53	8.13	1.69	34.22	16.16
1990	21.81	65.0%	2.17	8.32	1.25	33.55	15.85
1991	21.46	65.3%	2.15	8.06	1.18	32.85	15.52
1992	21.78	65.1%	2.22	8.53	0.95	33.48	15.81
			Average annual percentage change				
1973-92	0.9%		-3.1%	-0.3%	-5.8%	-0.2%	
1982-92	1.7%		-1.0%	0.9%	-4.9%	1.0%	

Source:
U.S. Department of Energy, Energy Information Administration, Monthly Energy Review, March 1993, pp. 25, 27, 29, 31.

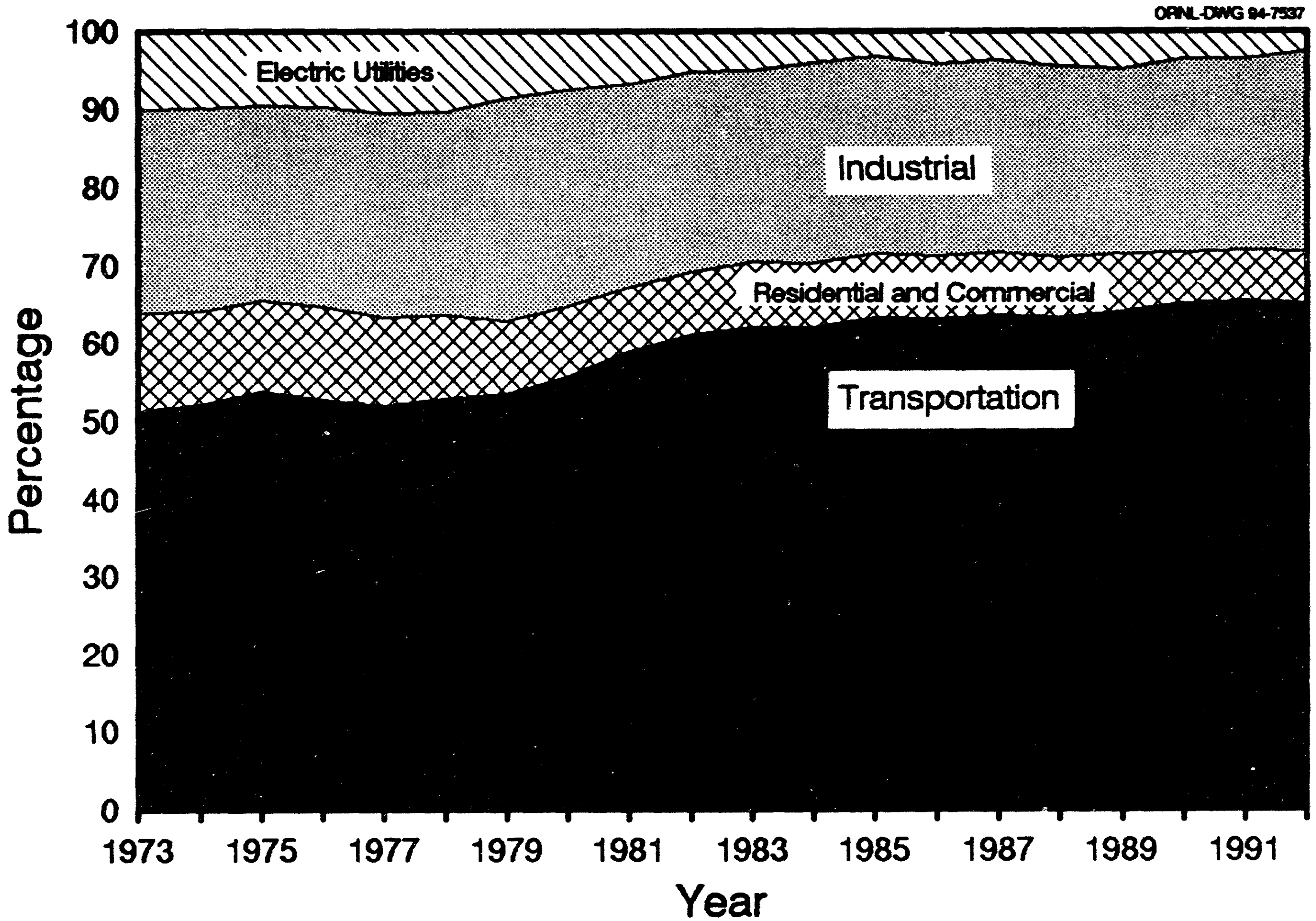
[a]Calculated from Total column. One million barrels per day of petroleum equals 2.117 quadrillion Btu per year.

Figure 2.3. United States Petroleum Production and Consumption, 1970-92



Source: See Tables 2.2 and 2.3.

Figure 2.4. Petroleum Use by End-Use Sector, 1973-92



Source: See Table 2.3.

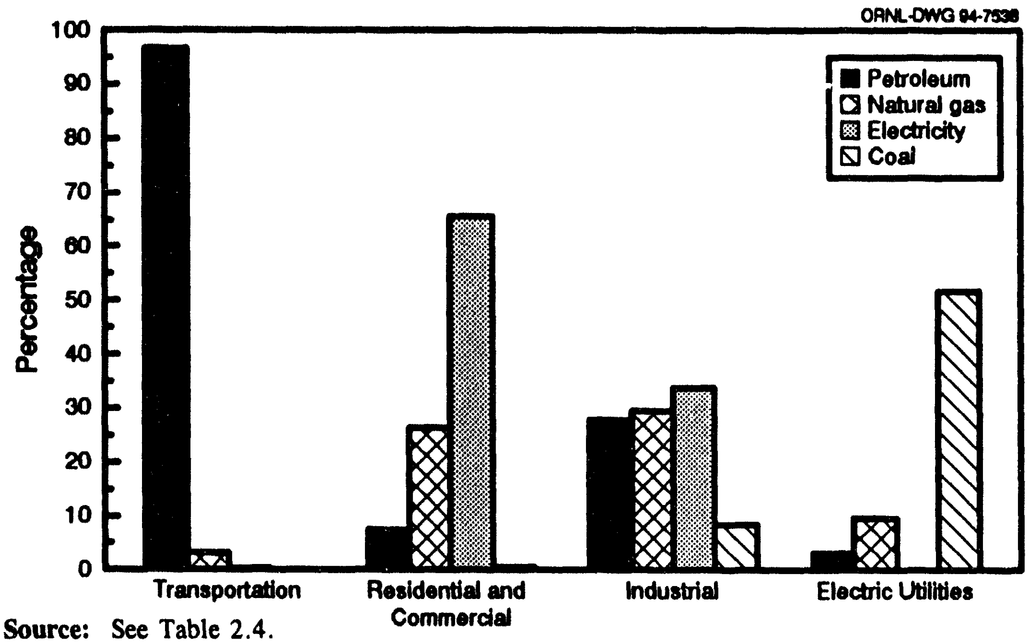
While other sectors have shifted between energy sources in the past ten years, the transportation sector continues to consume energy from the same sources. Energy use from petroleum, which is clearly the transportation sector's main source, is declining amoung the other sectors.

Table 2.4
Distribution of Energy Consumption by Source, 1982 and 1992
(percentage)

	Transportation		Residential and Commercial		Industrial		Electric Utilities	
Energy source	1982	1992	1982	1992	1982	1992	1982	1992
Petroleum	96.6	96.6	9.6	7.6	29.8	27.9	6.5	3.2
Natural gas[a]	3.2	3.2	29.0	26.4	27.2	29.6	13.8	9.6
Coal	0.0	0.0	0.7	0.5	9.8	8.4	51.8	54.8
Hydroelectric	0.0	0.0	0.0	0.0	0.1	0.1	14.6	9.3
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	12.9	22.5
Electricity[b]	0.2	0.2	60.7	65.6	33.1	33.8	0.0	0.0
Other[c]	0.0	0.0	0.0	0.0	0.0	0.1	0.4	0.6
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Source:
U.S. Department of Energy, Energy Information Administration, Monthly Energy Review, March 1992, Washington, DC, pp. 25, 27, 29, 31.

Figure 2.5. Distribution of Energy Consumption by Sector, 1992



Source: See Table 2.4.

[a]Includes supplemental gaseous fuels. Transportation sector includes pipeline fuel only.
[b]Includes electrical system energy losses.
[c]Energy generated from geothermal, wood, waste, wind, photovoltaic, and solar thermal energy sources.

Total energy consumption rose to an all-time high in 1992 after declines in 1990 and 1991. The transportation sector continues to account for more than 27% of total energy use.

Table 2.5
Consumption of Total Energy by End-Use Sector, 1970-92[a]
(quadrillion Btu)

Year	Transportation	Percentage transportation of total	Residential and Commercial	Industrial	Total
1970	16.07	24.2%	21.71	28.65	66.43
1971	16.70	24.6%	22.59	28.59	67.88
1972	17.70	24.8%	23.69	29.88	71.27
1973	18.61	25.1%	24.14	31.53	74.28
1974	18.12	25.0%	23.72	30.70	72.54
1975	18.24	25.9%	23.90	28.40	70.54
1976	19.10	25.7%	25.02	30.23	74.36
1977	19.82	26.0%	25.39	31.08	76.29
1978	20.61	26.4%	26.09	31.39	78.09
1979	20.47	25.9%	25.81	32.62	78.90
1980	19.70	25.9%	25.65	30.61	75.96
1981	19.51	26.4%	25.24	29.24	73.99
1982	19.07	26.9%	25.63	26.14	70.85
1983	19.13	27.1%	25.63	25.76	70.52
1984	19.80	26.7%	26.48	27.86	74.14
1985	20.07	27.1%	26.70	27.21	73.98
1986	20.81	28.0%	26.85	26.63	74.30
1987	21.45	27.9%	27.62	27.83	76.90
1988	22.31	27.8%	28.92	28.99	80.22
1989	22.56	27.7%	29.40	29.36	81.33
1990	22.54	27.7%	28.79	29.93	81.26
1991	22.12	27.3%	29.43	29.59	81.14
1992	22.53	27.4%	29.23	30.59	82.36
		Average annual percentage change			
1970-92	1.5%		1.4%	0.3%	1.0%
1982-92	1.7%		1.3%	1.6%	1.5%

Source:
U.S. Department of Energy, Energy Information Administration, Monthly Energy Review, March 1993, Washington, DC, Table 2.2, p. 23.

[a]Electrical energy losses have been distributed among the sectors.

Table 2.6
Domestic Consumption of Transportation Energy by Mode and Fuel Type, 1991
(trillion Btu)

	Gasoline	Diesel fuel	Liquefied petroleum gas	Jet fuel	Residual fuel oil	Natural gas	Electricity
HIGHWAY[a]	13,300.9	3,114.5	7.4				0.8
Automobiles	8,727.1[b]	117.7					
Motorcycles	22.9						
Buses	33.8	139.2					0.8
Transit	0.3	79.5					0.8
Intercity		22.6					
School	33.5	37.1					
Trucks	4,517.1	2,857.6	7.4				
Light trucks[c]	3,928.1	148.9	3.0				
Other trucks	589.0	2,708.7	4.4				
OFF-HIGHWAY[a] (heavy-duty)[d]	95.1	570.1					
Construction	31.4	178.5					
Farming	63.7	391.6					
NONHIGHWAY[a]	292.5	720.3		1,883.3	1,015.9	620.0	304.8
Air	42.5			1,883.3			
General aviation	42.5			77.9			
Domestic air carriers				541.6			
International air carriers				263.8[e]			
Water	250.0	300.6			1,015.9		
Freight		300.6			1,015.9		
Domestic trade		233.0			94.5		
Foreign trade		67.6			921.4		
Recreational boats	250.0						
Pipeline						620.0	244.2
Natural gas						620.0	32.1
Crude petroleum[f]							91.0
Petroleum product[f]							67.4
Coal slurry[g]							3.7
Water[d]							50.0
Rail		419.7					60.6
Freight		399.3					
Passenger		20.4					60.6
Transit							41.7
Commuter rail		7.5					14.6
Intercity		12.9					4.3
MILITARY OPERATIONS[h]	13.4	139.3		563.3	12.1		
TOTAL[i]	13,701.9	4,544.2	7.4	2,446.6	1,028.0	620.0	305.6

Source: See Appendix A for Table 2.6.

[a]Civilian consumption only; military consumption shown separately.
[b]Includes gasohol.
[c]Two-axle, four-tire trucks.
[d]1985 data.
[e]This figure represents an estimate of the energy purchased in the U.S. for international air carrier consumption.
[f]1981 data.
[g]1977 data.
[h]Based on fuel purchases.
[i]Totals may not include all possible uses of fuels for transportation (e.g., snowmobiles).

Table 2.7
Domestic Consumption of Transportation Energy by Mode and Fuel Type, 1992
(trillion Btu)

	Gasoline	Diesel fuel	Liquefied petroleum gas	Jet fuel	Residual fuel oil	Natural gas	Electricity
HIGHWAY[a]	13,780.1	3,188.5	7.5			0.0	0.9
Automobiles	9,117.6[b]	122.9					
Motorcycles	23.8						
Buses	33.8	139.5				0.0	0.9
Transit	0.3	79.8				0.0	0.9
Intercity		22.6					
School	33.5	37.1					
Trucks	4,604.9	2,926.1	7.5				
Light trucks[c]	4,001.6	151.7	3.0				
Other trucks	603.3	2,774.4	4.5				
OFF-HIGHWAY[a] (heavy-duty)[d]	95.1	570.1					
Construction	31.4	178.5					
Farming	63.7	391.6					
NONHIGHWAY[a]	290.6	756.9		1,933.1	1,077.7	605.9	302.9
Air	37.7			1,933.1			
General aviation	37.7			67.0			
Domestic air carriers				1,588.0			
International air carriers				278.1[e]			
Water	252.9	310.7			1,077.7		
Freight		310.7			1,077.7		
Domestic trade		240.8			100.2		
Foreign trade		69.9			977.5		
Recreational boats	252.9						
Pipeline						605.9	243.4
Natural gas						605.9	31.3
Crude petroleum[f]							91.0
Petroleum product[f]							67.4
Coal slurry[g]							3.7
Water[g]							50.0
Rail		446.2					59.5
Freight		425.4					
Passenger		20.8					59.5
Transit							40.9
Commuter rail		7.7					14.3
Intercity		13.1					4.3
MILITARY OPERATIONS[h]	11.2	117.6		326.5	16.5		
TOTAL[i]	14,177.0	4,633.1	7.5	2,259.6	1,094.2	605.9	303.8

Source: See Appendix A for Table 2.7.

[a] Civilian consumption only; military consumption shown separately.
[b] Includes gasohol.
[c] Two-axle, four-tire trucks.
[d] 1985 data.
[e] This figure represents an estimate of the energy purchased in the U.S. for international air carrier consumption.
[f] 1981 data.
[g] 1977 data.
[h] Based on fuel purchases.
[i] Totals may not include all possible uses of fuels for transportation (e.g., snowmobiles).

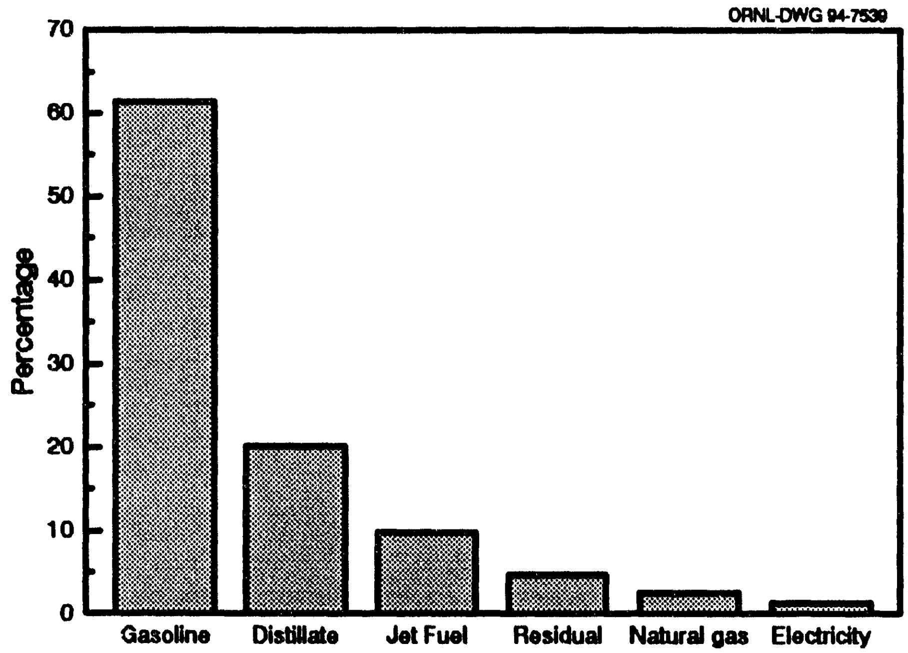
Table 2.8
Distribution of Domestic Consumption of Transportation Energy by Mode and Fuel Type, 1992
(percentage)

	Gasoline	Diesel fuel	Liquefied petroleum gas	Jet fuel	Residual fuel oil	Natural gas	Electricity
HIGHWAY[a]	**97.2**	**68.8**	**100.0**			0.0	0.3
Automobiles	**64.3**	**2.7**					
Motorcycles	**0.2**						
Buses	**0.2**	**3.0**				**0.0**	**0.3**
Transit	[b]	1.7				0.0	0.3
Intercity		0.5					
School	0.2	0.8					
Trucks	**32.5**	**63.2**	**100.0**				
Light trucks[c]	28.2	3.3	40.0				
Other trucks	4.3	59.9	60.0				
OFF-HIGHWAY[a] (heavy-duty)[d]	**0.7**	**12.3**					
Construction	**0.2**	**3.9**					
Farming	**0.4**	**8.5**					
NONHIGHWAY[a]	**2.0**	**16.3**		**85.6**	**98.5**	**100.0**	**99.7**
Air	**0.3**			**85.6**			
General aviation	0.3			3.0			
Domestic air carriers				70.3			
International air carriers				12.3[e]			
Water	**1.8**	**6.7**			**98.5**		
Freight		6.7			98.5		
Domestic trade		5.2			9.2		
Foreign trade		1.5			89.3		
Recreational boats	1.8						
Pipeline						**100.0**	**80.1**
Natural gas						100.0	10.3
Crude petroleum[f]							30.0
Petroleum product[f]							22.2
Coal slurry[g]							1.2
Water[g]							16.5
Rail		**9.6**					**19.6**
Freight		9.2					
Passenger		0.4					19.6
Transit							13.5
Commuter rail		0.2					4.7
Intercity		0.3					1.4
MILITARY OPERATIONS[h]	**0.1**	**2.5**		**14.4**	**1.5**		
TOTAL[i] (by fuel type)	**61.4**	**20.1**	**0.0**	**9.8**	**4.7**	**2.6**	**1.3**

Source: See Appendix A for Table 2.7.

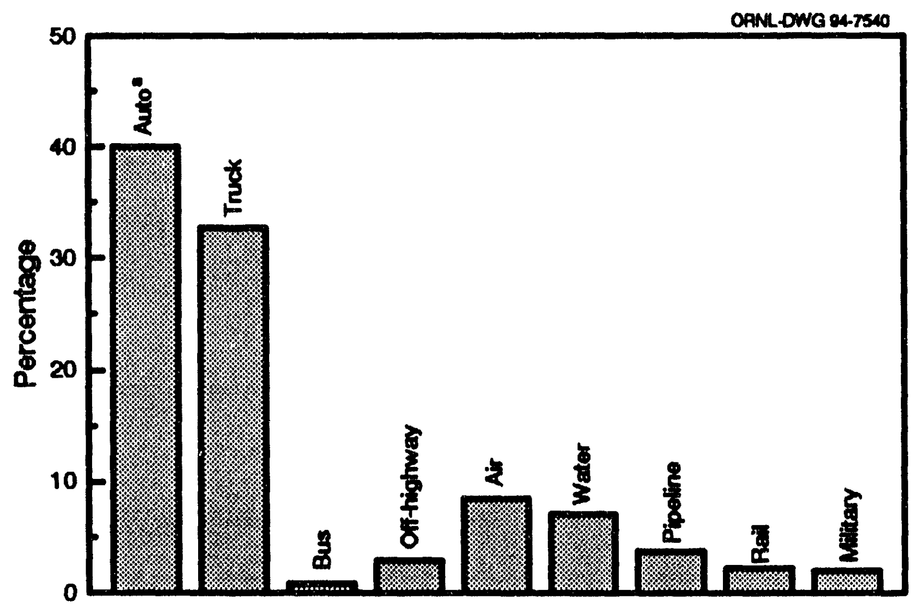
[a]Civilian consumption only; military consumption shown separately.
[b]Less than 0.05 percent.
[c]Two-axle, four-tire trucks.
[d]1985 data.
[e]This figure represents an estimate of the energy purchased in the U.S. for international air carrier consumption.
[f]1981 data.
[g]1977 data.
[h]Based on fuel purchased.
[i]Totals may not include all possible uses of fuels for transportation (e.g., snowmobiles).

Figure 2.6. Distribution of Transportation Energy Use by Fuel Type, 1992



Source: See Table 2.8.

Figure 2.7. Distribution of Transportation Energy Use by Mode, 1992



Source: See Table 2.9.

---

[a]Includes motorcycles.

Table 2.9
Transportation Energy Use by Mode, 1991-92

	Trillion Btu		Thousand barrels per day crude oil equivalent[a]		Percentage of total	
	1991	1992	1991	1992	1991	1992
HIGHWAY[b]	16,423.6	16,977.0	7,758.0	8,019.4	72.5%	73.6%
Automobiles	8,844.8	9,240.5	4,178.0	4,364.9	39.0%	40.0%
Motorcycles	22.9	23.8	10.8	11.2	0.1%	0.1%
Buses	173.8	174.2	82.1	82.3	0.8%	0.8%
Transit	80.6	81.0	38.1	38.3	0.4%	0.4%
Intercity	22.6	22.6	10.7	10.7	0.1%	0.1%
School	70.6	70.6	33.3	33.3	0.3%	0.3%
Trucks	7,382.1	7,538.5	3,487.1	3,560.9	32.6%	32.7%
Light trucks[c]	4,080.0	4,156.3	1,927.3	1,963.3	18.0%	18.0%
Other trucks	3,302.1	3,382.2	1,559.8	1,597.6	14.6%	14.7%
OFF-HIGHWAY[a] (heavy-duty)[d]	665.2	665.2	314.2	314.2	2.9%	2.9%
Construction	209.9	209.9	99.1	99.1	0.9%	0.9%
Farming	455.3	455.3	215.1	215.1	2.0%	2.0%
NONHIGHWAY[b]	4,836.8	4,967.1	2,284.7	2,346.3	21.4%	21.5%
Air	1,925.8	1,970.8	909.7	930.9	8.5%	8.5%
General aviation	120.4	104.7	56.9	49.5	0.5%	0.5%
Domestic air carriers.	1,541.6	1,588.0	728.2	750.1	6.8%	6.9%
International air carriers[e]	263.8	278.1	124.6	131.4	1.2%	1.2%
Water	1,566.5	1,641.3	740.0	775.3	6.9%	7.1%
Freight	1,316.5	1,388.4	621.9	655.8	5.8%	6.0%
Domestic	327.5	341.0	154.7	161.1	1.4%	1.5%
Foreign	989.0	1,047.4	467.2	494.8	4.4%	4.5%
Recreational	250.0	252.9	118.1	119.5	1.1%	1.1%
Pipeline	864.2	849.3	408.2	401.2	3.8%	3.7%
Natural gas	652.1	637.2	308.0	301.0	2.9%	2.8%
Crude petroleum[f]	91.0	91.0	43.0	43.0	0.4%	0.4%
Petroleum product[f]	67.4	67.4	31.8	31.8	0.3%	0.3%
Coal Slurry[g]	3.7	3.7	1.7	1.7	0.0%	0.0%
Water[g]	50.0	50.0	23.6	23.6	0.2%	0.2%
Rail	480.3	505.7	226.9	238.9	2.1%	2.2%
Freight	399.3	425.4	188.6	200.9	1.8%	1.8%
Passenger	81.0	80.3	38.3	37.9	0.4%	0.3%
Transit	41.7	40.9	19.7	19.3	0.2%	0.2%
Commuter	22.1	22.0	10.4	10.4	0.1%	0.1%
Intercity	17.2	17.4	8.1	8.2	0.1%	0.1%
MILITARY OPERATIONS[h]	728.1	471.8	343.9	222.9	3.2%	2.0%
TOTAL[i]	**22,653.7**	**23,081.1**	**10,700.9**	**10,902.7**	**100.0%**	**100.0%**

Source: See Appendix A for Table 2.7.

[a]Thousand barrels per day crude oil equivalents based on Btu content of a barrel of crude oil.
[b]Civilian consumption only; military consumption shown separately.
[c]Two-axle, four-tire trucks.
[d]1985 data.
[e]This figure represents an estimate of the energy purchased in the U.S. for international air carrier consumption.
[f]1981 data.
[g]1977 data.
[h]Based on fuel purchased.
[i]Totals may not include all possible uses of fuels for transportation (e.g., snowmobiles).

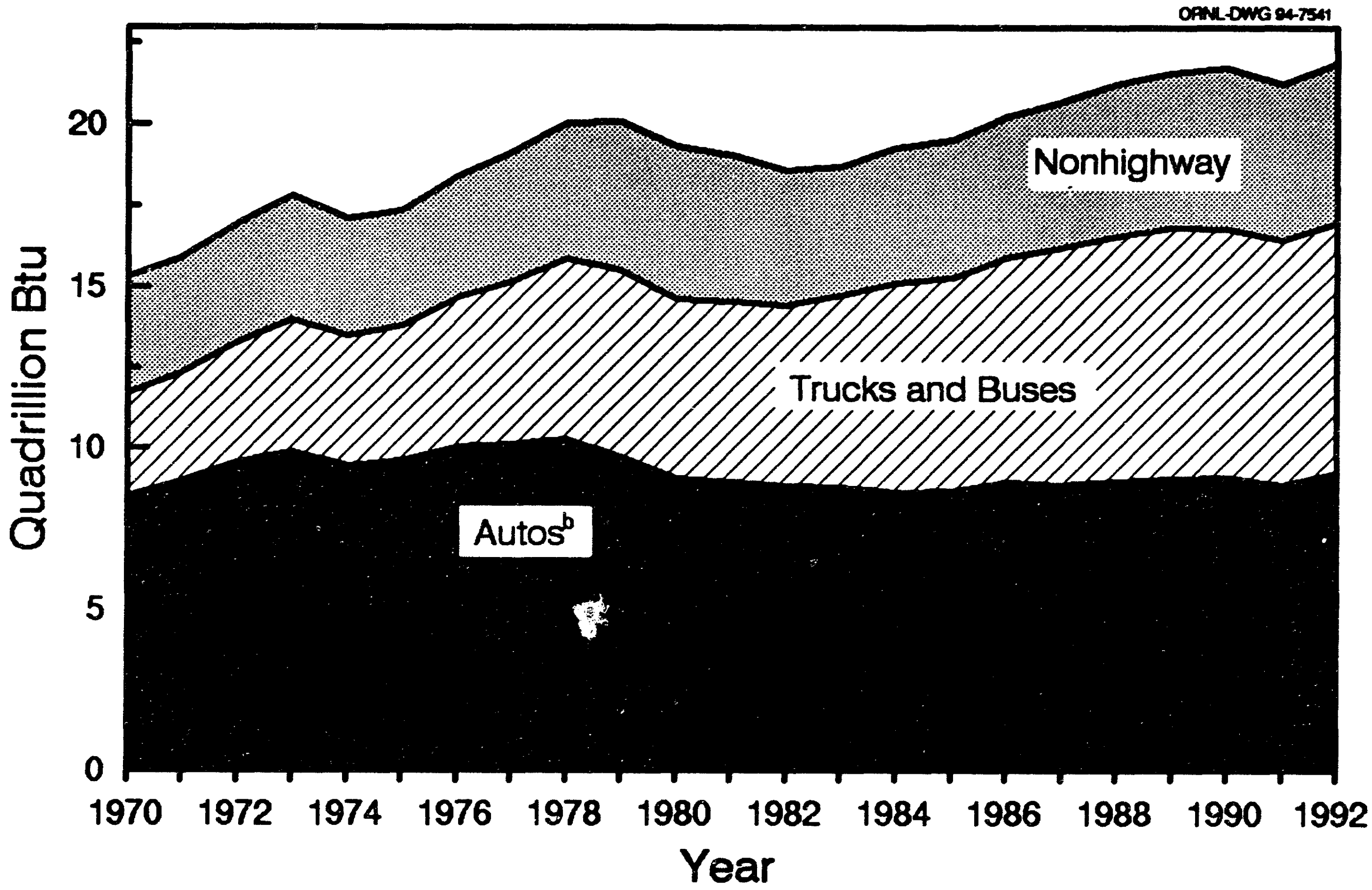
Table 2.10
Transportation Energy Consumption by Mode, 1970-92
(trillion Btu)

Year	Automobiles	Motorcycles	Buses	Light trucks[a]	Other trucks	Total highway	Air	Water	Pipeline	Rail	Total nonhighway	Total transportation[b]
1970	8,526	8	109	1,540	1,502	11,685	1,307	753	985	575	3,620	15,305
1971	8,971	9	108	1,686	1,568	12,342	1,304	698	1,007	556	3,565	15,907
1972	9,583	11	106	1,895	1,684	13,279	1,314	703	1,039	614	3,670	16,949
1973	9,890	13	109	2,105	1,844	13,961	1,377	827	996	652	3,852	17,813
1974	9,440	14	113	2,083	1,791	13,441	1,254	804	932	657	3,647	17,088
1975	9,611	14	119	2,240	1,789	13,773	1,274	851	835	596	3,556	17,329
1976	10,020	15	129	2,522	1,949	14,635	1,333	1,001	803	617	3,754	18,389
1977	10,108	16	132	2,738	2,155	15,149	1,411	1,103	781	627	3,922	19,071
1978	10,267	18	135	3,008	2,420	15,848	1,467	1,311	781	628	4,187	20,035
1979	9,719	22	137	3,094	2,510	15,482	1,568	1,539	856	656	4,619	20,101
1980	9,037	26	139	2,951	2,425	14,578	1,528	1,677	889	645	4,739	19,317
1981	8,927	27	143	2,964	2,461	14,522	1,455	1,562	899	627	4,543	19,065
1982	8,814	25	146	2,982	2,430	14,397	1,468	1,290	853	581	4,192	18,589
1983	8,762	22	145	3,196	2,599	14,724	1,505	1,187	738	574	4,004	18,728
1984	8,613	22	154	3,500	2,836	15,125	1,633	1,251	780	520	4,185	19,310
1985	8,673	23	161	3,630	2,924	15,411	1,678	1,311	758	501	4,248	19,659
1986	8,917	24	154	3,785	3,007	15,886	1,823	1,295	738	487	4,343	20,229
1987	8,863	25	157	4,032	3,137	16,214	1,894	1,326	775	496	4,491	20,704
1988	8,969	25	159	4,109	3,310	16,572	1,978	1,338	878	512	4,706	21,278
1989	9,054	26	163	4,147	3,440	16,830	1,981	1,376	895	516	4,768	21,598
1990	9,066	24	163	4,156	3,387	16,797	2,059	1,487	928	507	4,981	21,778
1991	8,845	23	174	4,080	3,302	16,424	1,926	1,567	864	480	4,837	21,261
1992	9,241	24	174	4,156	3,382	16,977	1,971	1,641	849	506	4,967	21,944
						Average annual percentage change						
1970-92	0.4%	5.1%	2.1%	4.6%	3.8%	1.7%	1.9%	3.6%	-0.7%	-0.6%	1.4%	1.7%
1982-92	0.5%	-0.4%	1.8%	3.4%	3.4%	1.7%	3.0%	2.4%	0.0%	-1.4%	1.7%	1.7%

Source:
See Appendix A for Table 2.10.

[a]Light trucks include only those trucks which have 2-axles and 4-tires.
[b]Total transportation figures do not include military and off-highway energy use and may not include all possible uses of fuel for transportation (e.g. snowmobiles).

Figure 2.8. Transportation Energy Consumption by Mode, 1970-92[a]



Source: See Table 2.10.

---

[a] Does not include military or off-highway energy use.
[b] Includes motorcycles.

Although continuing to decline in 1991, highway fuel use rose to an all-time high in 1992. The special fuels share of highway fuel declined for the first time in 1991, but rose to a high of 16.5% in 1992.

Table 2.11
Highway Usage of Gasoline and Special Fuels, 1973-92
(million gallons)

Year	Gasoline	Gasohol	Total Gasoline and Gasohol	Special fuels[a]	Percent special fuels	Total highway fuel use
1973	b	b	100,636	9,837	8.9%	110,473
1974	b	b	96,505	9,796	9.2%	106,301
1975	b	b	99,354	9,631	8.8%	108,985
1976	b	b	104,978	10,721	9.3%	115,699
1977	b	b	107,978	11,646	9.7%	119,624
1978	b	b	112,239	12,828	10.3%	125,067
1979	b	b	108,126	13,989	11.5%	122,115
1980	100,686	497	101,183	13,777	12.0%	114,960
1981	98,884	713	99,597	14,856	13.0%	114,453
1982	96,220	2,259	98,479	14,905	13.1%	113,384
1983	95,852	4,254	100,106	15,975	13.8%	116,081
1984	95,996	5,420	101,416	17,320	14.6%	118,736
1985	95,567	8,004	103,571	17,751	14.6%	121,322
1986	98,618	8,138	106,756	18,427	14.7%	125,183
1987	101,790	6,912	108,702	19,046	14.9%	127,748
1988	101,678	8,138	109,816	20,070	15.5%	129,886
1989	103,691	6,941	110,632	21,232	16.1%	131,864
1990	102,645	7,539	110,184	21,399	16.3%	131,583
1991	99,304	8,644	107,948	20,676	16.1%	128,624
1992	102,119	8,831	110,950	21,988	16.5%	132,938
			Average annual percentage change			
1973-92	c	c	0.5%	4.3%		1.0%
1982-92	0.6%	14.6%	1.2%	4.0%		1.6%

Source:
U.S. Department of Transportation, Federal Highway Administration, Highway Statistics 1991, Washington, DC, 1992, pp. 6, 8, and annual.
Total highway fuel use - Calculated as the sum of gasoline and special fuels.

[a]Special fuels consist primarily of diesel fuel, with small quantities of liquified petroleum gas.
[b]Data for gasoline and gasohol cannot be separated in this year.
[c]Data are not available.

Section 2.2.
Energy Efficiency and Intensity

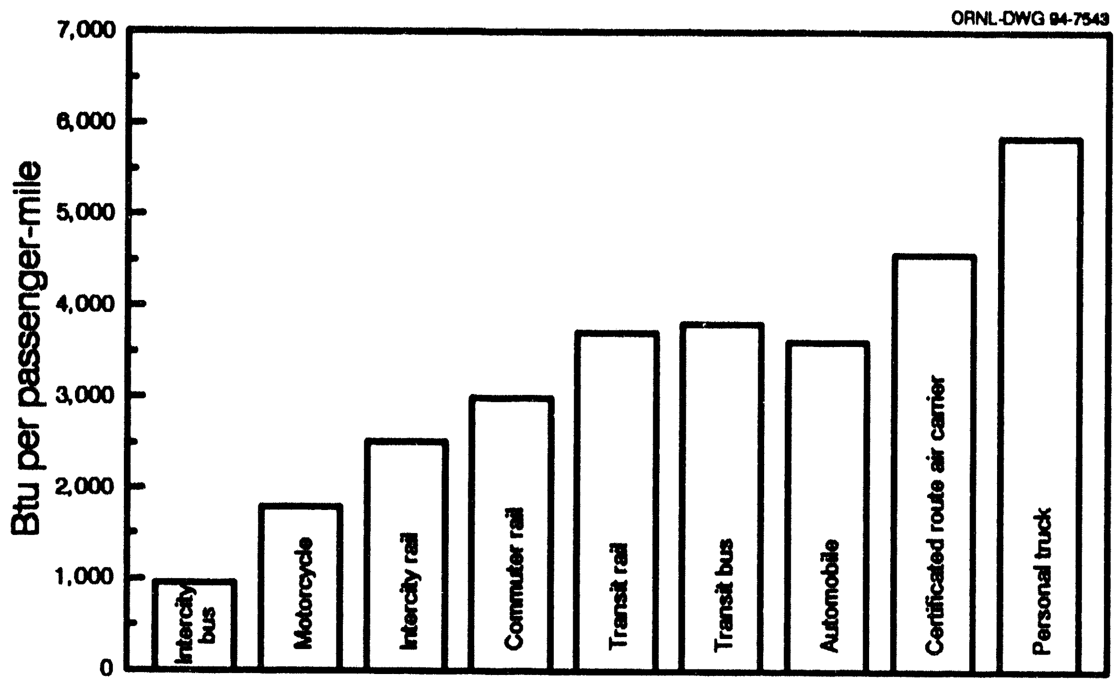
Table 2.12
Passenger Travel and Energy Use in the United States, 1991

	Number of vehicles (thousands)	Vehicle-miles (millions)	Passenger miles (millions)	Load factor (persons/vehicle)	Energy intensities (Btu per vehicle-mile)	Energy intensities (Btu per passenger-mile)	Energy use (trillion Btu)
Automobiles	**142,568.9**	**1,533,552**	**2,453,683**	**1.6**	**5,767**	**3,604**	**8,844.8**
Personal Trucks	**27,529.9**	**299,984**	**449,976**	**1.5**	**8,781**	**5,854**	**2,634.1**
Motorcycles	**4,177.4**	**9,178**	**12,849**	**1.4**	**2,495**	**1,782**	**22.9**
Buses	**591.5**	**7,495**	**127,950**	17.1	23,229	1,371	174.1
Transit[a]	57.9	2,182	21,150	9.7	36,939	3,811	80.6
Intercity	20.4	1,013	23,500	23.2	22,310	962	22.6
School	513.2	4,300	83,300	19.4	16,419	848	70.6
Air	[b]	**7,772**	**350,685**	**45.1**	**213,845**	**4,739**	**1,662.0**
Certificated route (domestic)	[b]	3,843	337,526	87.8	401,145	4,567	1,541.6
General aviation	198.5	3,918 [c]	12,600	3.2	30,730	9,556	120.4
Recreational boats	**10,271.0**						**250.0**
Rail	**17.9**	**1,082**	**24,815**	**22.9[d]**	**73,198**	**3,192**	**79.2**
Intercity[e]	2.1 [f]	312 [g]	6,273 [h]	20.1[d]	50,321	2,503	15.7
Transit[i]	11.2	553	11,158	20.2[d]	74,864 [j]	3,710	41.4
Commuter	4.6	217	7,384	34.0[d]	101,843	2,993	22.1

Source:
See Appendix A for Table 2.12.

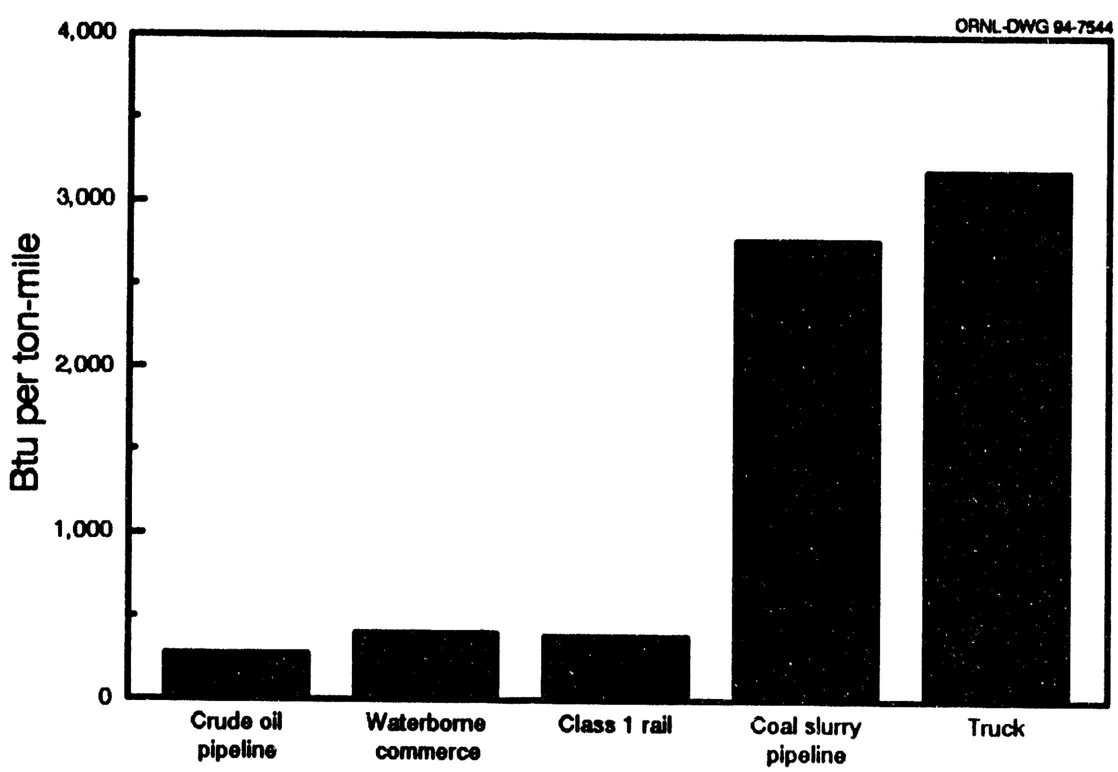
[a]Transit figures include motor bus only.
[b]Data are not available.
[c]Nautical miles.
[d]Based on passenger train car-miles.
[e]Amtrak only.
[f]Sum of passenger train cars and locomotive units.
[g]Passenger train car-miles.
[h]Revenue passenger miles.
[i]Light and heavy rail.
[j]Large system-to-system variations exist within this category.

Figure 2.9 Passenger Energy Intensities by Type of Carrier, 1991



Source: See Table 2.12.

Figure 2.10. Intercity Freight Energy Intensities by Type of Carrier, 1991



Source: See Table 2.13.

Table 2.13
Intercity Freight Movement and Energy Use in the United States, 1991

	Number of vehicles (thousands)	Vehicle-miles (millions)	Ton-miles (millions)	Tons shipped (millions)	Average length of haul (miles)	Energy intensity (Btu/ton-mile)	Energy use (trillion Btu)
Truck	**4,227**	**140,446**	**758,000**	**2,684**	**589[a]**	**3,179**	**2,409.5**
Waterborne commerce[b]	**39[c]**	[d]	**833,544[c]**	**1,118[c]**	**746[c]**	**393**	**327.5**
Coastal	[d]	[d]	479,134[c]	299[c]	1,602[c]	[d]	[d]
Lakewise	[d]	[d]	60,930[c]	110[c]	554[c]	[d]	[d]
Internal and local	[d]	[d]	293,480[c]	709[c]	470[c,e]	[d]	[d]
Pipeline	[d]	[d]	[d]	**1,458**	[d]	[d]	**814.2**
Natural gas	[d]	[d]	[d]	425	[d]	[d]	652.1
Crude oil and products	[d]	[d]	577,800	1,028	[d]	274	158.4
Coal slurry	[d]	[d]	1,338	5	273	2,765	3.7
Class I Railroads[f]	**633**	**25,628**	**1,038,875**	**1,987**	**751**	**384**	**399.3**

Source:
See Appendix A for Table 2.13.

[a]For general freight (less than truckload). Based on data from the Eno Transportation Foundation, the average length of haul for specialized freight (truckload) was 228 miles.
[b]Includes commerce by foreign and domestic carriers in the U.S.
[c]1990 data. 1991 data are not yet available.
[d]Data are not available.
[e]Internal only. Average length of haul for local was 13 miles.
[f]Railroad measures are: Number vehicles = Number freight cars, Vehicle-miles = car-miles, Ton miles = revenue ton-miles.

Table 2.14
Energy Intensities of Passenger Modes, 1970-91

Year	Automobiles (Btu per vehicle-mile)	Automobiles (Btu per passenger-mile)	Buses: Transit[a] (Btu per vehicle-mile)	Buses: Transit[a] (Btu per passenger-mile)	Buses: Intercity (Btu per passenger-mile)	Buses: School (Btu per vehicle-mile)	Air: Certificated air carriers (Btu per passenger-mile)	Air: General aviation (Btu per passenger-mile)	Rail: Intercity Amtrak (Btu per passenger-mile)	Rail: Rail transit (Btu per passenger-mile)
1970	9,301	5,471	31,796	2,472	1,051	17,857	10,351	10,374	[b]	2,453
1971	9,284	5,461	30,255	2,475	1,039	17,857	10,103	9,957	[b]	2,595
1972	9,383	5,519	30,352	2,454	1,016	16,956	9,017	10,340	[b]	2,540
1973	9,455	5,562	30,657	2,597	981	16,957	8,919	8,449	3,756	2,460
1974	9,372	5,513	31,516	2,518	949	16,980	7,917	9,054	3,240	2,840
1975	9,295	5,468	33,748	2,814	976	17,040	7,883	10,658	3,677	2,962
1976	9,293	5,467	34,598	2,896	996	17,051	7,481	10,769	3,397	2,971
1977	9,113	5,360	35,120	2,889	961	16,983	7,174	11,695	3,568	2,691
1978	8,955	5,268	36,603	2,883	953	17,018	6,333	11,305	3,683	2,210
1979	8,727	5,134	36,597	2,795	963	16,980	5,858	10,787	3,472	2,794
1980	8,130	4,782	36,553	2,813	1,169	16,379	5,837	11,497	3,176	3,008
1981	7,894	4,644	37,745	3,027	1,155	16,385	5,743	11,123	2,957	2,946
1982	7,558	4,446	38,766	3,237	1,149	16,296	5,147	13,015	3,156	3,069
1983	7,314	4,302	37,962	3,177	1,174	16,236	5,107	11,331	2,957	3,212
1984	7,031	4,136	37,507	3,204	1,247	14,912	5,031	11,912	3,027	3,732
1985	6,880	4,047	38,862	2,421	1,323	16,531	5,679	11,339	2,800	3,461
1986	6,853	4,031	39,869	3,512	869	15,622	5,447	11,935	2,574	3,531
1987	6,530	3,841	38,557	3,542	939	15,615	4,753	11,218	2,537	3,534
1988	6,275	3,598	39,121	3,415	965	15,585	4,814	11,966	2,462	3,585
1989	6,095	3,809	36,583	3,711	963	15,575	4,796	10,984	2,731	3,397
1990	5,983	3,739	36,647	3,735	944	16,368	4,811	10,146	2,609	3,453
1991	5,767	3,604	36,939	3,811	962	16,419	4,560	9,556	2,503	3,710
					Average annual percentage change					
1970-91	-2.2%	-2.0%	0.7%	2.1%	-0.4%	-0.4%	-3.8%	-0.4%	-1.7%[c]	2.0%
1982-91	-3.0%	-2.3%	-0.5%	1.9%	-2.0%	0.1%	-1.3%	-3.4%	-1.6%	2.1%

Source:
See Appendix A for Table 2.14.

[a]Transit bus statistics include motor bus only. Series not continuous between 1983 and 1984 because of a change in data source by the American Public Transit Association (APTA). Beginning in 1984, data provided by APTA are taken from mandatory reports filed with the Urban Mass Transit Administration (UMTA). Data for prior years were provided on a voluntary basis by APTA members and expanded statistically.

[b]Data are not available.

[c]Average annual percentage change is for years 1973-91.

All freight modes experienced energy efficiency improvements from 1970 to 1991. Domestic waterborne commerce, however, reversed this trend from 1982 to 1991 with a 2.9% decline in energy efficiency.

Table 2.15
Energy Intensities of Freight Modes, 1970-91

Year	Trucks			Class I freight railroad		Domestic waterborne commerce (Btu per ton-mile)
	Light truck[a] (Btu per vehicle-mile)	Other trucks (Btu per vehicle-mile)	Total trucks (Btu per vehicle-mile)	(Btu per freight car-mile)	(Btu per ton-mile)	
1970	12,491	24,142	16,399	16,748	655	545
1971	12,229	23,685	15,945	17,655	696	506
1972	12,099	23,350	15,646	18,087	706	522
1973	11,909	23,251	15,417	18,046	662	576
1974	11,398	22,555	14,669	18,422	665	483
1975	11,161	21,997	14,286	18,604	682	549
1976	11,167	22,644	14,335	18,843	677	468
1977	10,926	22,679	14,157	19,180	667	458
1978	10,765	22,887	14,093	18,802	637	383
1979	10,599	23,027	13,978	19,113	616	457
1980	10,143	22,352	13,489	18,585	592	358
1981	10,002	22,640	13,394	18,582	571	360
1982	9,741	22,736	13,103	18,224	547	310
1983	9,755	22,967	13,146	17,719	521	319
1984	9,777	22,884	13,147	17,740	508	346
1985	9,730	23,100	12,851	17,131	487	446
1986	9,729	23,106	13,082	16,855	474	463
1987	9,705	23,136	13,010	16,307	443	402
1988	9,350	23,387	12,767	16,436	434	361
1989	9,081	23,128	12,532	16,525	427	403
1990	8,904	22,581	12,230	16,254	411	388
1991	8,632	21,917	11,843	15,577	384	393[b]
			Average annual percentage change			
1970-91	-1.7%	-0.5%	-1.5%	-0.3%	-2.5%	-1.4%
1982-91	-1.3%	-0.4%	-1.0%	-1.7%	-3.9%	2.9%

Source:
See Appendix A for Table 2.15.

[a]Two-axle, four-tire trucks.
[b]Assuming ton-miles remain constant from 1990. 1991 data are not yet available.

Section 2.3.
Economics

Table 2.16
Retail Prices for Motor Fuel, 1978-92
(cents per gallon, including tax)

Year	Diesel Fuel [a]		Unleaded regular gasoline [b]		Unleaded premium gasoline [b]		Average for all gasoline types [b]	
	Current	Constant 1990[c]	Current	Constant 1990[c]	Current	Constant 1990[c]	Current	Constant 1990[c]
1978	[d]	[d]	67.0	134.2	[d]	[d]	65.2	130.6
1979	[d]	[d]	90.3	162.6	[d]	[d]	88.2	158.8
1980	101.0	160.2	124.5	197.4	[d]	[d]	122.1	193.6
1981	118.0	169.5	137.8	198.0	147.0	211.2	135.3	194.4
1982	116.0	157.0	129.6	175.5	141.5	191.6	128.1	173.4
1983	120.0	157.4	124.1	162.8	138.3	181.4	122.5	160.7
1984	122.0	153.5	121.2	152.5	136.6	171.9	119.8	150.7
1985	122.0	148.2	120.2	146.0	134.0	162.8	119.6	145.3
1986	94.0	112.0	92.7	110.5	108.5	129.3	93.1	111.0
1987	96.0	110.4	94.8	109.0	109.3	125.7	95.7	110.0
1988	95.0	104.9	94.6	104.5	110.7	122.3	96.3	106.4
1989	102.0	107.5	102.1	107.6	119.7	126.2	106.0	111.7
1990	99.0	99.0	116.4	116.4	134.9	134.9	121.7	121.7
1991	91.0	87.3	114.0	109.3	132.1	126.7	119.6	114.7
1992	106.0	98.7	112.7	104.9	131.6	122.5	119.0	110.8
	Average annual percentage change							
1978-92	0.4% [e]	-4.0% [e]	3.8%	-1.7%	-1.0% [f]	-4.8% [f]	4.4%	-1.2%
1982-92	-0.9%	-4.5%	-1.4%	-5.0%	-0.7%	4.4%-	-0.7%	-4.4%

Sources:
Gasoline - U.S. Department of Energy, Energy Information Administration, Monthly Energy Review March 1993, Washington, DC, Table 9.4, p. 108.
Diesel - U.S. Department of Energy, Energy Information Administration, International Energy Annual 1991, Washington, DC, December 1992, pp. 153.

[a]Collected from a survey of prices on January 1 of the current year.

[b]These prices were collected from a sample of service stations in 85 urban areas selected to represent all urban consumers. Urban consumers make up about 80% of the total U.S. population.

[c]Adjusted by the Consumer Price Inflation Index.

[d]Data are not available.

[e]Average annual percentage change is for years 1980-92.

[f]Average annual percentage change is for years 1981-92.

The fuel prices shown here are refiner sales prices of transportation fuels to end users, excluding tax. Sales to end users are those made directly to the ultimate consumer, including bulk consumers. Bulk sales to utility, industrial, and commercial accounts previously included in the wholesale category are now counted as sales to end users.

Table 2.17
Prices for Selected Transportation Fuels, 1978-92
(cents per gallon, excluding tax)

	Propane[a]		Finished Aviation gasoline		Kerosene-type jet fuel		Diesel fuel oil[b]	
Year	Current	Constant 1990[c]	Current	Constant 1990[c]	Current	Constant 1990[c]	Current	Constant 1990[c]
1978	33.5	67.1	51.6	103.4	38.7	77.5	37.9	75.9
1979	35.7	64.3	68.9	124.0	54.7	98.5	57.6	103.7
1980	48.2	76.4	108.4	171.9	86.6	137.3	83.0	131.6
1981	56.5	81.2	130.3	187.2	102.4	147.1	100.2	144.0
1982	59.2	80.1	131.2	177.6	96.3	130.4	95.4	129.2
1983	70.9	93.0	125.5	164.6	87.8	115.2	83.1	109.0
1984	73.7	92.7	123.4	155.3	84.2	105.9	82.6	103.9
1985	71.7	87.1	120.1	145.9	79.6	96.7	78.3	95.1
1986	74.5	88.8	101.1	120.5	52.9	63.0	49.2	58.6
1987	70.1	80.6	90.7	104.3	54.3	62.4	53.8	61.9
1988	71.4	78.9	89.1	98.4	51.3	56.7	49.2	54.4
1989	61.5	64.8	99.5	104.9	59.2	62.4	56.3	59.3
1990	74.5	74.5	112.0	112.0	76.6	76.6	69.2	69.2
1991	73.0	70.0	104.7	100.4	65.2	62.6	67.2	64.4
1992	66.2	61.6	102.7	95.6	61.0	58.3	[d]	[d]
				Average annual percentage change				
1978-92	5.0%	-0.6%	5.0%	-0.6%	3.3%	-2.0%	4.5%[e]	-1.3%
1982-92	1.0%	-2.6%	-2.4%	-6.0%	-4.5%	-7.7%	-3.8%[e]	-7.4%

Sources:
U.S. Department of Energy, Energy Information Administration, Monthly Energy Review, March 1992, Washington, DC, Table 9.7, p. 113.
Diesel fuel oil - Association of American Railroads, Railroad Facts, 1991 edition, Washington, DC, September 1991, p. 60.

[a]Consumer grade.
[b]Wholesale cost.
[c]Adjusted by the Consumer Price Inflation Index.
[d]Data are not available.
[e]Average annual percentage change is for years 1978-91 and 1982-91.

The average price of a barrel of crude oil (in constant 1990 dollars) declined by 22.8% from 1990 to 1992, while the average price of a gallon of gasoline declined only 8.9% in this same time period.

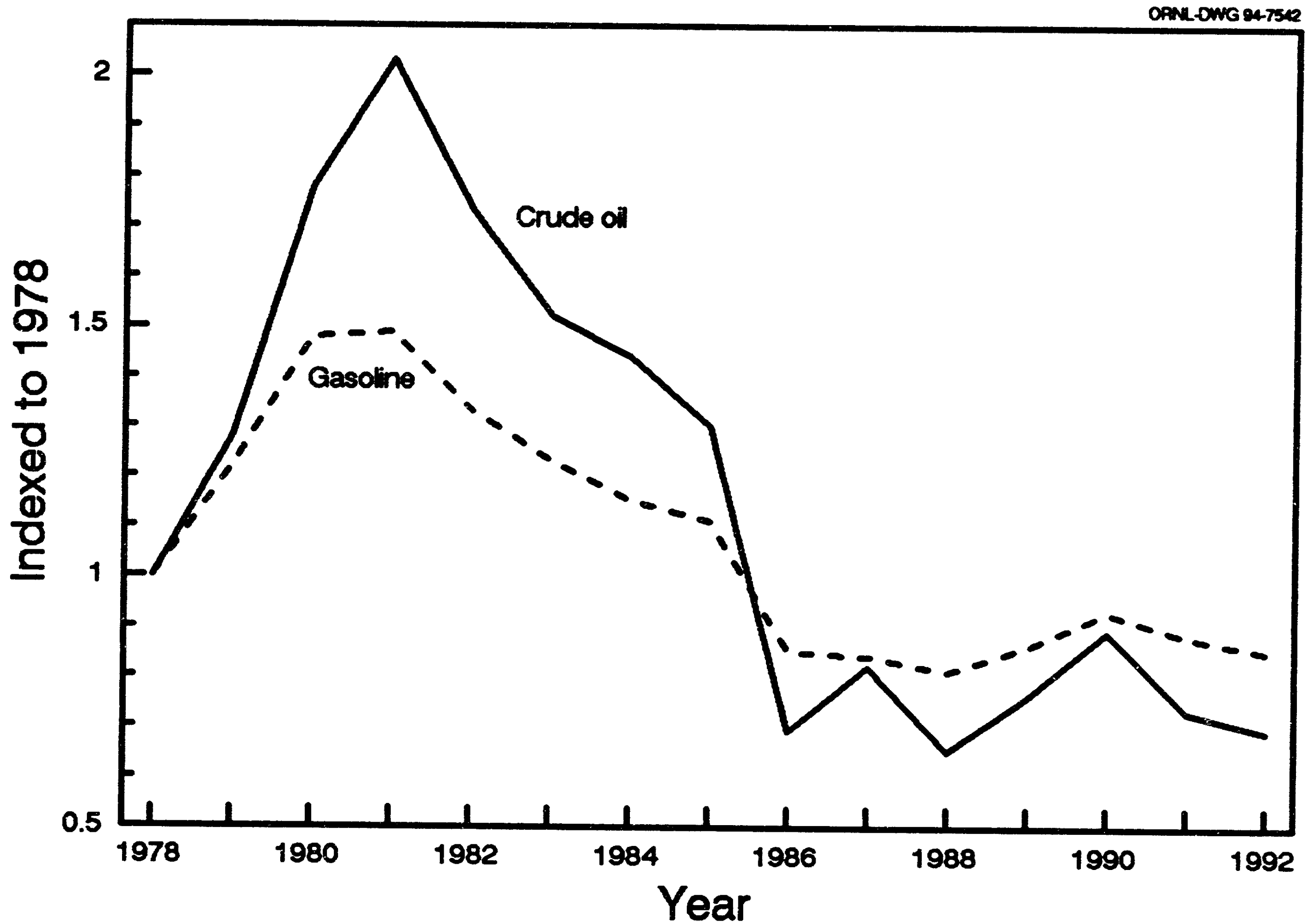
Table 2.18
Prices for a Barrel of Crude Oil and a Gallon of Gasoline, 1978-92

	Crude Oil[a] (dollars per barrel)		Gasoline[b] (dollars per gallon)	
Year	Current	Constant 1990[c]	Current	Constant 1990[c]
1978	12.46	24.96	65.2	130.6
1979	17.72	31.90	88.2	158.8
1980	28.07	44.52	122.1	193.6
1981	35.24	50.63	135.3	194.4
1982	31.87	43.15	128.1	173.4
1983	28.99	38.03	122.5	160.7
1984	28.63	36.02	119.8	150.7
1985	26.75	32.50	119.6	145.3
1986	14.55	17.34	93.1	111.0
1987	17.90	20.58	95.7	110.0
1988	14.67	16.21	96.3	106.4
1989	17.97	18.94	106.0	111.7
1990	22.22	22.22	121.7	121.7
1991	19.06	18.28	119.6	114.7
1992	18.43	17.16	119.0	110.8
		Average annual percentage change		
1978-92	3.3%	-2.3%	4.4%	-1.2%
1982-92	-5.6%	-8.8%	-0.7%	-4.4%

Sources:
Crude Oil - U.S. Department of Energy, Energy Information Administration, Monthly Energy Review, March 1993, Washington, DC, Table 9.1, p. 107.
Gasoline - U.S. Department of Energy, Energy Information Administration Monthly Energy Review, March 1993, Washington, DC, Table 9.4, p. 110.

[a]Refiner acquisition cost of composite (domestic and import) crude oil.
[b]Average for all types. These prices were collected from a sample of service stations in 85 urban areas selected to represent all urban consumers. Urban consumers make up about 80% of the total U.S. population.
[c]Adjusted by the Consumer Price Inflation Index.

Figure 2.11. Crude Oil and Gasoline Price Indices, 1978-92 (based on constant 1990 dollars)



Source: See Table 2.18.

Transportation's share of the Gross National Product (GNP) remains just under 17% in 1992. GNP has been growing at an average rate of 2.8% from 1970 to 1992, while transportation outlays have grown an average of 2.1% annually, in constant 1990 dollars.

Table 2.19
Gross National Product (GNP) as Related to Transportation, 1970-92

	Gross National Product (billion dollars)		Total transportation outlays (billion dollars)		Transportation
Year	Current	Constant 1990[a]	Current	Constant 1990[a]	as a percent of GNP
1970	1,015.5	3,031.3	195.2	582.7	19.2%
1971	1,102.7	3,127.8	222.0	629.7	20.1%
1972	1,212.8	3,304.5	242.3	660.2	20.0%
1973	1,359.3	3,499.9	266.5	686.2	19.6%
1974	1,472.8	3,490.0	282.6	669.7	19.2%
1975	1,598.4	3,463.9	298.9	647.8	18.7%
1976	1,782.8	3,671.3	351.1	723.0	19.7%
1977	1,990.5	3,871.3	400.9	779.7	20.1%
1978	2,249.7	4,076.6	453.4	821.6	20.2%
1979	2,508.2	4,182.2	503.0	838.7	20.1%
1980	2,732.0	4,167.4	524.9	800.7	19.2%
1981	3,052.6	4,259.0	592.5	826.7	19.4%
1982	3,166.0	4,163.3	591.4	777.7	18.7%
1983	3,405.7	4,308.3	643.2	813.7	18.9%
1984	3,772.2	4,573.5	715.5	867.5	19.0%
1985	4,010.3	4,730.4	753.1	888.3	18.8%
1986	4,235.0	4,861.8	760.9	873.5	18.0%
1987	4,515.6	5,053.2	807.5	903.6	17.9%
1988	4,873.7	5,268.1	868.9	939.2	17.8%
1989	5,200.8	5,416.5	915.2	953.2	17.6%
1990	5,524.5	5,524.5	964.2	964.2	17.5%
1991	5,694.9	5,444.3	957.6	915.5	16.8%
1992	5,961.9	5,508.8	1,005.5	929.1	16.9%
		Average annual percentage change			
1970-92	8.4%	2.8%	7.7%	2.1%	
1982-92	6.5%	2.8%	5.5%	1.8%	

Sources:

1970-86 GNP - U.S. Department of Commerce, Bureau of Census, Statistical Abstract of the United States 1988, p.410.

1987-92 GNP - U.S. Department of Commerce, Bureau of Economic Analysis, Survey of Current Business, July, 1993, p.9., and annual.

Transportation Outlays - Eno Transportation Foundation, Transportation in America, Eleventh Edition, Washington, DC, 1993, p.38.

[a]Adjusted by the implicit GNP price deflator.

Personal consumption expenditures (PCE) have nearly doubled from 1970 to 1992. Transportation PCE have grown 77.2% in that same time period. Transportation expenditures accounted for 11.3% of total PCE in 1992.

Table 2.20
Personal Consumption Expenditures (PCE) as Related to Transportation, 1970-92

Year	Personal Consumption Expenditures (billion dollars) Current	Personal Consumption Expenditures (billion dollars) Constant 1990[b]	Transportation Personal Consumption Expenditures[a] (billion dollars) Current	Transportation Personal Consumption Expenditures[a] (billion dollars) Constant 1990[b]	Transportation PCE as a percent of total PCE
1970	640.0	1,910.4	81.5	243.3	12.7%
1971	691.6	1,961.7	95.2	270.0	13.8%
1972	757.6	2,064.2	105.8	288.3	14.0%
1973	837.2	2,155.6	116.0	298.7	13.9%
1974	916.5	2,171.8	119.8	283.9	13.1%
1975	1,012.8	2,194.9	131.2	284.3	13.0%
1976	1,129.3	2,325.6	157.1	323.5	13.9%
1977	1,257.2	2,445.1	181.5	353.0	14.4%
1978	1,403.5	2,543.2	199.9	362.2	14.2%
1979	1,566.8	2,612.5	222.0	370.2	14.2%
1980	1,732.6	2,642.9	238.5	363.8	13.8%
1981	1,915.1	2,672.0	261.5	364.8	13.7%
1982	2,050.7	2,696.7	267.6	351.9	13.0%
1983	2,234.5	2,826.7	295.4	373.7	13.2%
1984	2,430.5	2,946.8	329.5	399.5	13.6%
1985	2,629.0	3,101.1	359.5	424.1	13.7%
1986	2,797.4	3,211.4	366.3	420.5	13.0%
1987	3,009.4	3,367.7	379.7	424.9	12.6%
1988	3,296.1	3,562.9	413.2	446.6	12.5%
1989	3,523.1	3,669.2	437.3	455.4	12.4%
1990	3,448.4	3,448.4	453.9	453.7	13.1%
1991	3,887.7	3,716.6	434.6	418.9	11.2%
1992	4,095.8	3,813.2	463.1	431.1	11.3%
		Average annual percentage change			
1970-92	8.8%	3.2%	8.2%	2.6%	
1982-92	7.2%	3.5%	5.6%	2.1%	

Sources:
1970-86 data - U.S. Department of Commerce, Bureau of Census, Statistical Abstract of the United States 1988, p.412.
1987-92 data - U.S. Department of Commerce, Bureau of Economic Analysis, Survey of Current Business, August 1993, p. 64, and annual.

[a]Transportation Personal Consumption Expenditures include user operating expenses (new and used auto purchases, gas and oil, repair, greasing, washing, parking, storage, rental, other motor vehicles, tires, tubes and other parts, insurance premiums); purchased intercity transportation; and purchased local transportation.

[b]Adjusted by the implicit GNP price deflator.

The Consumer Price Index (CPI) for transportation has more than tripled from 1970 to 1992; and the Used Car CPI continued to grow at a much faster rate than did the New Car CPI. This means that while consumers paid for a new automobile in 1992 more than double what they did in 1970, they paid almost four times more to buy a used car in 1992 than in 1970.

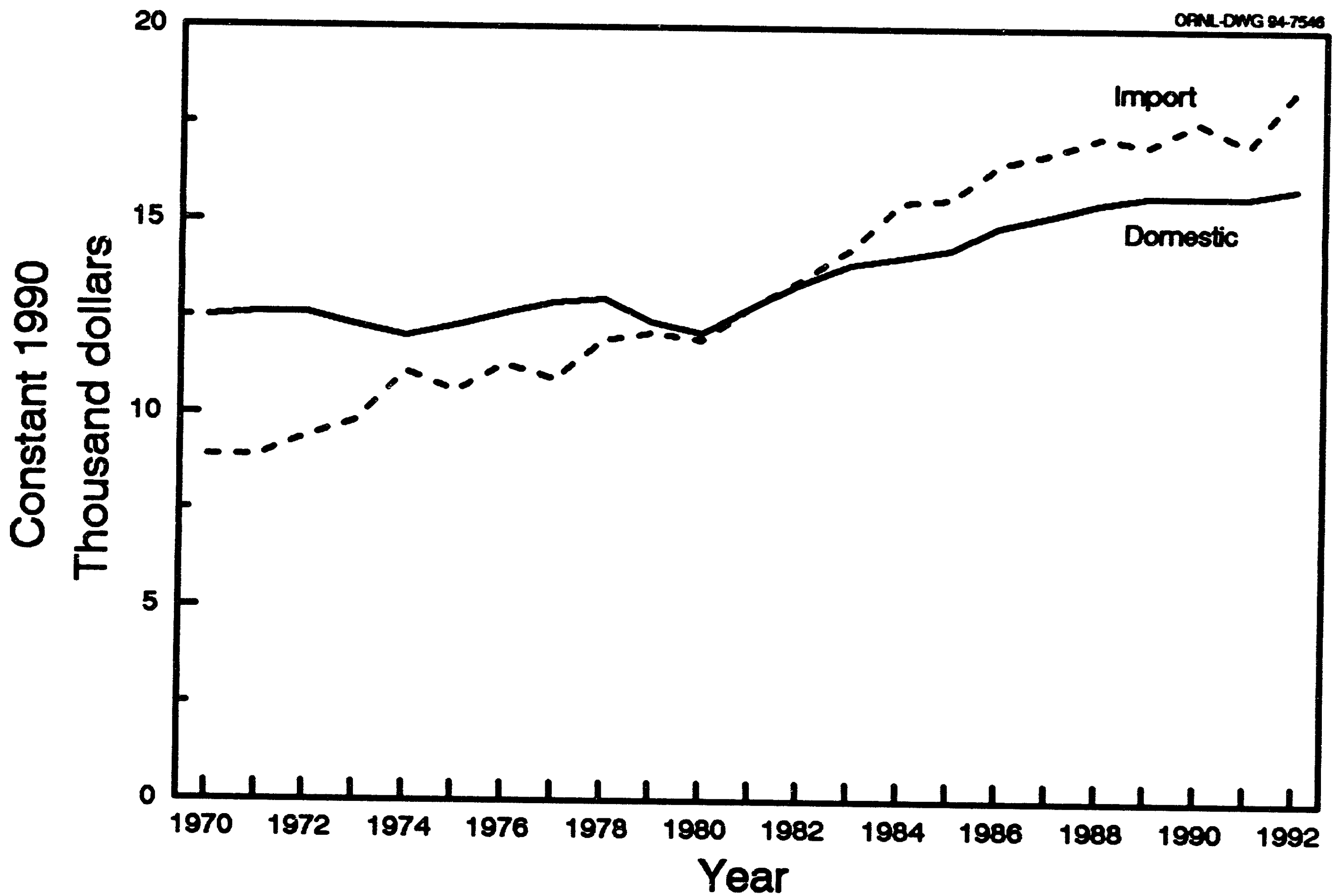
Table 2.21
Statistical Indices as Related to Transportation, 1970-92
(1970 = 1.000)

Year	Consumer Price Index	Transportation Consumer Price Index[a]	New car Consumer Price Index	Used car Consumer Price Index	Gross National Product
1970	1.000	1.000	1.000	1.000	1.000
1971	1.043	1.052	1.041	1.057	1.086
1972	1.077	1.064	1.032	1.059	1.194
1973	1.144	1.098	1.033	1.128	1.339
1974	1.270	1.222	1.092	1.175	1.450
1975	1.386	1.336	1.186	1.404	1.574
1976	1.466	1.469	1.261	1.610	1.756
1977	1.561	1.572	1.328	1.753	1.960
1978	1.680	1.646	1.429	1.788	2.215
1979	1.869	1.881	1.543	1.927	2.470
1980	2.122	2.216	1.667	1.995	2.690
1981	2.342	2.484	1.768	2.463	3.006
1982	2.486	2.587	1.836	2.842	3.118
1983	2.566	2.648	1.883	3.161	3.354
1984	2.675	2.766	1.938	3.602	3.715
1985	2.770	2.838	2.000	3.640	3.954
1986	2.824	2.728	2.087	3.487	4.176
1987	2.927	2.811	2.162	3.625	4.447
1988	3.046	2.899	2.206	3.782	4.799
1989	3.193	3.043	2.249	3.859	5.121
1990	3.365	3.213	2.283	3.769	5.382
1991	3.508	3.301	2.364	3.785	5.608
1992	3.614	3.373	2.423	3.949	5.871

Sources:
U.S. Department of Commerce, Bureau of Economic Analysis, Survey of Current Business, Washington, DC, July 1993, p. S-6, and annual.
Gross National Product - Indexed to 1970 from Table 2.19.

[a]Transportation Consumer Price Index includes new and used cars, gasoline, auto insurance rates, intracity mass transit, intracity bus fare, and airline fares.

Figure 2.12. Consumer Price Indices, 1970-92



Source: See Table 2.21.

---

[a]For each data series, the 1970 value is set equal to one, and other annual values are expressed as relative proportions.

In 1992, for the first time, the average price for all new cars in current dollars was more than 17 thousand dollars. Average domestic car prices in 1970 were $3,567 more than imports (in constant 1990 dollars), but in 1992, domestic car prices were $2,648 less than imports.

Table 2.22
Average Price of a New Car, 1970-92

	Domestic		Import		Total		Estimated Average New Car Price for a 1967 "Comparable Car"	
Year	Current dollars	Constant 1990 dollars[a]	Current dollars	Constant 1990 dollars[a]	Current dollars	Constant 1990 dollars[a]	With added safety & emissions equipment[b]	Without added safety & emissions equipment[c]
1970	3,708	12,479	2,648	8,912	3,542	11,920	3,601	3,459
1971	3,919	12,645	2,769	8,935	3,742	12,074	3,777	3,601
1972	4,034	12,601	2,994	9,352	3,879	12,117	3,789	3,570
1973	4,181	12,295	3,344	9,834	4,052	11,915	3,903	3,572
1974	4,524	11,988	4,206	11,146	4,440	11,766	4,237	3,779
1975	5,084	12,344	4,384	10,645	4,950	12,019	4,686	4,103
1976	5,506	12,640	4,923	11,301	5,418	12,438	4,988	4,362
1977	5,985	12,906	5,072	10,938	5,814	12,538	5,272	4,593
1978	6,478	12,976	5,934	11,886	6,379	12,778	5,687	4,944
1979	6,889	12,403	6,704	12,070	6,847	12,327	6,176	5,337
1980	7,609	12,067	7,482	11,886	7,574	12,012	6,863	5,764
1981	8,912	12,805	8,896	12,782	8,910	12,802	7,700	6,115
1982	9,865	13,356	9,957	13,480	9,890	13,390	8,078	6,350
1983	10,559	13,850	10,873	14,262	10,640	13,956	8,387	6,544
1984	11,172	14,056	12,354	15,543	11,450	14,405	8,685	6,742
1985	11,733	14,253	12,875	15,640	12,022	14,604	8,984	6,958
1986	12,526	14,929	13,815	16,465	12,894	15,368	9,395	7,259
1987	13,239	15,223	14,602	16,790	13,657	15,703	9,743	7,518
1988	14,029	15,498	15,537	17,164	14,468	15,983	9,995	7,668
1989	14,937	15,746	16,126	16,999	15,278	16,105	10,248	7,825
1990	15,650	15,650	17,562	17,562	16,162	16,162	10,581	7,938
1991	16,412	15,739	17,773	17,044	16,778	16,090	11,152	8,224
1992	17,068	15,890	19,912	18,538	17,784	16,557	11,462	8,427
	Average annual percentage change							
1970-92	7.2%	1.1%	9.6%	3.4%	7.6%	1.5%		
1982-92	5.6%	1.8%	7.2%	3.2%	6.0%	2.1%		

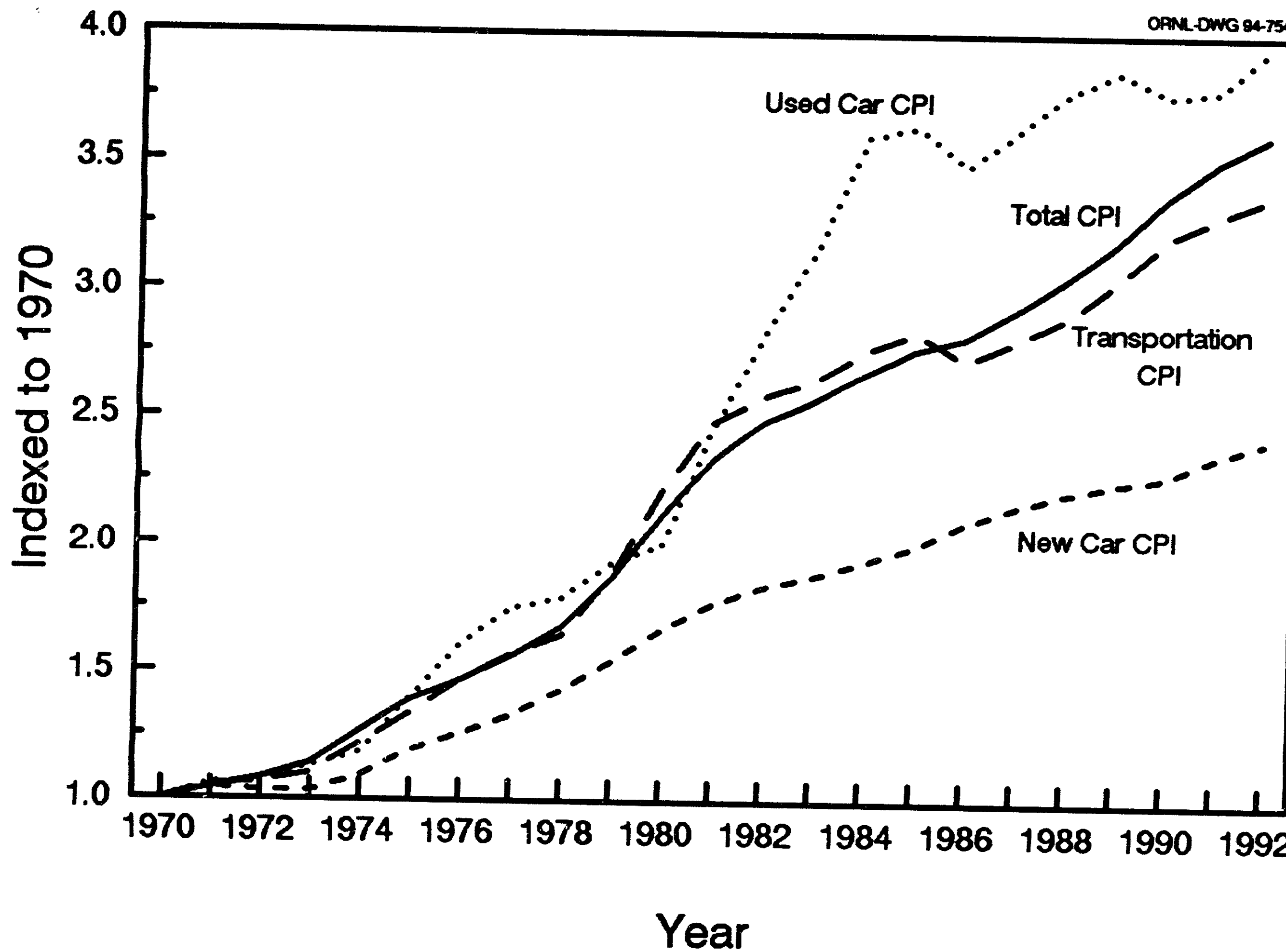
Source: American Automobile Manufacturers Association, Motor Vehicle Facts and Figures '93, Detroit, MI, 1993, p.56.

[a]Adjusted by the Consumer Price Inflation Index.

[b]1967 "Average Transaction Price" plus the value of added safety and emissions equipment as determined by the U.S. Bureau of Labor Statistics, all inflated to current dollars, using the U.S. Bureau of Labor Statistics, "New Car Consumer Price Index - All Urban consumers." For example, 1969 is equal to the 1968 value plus the BLS stated value of added safety and emissions equipment for the 1969 model year multiplied by 1968-1969 monthly changes in the New Car Consumer Price Index.

[c]1967 "Average Transaction Price" inflated to current dollars.

Figure 2.13. Average Price of New Cars, 1970-92



Source: See Table 2.22.

The total cost of operating an automobile is the sum of the fixed cost (depreciation, insurance, finance charge, and license fee) and the variable cost, which is related to the amount of travel. The cost of operating a car in 1992 was approximately 43 cents per mile. From 1985 to 1992 the fixed costs have risen an average of 5.6% per year while the variable costs have declined at an average annual rate of 2.0%.

Table 2.23
Automobile Operating Costs, 1975-92

	Variable costs (Constant 1990 cents per mile[a])				Constant 1990 dollars per 10,000 miles[a]			Total cost per mile[b] (Constant 1990 cents[a])
Year[c]	Gas and oil	Percentage gas and oil of total cost	Maintenance	Tires	Variable cost	Fixed cost	Total cost	
1975	11.70	26.3%	2.36	1.60	1,566	2,880	4,446	44.46
1977	8.86	20.3%	2.22	1.42	1,251	3,103	4,354	43.54
1979	7.40	17.1%	1.98	1.17	1,055	3,260	4,315	43.15
1980	9.29	21.0%	1.78	1.01	1,208	3,224	4,433	44.33
1981	9.01	19.6%	1.70	1.03	1,174	3,413	4,586	45.86
1982	9.12	21.5%	1.35	0.97	1,133	3,145	4,243	42.43
1983	8.71	19.9%	1.36	0.89	1,097	3,287	4,384	43.84
1984	7.79	19.8%	1.31	0.79	989	2,952	3,940	39.40
1985	7.48	22.6%	1.49	0.79	977	2,328 [d]	3,304 [d]	33.04 [d]
1986	5.34	15.1%	1.63	0.80	777	2,750 [d]	3,577 [d]	35.27 [d]
1987	5.52	14.7%	1.84	0.92	828	2,925 [d]	3,753 [d]	37.53 [d]
1988	5.74	15.6%	1.77	0.88	840	2,851 [d]	3,691 [d]	36.91 [d]
1989	5.48	13.6%	2.00	0.84	833	3,194 [d]	4,027 [d]	40.27 [d]
1990	5.40	13.2%	2.10	0.90	840	3,256 [d]	4,096 [d]	40.96 [d]
1991	6.43	15.4%	2.11	0.86	940	3,245 [d]	4,185 [d]	41.85 [d]
1992	5.59	13.1%	2.05	0.84	847	3,414 [d]	4,261 [d]	42.61 [d]
				Average annual percentage change				
1975-84	-4.4%		-6.3%	-7.5%	-5.0%	0.3%	-1.3%	-1.3%
1985-92	-4.1%		4.7%	0.9%	-2.0%	5.6%	3.7%	3.7%

Source:
American Automobile Association, "Your Driving Costs," 1993 Edition, Falls Church, VA, and annual.

[a]Adjusted by the Consumer Price Inflation Index.
[b]Based on 10,000 miles per year.
[c]Data for 1976 and 1978 are not available.
[d]Fixed and total operating costs preceeding 1985 are not comparable with figures after 1985. Fixed cost depreciation from 1975-84 was based on four years or 60,000 miles. After 1984, the depreciation was based on six years or 60,000 miles.

CHAPTER 3
HIGHWAY MODE

This chapter presents data on highway transportation and is organized into seven sections. The first Section compares data for all types of highway transportation modes. Section 3.2 presents statistics on automobiles. Truck data are presented in Section 3.3, bus data in Section 3.4, and fleet data in Section 3.5. Federal regulations and standards on fuel economy are included in Section 3.6, and high-occupancy vehicle (HOV) lanes are the subject of Section 3.7.

Highway energy use represented 77.4% of transportation energy use in 1992. Of the highway modes, automobiles had the greatest share of energy use, 42.2% (Table 3.1). The automobiles were also responsible for the majority of vehicle miles traveled in 1992. Light trucks with two axles and four tires have experienced a rapid increase in vehicle miles traveled, an average of 6.3% annually from 1970 to 1992 (Table 3.2).

The number of automobiles and trucks in use are reported by both the Federal Highway Administration and R. L. Polk and Company (Table 3.4). According to R. L. Polk, the number of automobiles in the U. S. declined from 1991 to 1992. A discussion of this decline and of differences between the two sets of estimates can be found on page 3-9.

Automobile sales which had been declining since 1988 rose slightly in 1992. Imports accounted for 23.6% of sales in 1992, declining from a high of 31.1% in 1987 (Table 3.10). Fuel economy for the automobile population has increased from 13.5 miles per gallon in 1970 to 21.6 miles per gallon in 1992 (Table 3.12). As the older autos are scrapped, they are replaced with newer, more fuel efficient autos which help to raise the population fuel economy. The sales-weighted fuel economy for new automobiles remained at 27.6 mpg for the 1990 and 1991 sales periods, as well as for the first six months of the 1992 sales period (Table 3.18).

Truck travel data are based mainly on the Truck Inventory and Use Survey (TIUS) conducted by the U.S. Bureau of the Census. As part of the nation's economic surveys, TIUS is required by law to be conducted every 5 years for the years ending in 2 and 7 to provide data on the physical and operational characteristics of the nation's truck population. The survey is based on a probability sample of private and commercial trucks registered (or licensed) in each state. The most recent survey for which results are available was conducted in 1987. In addition to trucks, the following types of vehicles were also included in the 1987 survey: minivans, vans, station wagons, and jeep-like vehicles. The 1977 and 1982 surveys did not include those vehicle types. The estimated number of trucks that were within the scope of the TIUS and registered in the U.S. as of July 1, 1987 was 44.6 million. These trucks were estimated to have been driven a total of 529,315 million miles during 1987, an increase of 40.3% from 1982. The average annual miles traveled per truck was estimated at 11,900 miles.

School and other non-revenue buses accounted for more than 86% of all 1990 buses in operation, but accounted for only 41% of bus energy use (Tables 3.27). Even with a slight decline in the number of transit buses in 1991, the vehicle-miles and passenger-miles increased form 1990 to 1991 (Table 3.27).

Tables 3.31-3.34 present data from a new study on fleet vehicles in the U. S. The study, sponsored by the Office of Transportation Technologies and the Office of Policy, Planning, and Analysis of the Department of Energy, summarized available data pertaining to fleet vehicles.

Although the **average** Corporate Average Fuel Economy (CAFE) of automobiles and light trucks has met the CAFE standard each year except 1984, there are still manufacturers who fall short of meeting the standard. The domestic automobile CAFE estimate did not meet the 1992 standard, but the import estimate exceeded the standard, pulling the combined automobile CAFE estimate above the standard (Table 3.35). The fines collected for model year 1991 violations totalled more than 39 million dollars (Table 3.36). Since 1986 the Gas Guzzler tax has been assessed on automobiles with a fuel economy rating of less than 22.5 miles per gallon. These tax rates, which remained constant from 1986 to 1990, doubled in 1991 (Table 3.38).

Section 3.1.
Highway Vehicle Characteristics

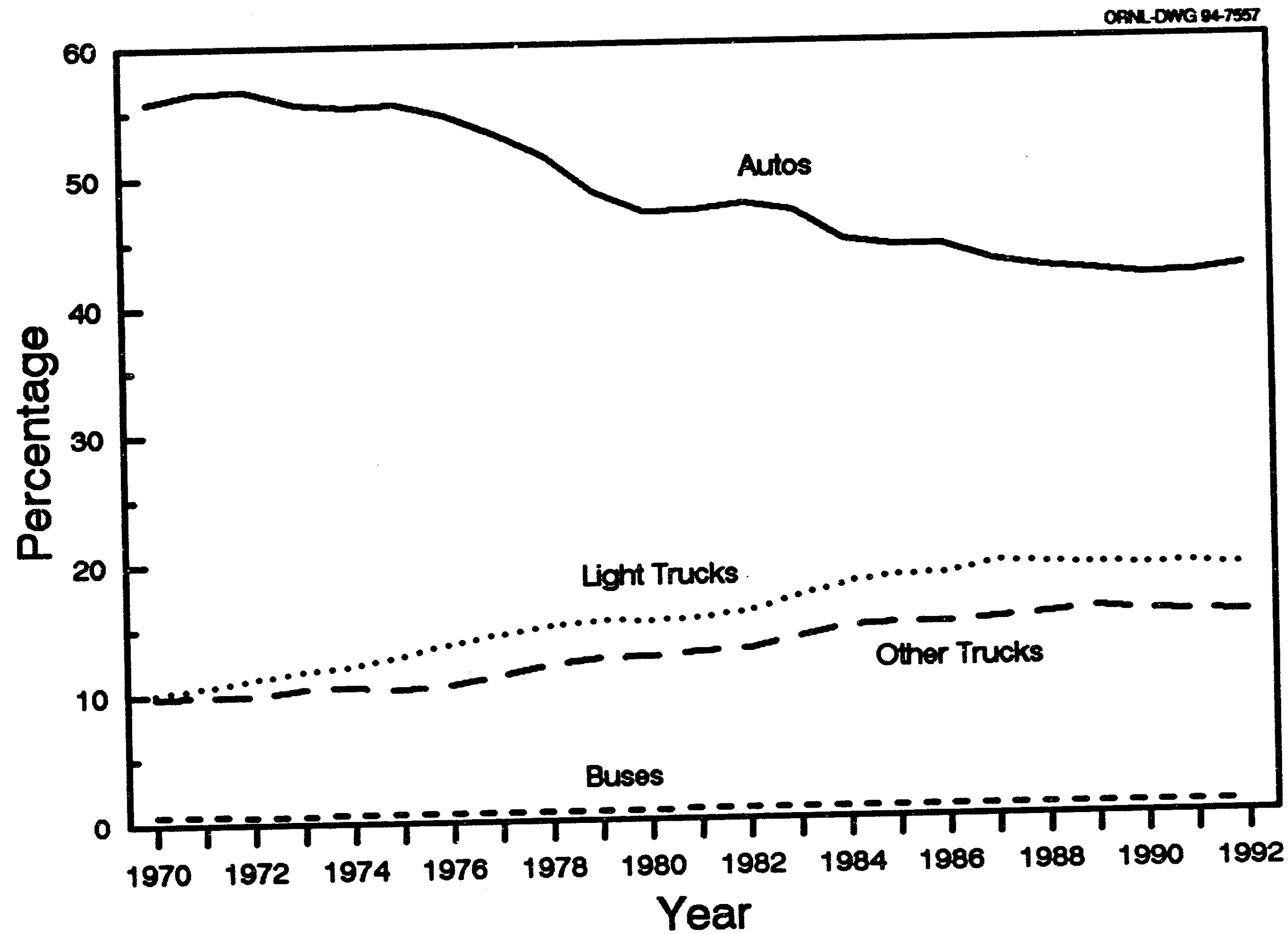
Table 3.1
Highway Energy Use by Mode, 1970-92

Year	Autos[a]	Light trucks	Other trucks	Buses	Total highway	Transportation energy use[b] (trillion Btu)
	(percentage of total)					
1970	55.8%	10.1%	9.8%	0.7%	76.3%	**15,305**
1971	56.5%	10.6%	9.9%	0.7%	77.6%	**15,907**
1972	56.6%	11.2%	9.9%	0.6%	78.3%	**16,949**
1973	55.6%	11.8%	10.4%	0.6%	78.4%	**17,813**
1974	55.3%	12.2%	10.5%	0.7%	78.7%	**17,088**
1975	55.5%	12.9%	10.3%	0.7%	79.5%	**17,329**
1976	54.6%	13.7%	10.6%	0.7%	79.6%	**18,389**
1977	53.1%	14.4%	11.3%	0.7%	79.4%	**19,071**
1978	51.3%	15.0%	12.1%	0.7%	79.1%	**20,035**
1979	48.5%	15.4%	12.5%	0.7%	77.0%	**20,101**
1980	46.9%	15.3%	12.6%	0.7%	75.5%	**19,317**
1981	47.0%	15.5%	12.9%	0.8%	76.2%	**19,065**
1982	47.5%	16.0%	13.1%	0.8%	77.4%	**18,589**
1983	46.9%	17.1%	13.9%	0.8%	78.6%	**18,728**
1984	44.7%	18.1%	14.7%	0.8%	78.3%	**19,310**
1985	44.2%	18.5%	14.9%	0.8%	78.4%	**19,659**
1986	44.2%	18.7%	14.9%	0.8%	78.5%	**20,229**
1987	42.9%	19.5%	15.2%	0.8%	78.3%	**20,704**
1988	42.3%	19.3%	15.5%	0.8%	77.9%	**21,278**
1989	42.0%	19.2%	15.9%	0.8%	77.9%	**21,598**
1990	41.6%	19.1%	15.6%	0.8%	77.1%	**21,778**
1991	41.7%	19.2%	15.5%	0.8%	77.3%	**21,261**
1992	42.2%	18.9%	15.4%	0.8%	77.4%	**21,944**

Source:
See Appendix A for Table 2.10.

[a]Includes motorcycles.
[b]Does not include off-highway and military transportation energy use.

Figure 3.1. Percentages of Highway Energy Use by Mode, 1970-92



Source: See Table 3.1.

Although automobiles continued to be responsible for the majority of highway travel, two-axle, four-tire trucks had the fastest average growth in vehicle miles for 1970-92 and 1982-92.

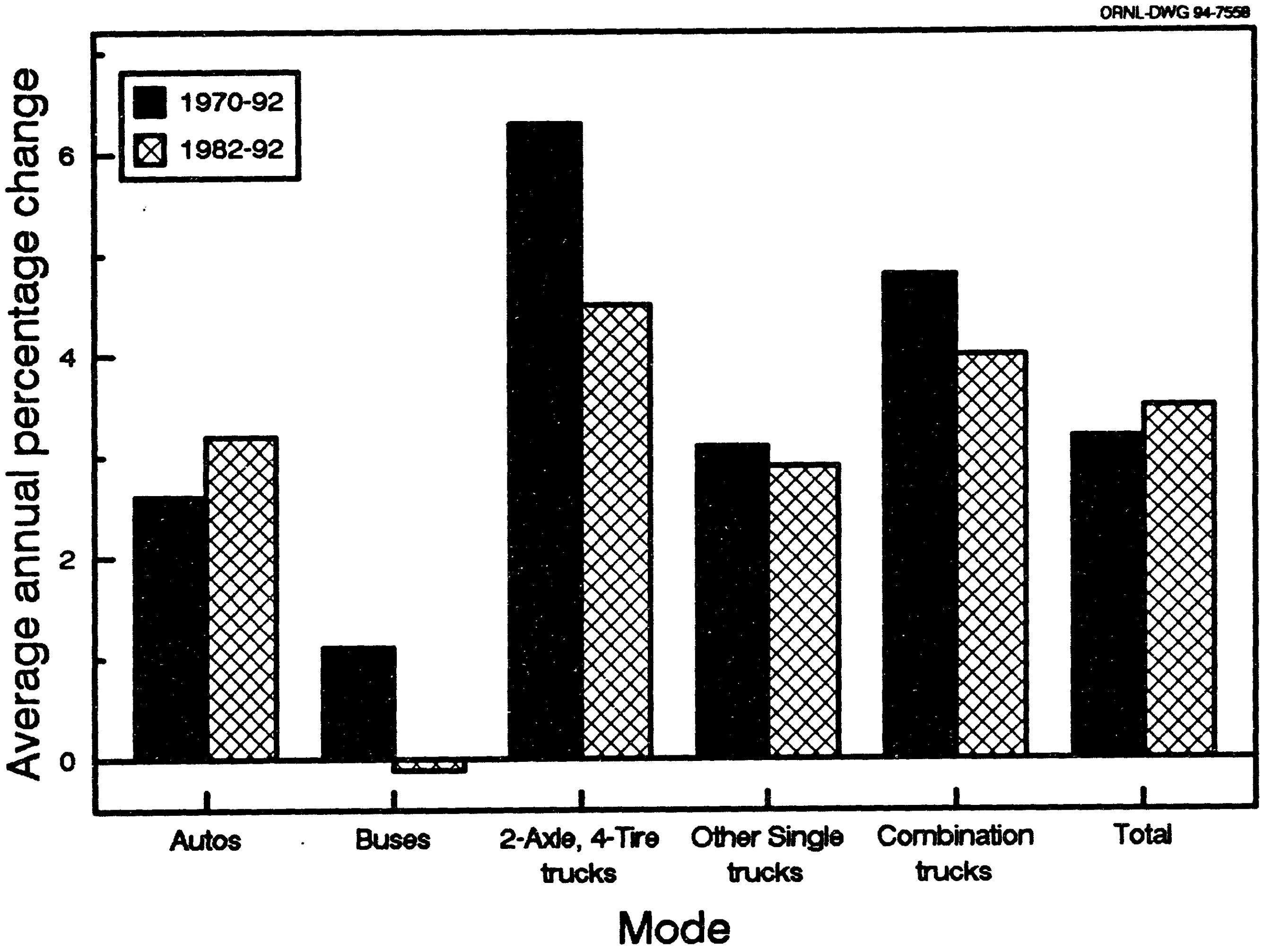
Table 3.2
Highway Vehicle Miles Traveled by Mode, 1970-92
(million miles)

Year	Automobiles[a]	Two-axle, four-tire trucks	Other single-unit trucks	Combination trucks	Buses[b]	Total
1970	919,679	123,286	27,081	35,134	4,544	1,109,724
1971	969,947	137,870	28,985	37,217	4,792	1,178,811
1972	1,025,696	156,622	31,414	40,706	5,348	1,259,786
1973	1,051,175	176,833	33,661	45,649	5,792	1,313,110
1974	1,012,696	182,757	33,441	45,966	5,684	1,280,544
1975	1,039,579	200,700	34,606	46,724	6,055	1,327,664
1976	1,084,218	225,834	36,390	49,680	6,258	1,402,380
1977	1,115,592	250,591	39,339	55,682	5,823	1,467,027
1978	1,153,666	279,414	42,747	62,992	5,885	1,544,704
1979	1,122,277	291,905	42,012	66,992	5,947	1,529,133
1980	1,121,810	290,935	39,813	68,678	6,059	1,527,295
1981	1,141,517	296,343	39,568	69,134	6,241	1,552,803
1982	1,176,166	306,141	40,212	66,668	5,823	1,595,010
1983	1,206,783	327,643	43,409	69,754	5,199	1,652,788
1984	1,233,703	357,999	46,560	77,367	4,640	1,720,269
1985	1,269,651	373,072	46,980	79,600	4,876	1,774,179
1986	1,312,921	389,123	48,413	82,696	5,087	1,838,240
1987	1,364,836	415,449	49,537	86,064	5,318	1,921,204
1988	1,439,603	439,496	51,239	90,158	5,466	2,025,962
1989	1,488,140	454,339	52,969	95,349	5,659	2,096,456
1990	1,522,741	466,092	53,443	96,367	5,719	2,144,362
1991	1,542,730	472,848	53,787	96,942	5,743	2,172,050
1992	1,604,964	476,587	53,506	99,032	5,739	2,239,828
		Average annual percentage change				
1970-92	2.6%	6.3%	3.1%	4.8%	1.1%	3.2%
1982-92	3.2%	4.5%	2.9%	4.0%	0.1%	3.5%

Source:
U.S. Department of Transportation, Federal Highway Administration, Highway Statistics 1992, Washington, DC, 1993, Table VM-1, p. 207, and annual.

[a]Includes motorcycles.
[b]The data do not correspond with vehicle miles of travel presented in the Bus section of this chapter due to differing data sources.

Figure 3.2. Annual Growth Rates of Highway Vehicle Miles Traveled by Mode, 1970-92 and 1982-92



Source: See Table 3.2.

Table 3.3
Vehicle Stock and New Sales in United States, 1992 Calendar Year

	Vehicle Stock[a] (thousands)	New Sales Domestic (thousands)	New Sales Import[b] (thousands)	New Sales Total (thousands)
Autos[c]	**120,347**	**6,277 (76.4%)**	**1,938 (23.5%)**	**8,214 (100.0%)**
Two seaters	2,681	19 (19.4%)	79 (80.6%)	98 (100.0%)
Minicompact	2,939	0 (0.0%)	93 (100.0%)	93 (100.0%)
Subcompact	28,029	1,281 (60.7%)	828 (39.3%)	2,109 (100.0%)
Compact	34,004	1,952 (76.5%)	599 (23.5%)	2,551 (100.0%)
Midsize	33,845	1,839 (84.7%)	333 (15.3%)	2,172 (100.0%)
Large	18,849	1,186 (99.5%)	6 (0.5%)	1,192 (100.0%)
Fleets of ten or more	8,502[d]	[e]	[e]	[e]
Personal autos	111,845	[e]	[e]	[e]
Motorcycles	**4,001[f]**	**195 (43.6%)**	**252 (56.4%)**	**447 (100.0%)**
Recreational vehicles	[e]	**390 (100.0%)**	**0 (0.0%)**	**390 (100.0%)**
Trucks[g]	**61,172**	**4,481 (91.4%)**	**422 (8.6%)**	**4,903 (100.0%)**
Light	56,217	4,234 (91.5%)	395 (8.5%)	4,629 (100.0%)
Medium	1,407	37 (68.5%)	17 (31.5%)	54 (100.0%)
Light-heavy	1,040	23 (82.1%)	5 (17.9%)	28 (100.0%)
Heavy-heavy	2,508	188 (97.9%)	4 (2.1%)	192 (100.0%)

Source:
See Appendix A for Table 3.3

[a]Vehicle stock as of July 1.
[b]Includes domestic-sponsored imports.
[c]These figures represent only those automobiles that could be matched to the Environmental Protection Agency size classes.
[d]Federal Government fleet data for 1992 were not available; therefore, the 1992 data were assumed to be equal to the 1991 Federal Government fleet figures.
[e]Data are not available.
[f]Includes mostly on-highway motorcycles. Many states do not require registration for off-highway vehicles.
[g]Trucks are classified by gross vehicle weight as follows:

Light	0-10,000 pounds
Medium	10,001-19,500 pounds
Light-heavy	19,501-26,000 pounds
Heavy-heavy	26,001 pounds and over.

VEHICLES IN USE

Both the Federal Highway Administration (FHWA) and R. L. Polk and Company report figures on the automobile and truck population each year. The two estimates, however, differ by as much as 25.6% for trucks. The differences can be attributed to several factors.

(1) The FHWA data include all vehicles which have been registered at any time throughout the calendar year. Therefore, the data include vehicles which were retired during the year and may double count vehicles which have been registered twice in different or the same states. The R. L. Polk data include only those vehicles which are registered on July 1 of the given year.

(2) In many states mini-vans, station wagons on truck chassis, and utility vehicles (e.g., jeep-like vehicles) are classified as passenger cars and are included in the FHWA automobile data. The R. L. Polk data included passenger vans in the automobile count until 1970; since 1980 all vans have been counted as trucks.

According to the R. L. Polk statistics, the number of passenger cars in use in the U.S. declined from 1991 to 1992. This is the first decline in vehicle stock since the figures were first reported in 1924. However, the data should be viewed with caution. A redesign of Polk's approach in 1992 allowed a national check for duplicate registrations which was not possible in earlier years. Polk estimates that due to processing limitations, it's vehicle population counts may have been inflated by as much as 1½ percent. Assuming that percentage is correct, the number of passenger cars in use would have declined from 1991 to 1992 under the previous Polk method.

The Federal Highway Administration estimates indicated growth in both the number of passenger cars and trucks from 1991 to 1992, raising the differences between FHWA and Polk for both vehicle types (20% for passenger cars, -26% for trucks). It is apparent that the method for classifying vehicles as passenger cars or trucks is different for the two sources, since the difference in total vehicles has been less than 5% each year since 1990.

Table 3.4
Automobiles and Trucks in Use, 1970-92
(thousands)

	Automobiles			Trucks			Total		
Years	FHWA	R. L. Polk	Percentage Difference	FHWA	R.L. Polk	Percentage Difference	FHWA	R.L. Polk	Percentage Difference
1970	89,244	80,448	11.0	18,797	17,688	6.3	108,041	98,136	10.1%
1971	92,718	83,138	11.5	19,871	18,462	7.6	112,589	101,600	10.8%
1972	97,082	86,439	12.3	21,308	19,773	7.8	118,390	106,212	11.5%
1973	101,985	89,805	13.6	23,244	21,412	8.6	125,229	111,217	12.6%
1974	104,856	92,608	13.2	24,630	23,312	5.7	129,486	115,920	11.7%
1975	106,704	95,241	12.0	25,781	24,813	3.9	132,485	120,054	10.4%
1976	110,189	97,818	12.6	27,876	26,560	5.0	138,065	124,378	11.0%
1977	112,288	99,904	12.4	29,314	28,222	3.7	141,602	128,126	10.5%
1978	116,573	102,957	13.2	31,336	30,565	2.5	147,909	133,522	10.8%
1979	118,429	104,677	13.1	32,914	32,583	1.0	151,343	137,260	10.3%
1980	121,601	104,564	16.3	33,667	35,268	-4.5	155,268	139,832	11.0%
1981	123,098	105,839	16.3	34,644	36,069	-4.0	157,742	141,908	11.2%
1982	123,902	106,867	15.9	35,382	36,987	-4.3	159,284	143,854	10.7%
1983	126,444	108,961	16.0	36,723	38,143	-3.7	163,167	147,104	10.9%
1984	128,158	112,019	14.4	37,507	40,143	-6.6	165,665	152,162	8.9%
1985	131,864	114,662	15.0	39,196	42,387	-7.5	171,060	157,049	8.9%
1986	135,431	117,268	15.5	40,069	44,826	-10.6	175,500	162,094	8.3%
1987	137,208	119,849	14.5	41,144	47,344	-13.1	178,352	167,193	6.7%
1988	141,252	121,519	16.2	42,529	50,221	-15.3	183,781	171,740	7.0%
1989	143,026	122,758	16.5	43,609	53,202	-18.0	186,635	175,960	6.1%
1990	143,453	123,276	16.4	44,717	56,023	-20.2	188,170	179,299	4.9%
1991	142,569	123,268	15.7	44,936	58,179	-22.8	187,505	181,438	3.3%
1992	144,213	120,347	19.8	45,504	61,172	-25.6	189,717	181,519	4.5%

Sources:
FHWA - U.S. Department of Transportation, Federal Highway Administration, Highway Statistics 1992, Washington, DC, 1993, Table VM-1, p. 207, and annual.
R. L. Polk - R. L. Polk and Company, Detroit, Michigan. **FURTHER REPRODUCTION PROHIBITED.**

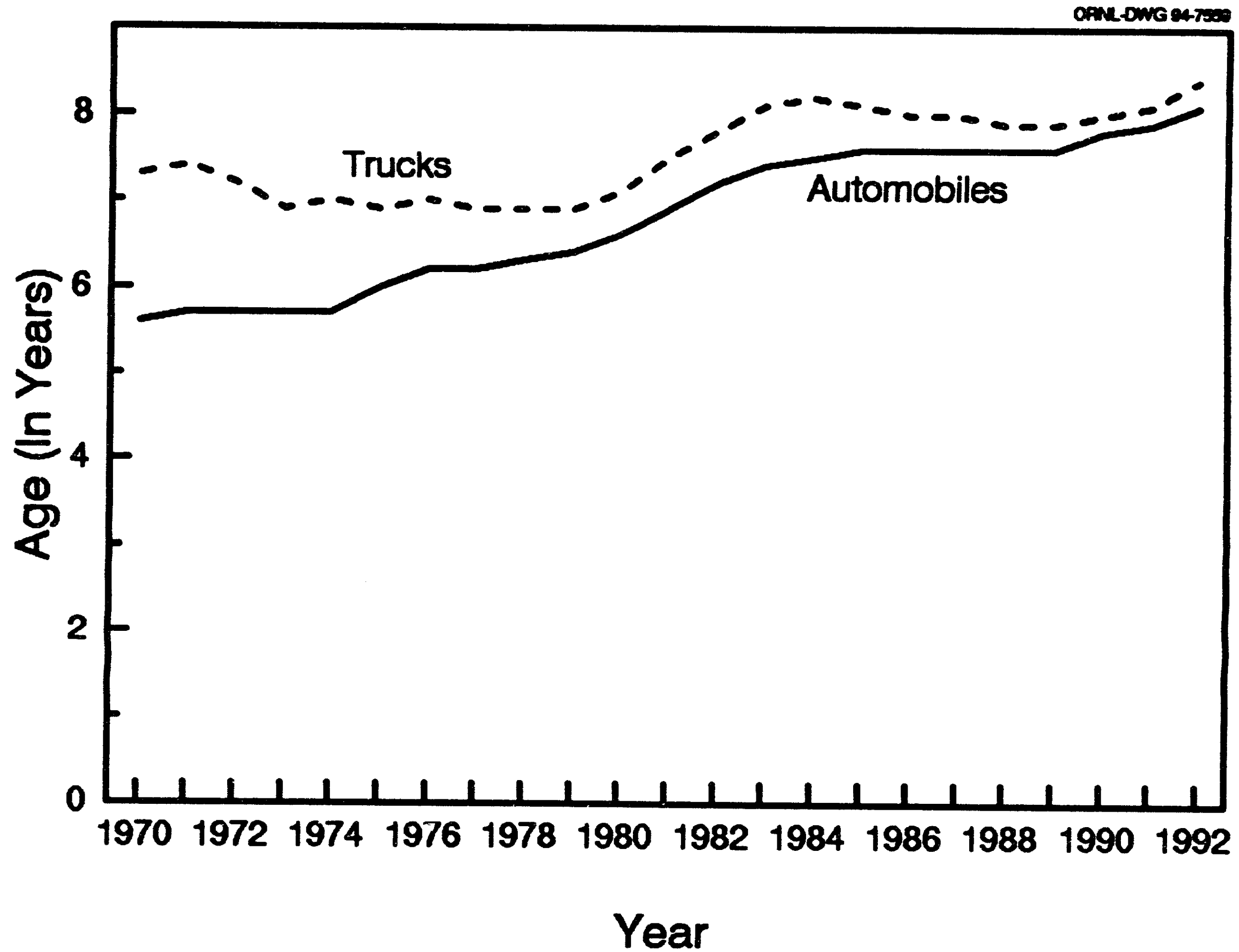
In 1992 the average age of automobiles rose above 8 years for the first time in the twelve-year series. The average age gap between autos and trucks grew to 0.3 years in 1992.

Table 3.5
Average Age of Automobiles and Trucks in Use, 1970-92
(years)

Calendar year	Automobiles		Trucks	
	Mean	Median	Mean	Median
1970	5.6	4.9	7.3	5.9
1971	5.7	5.1	7.4	6.1
1972	5.7	5.1	7.2	6.0
1973	5.7	5.1	6.9	5.8
1974	5.7	5.2	7.0	5.6
1975	6.0	5.4	6.9	5.8
1976	6.2	5.5	7.0	5.8
1977	6.2	5.6	6.9	5.7
1978	6.3	5.7	6.9	5.8
1979	6.4	5.9	6.9	5.9
1980	6.6	6.0	7.1	6.3
1981	6.9	6.0	7.5	6.5
1982	7.2	6.2	7.8	6.8
1983	7.4	6.5	8.1	7.2
1984	7.5	6.7	8.2	7.4
1985	7.6	6.9	8.1	7.6
1986	7.6	7.0	8.0	7.7
1987	7.6	6.9	8.0	7.8
1988	7.6	6.8	7.9	7.1
1989	7.6	6.5	7.9	6.7
1990	7.8	6.5	8.0	6.5
1991	7.9	6.7	8.1	6.8
1992	8.1	7.0	8.4	7.2

Source:
R. L. Polk and Co., Detroit, MI. **FURTHER REPRODUCTION PROHIBITED.**

Figure 3.3. Average Age of Automobiles and Trucks in Use, 1970-92



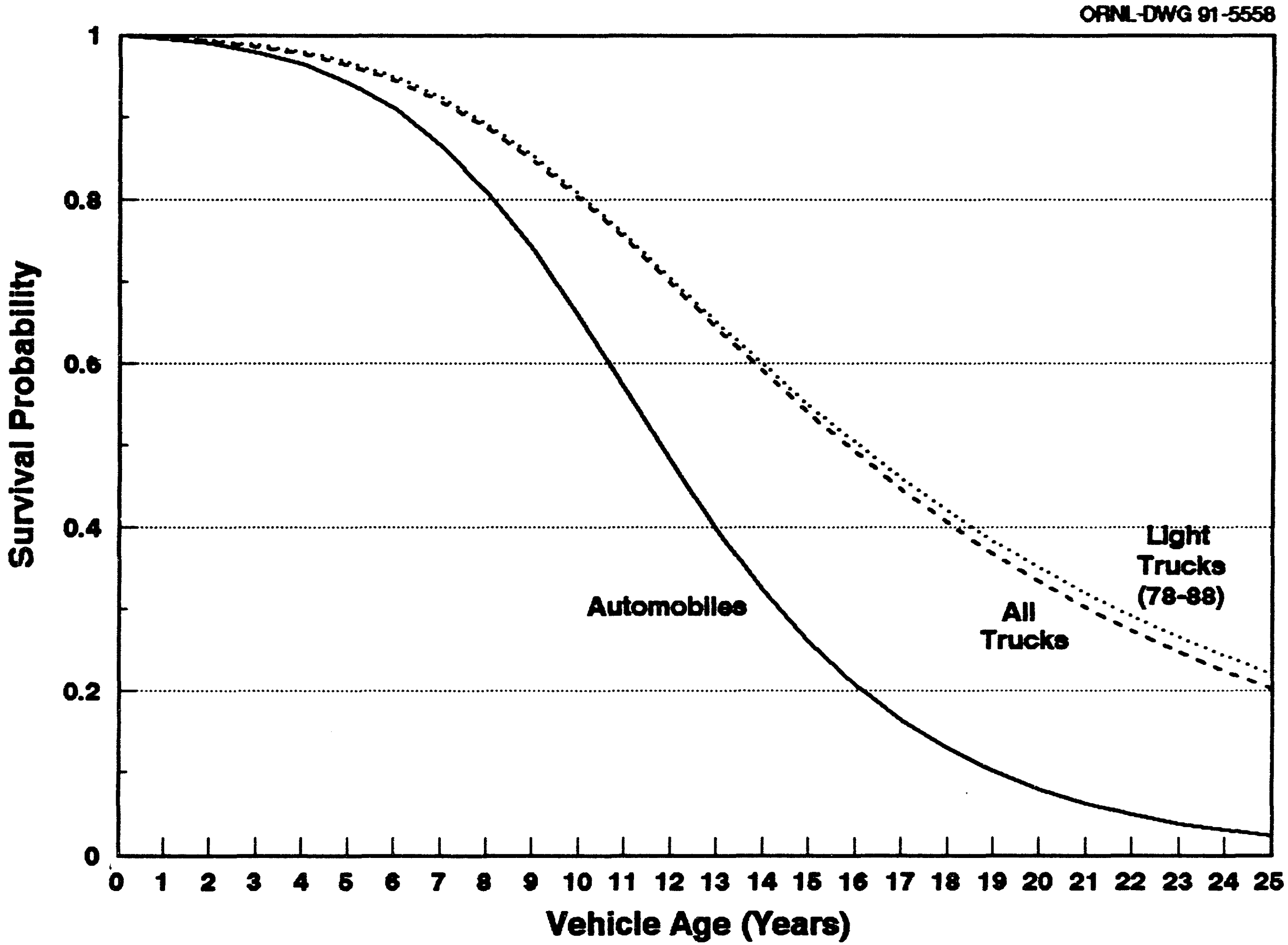
Source: See Table 3.5.

Table 3.6
Scrappage and Survival Rates for Automobiles, All Trucks, and Light Trucks

Vehicle	Automobiles (1978-89)		All Trucks (1978-89)		Light Trucks (1978-88)	
Age (Years)	Scrappage Rate	Survival Rate	Scrappage Rate	Survival Rate	Scrappage Rate	Survival Rate
0	0.00000	1.00000	0.00000	1.00000	0.00000	1.00000
1	0.00441	0.99559	0.00312	0.99688	0.00249	0.99751
2	0.00674	0.98888	0.00461	0.99228	0.00383	0.99369
3	0.01025	0.97874	0.00676	0.98557	0.00583	0.98790
4	0.01546	0.96361	0.00980	0.97591	0.00877	0.97923
5	0.02303	0.94142	0.01399	0.96226	0.01296	0.96654
6	0.03368	0.90971	0.01957	0.94343	0.01869	0.94848
7	0.04803	0.86602	0.02663	0.91830	0.02606	0.92376
8	0.06629	0.80861	0.03507	0.88609	0.03488	0.89154
9	0.08790	0.73753	0.04445	0.84671	0.04454	0.85182
10	0.11137	0.65539	0.05408	0.80092	0.05416	0.80569
11	0.13460	0.56717	0.06320	0.75030	0.06285	0.75505
12	0.15557	0.47894	0.07121	0.69687	0.07006	0.70215
13	0.17300	0.39608	0.07776	0.64268	0.07562	0.64905
14	0.18650	0.32221	0.08285	0.58944	0.07967	0.59734
15	0.19641	0.25893	0.08662	0.53838	0.08251	0.54805
16	0.20339	0.20626	0.08932	0.49029	0.08443	0.50178
17	0.20818	0.16332	0.09122	0.44557	0.08571	0.45877
18	0.21140	0.12880	0.09253	0.40434	0.08655	0.41907
19	0.21353	0.10130	0.09343	0.36656	0.08710	0.38257
20	0.21493	0.07952	0.09403	0.33209	0.08745	0.34911
21	0.21585	0.06236	0.09444	0.30073	0.08768	0.31850
22	0.21644	0.04886	0.09471	0.27225	0.08783	0.29052
23	0.21683	0.03827	0.09490	0.24641	0.08793	0.26498
24	0.21708	0.02996	0.09502	0.22300	0.08799	0.24166
25	0.21724	0.02345	0.09510	0.20179	0.08803	0.22039

Source:
Miaou, Shaw-Pin, "Study of Vehicle Scrappage Rates," Oak Ridge National Laboratory, Oak Ridge, TN, August 1990.

Figure 3.4. Survival Probabilities of Automobiles, All Trucks, and Light Trucks



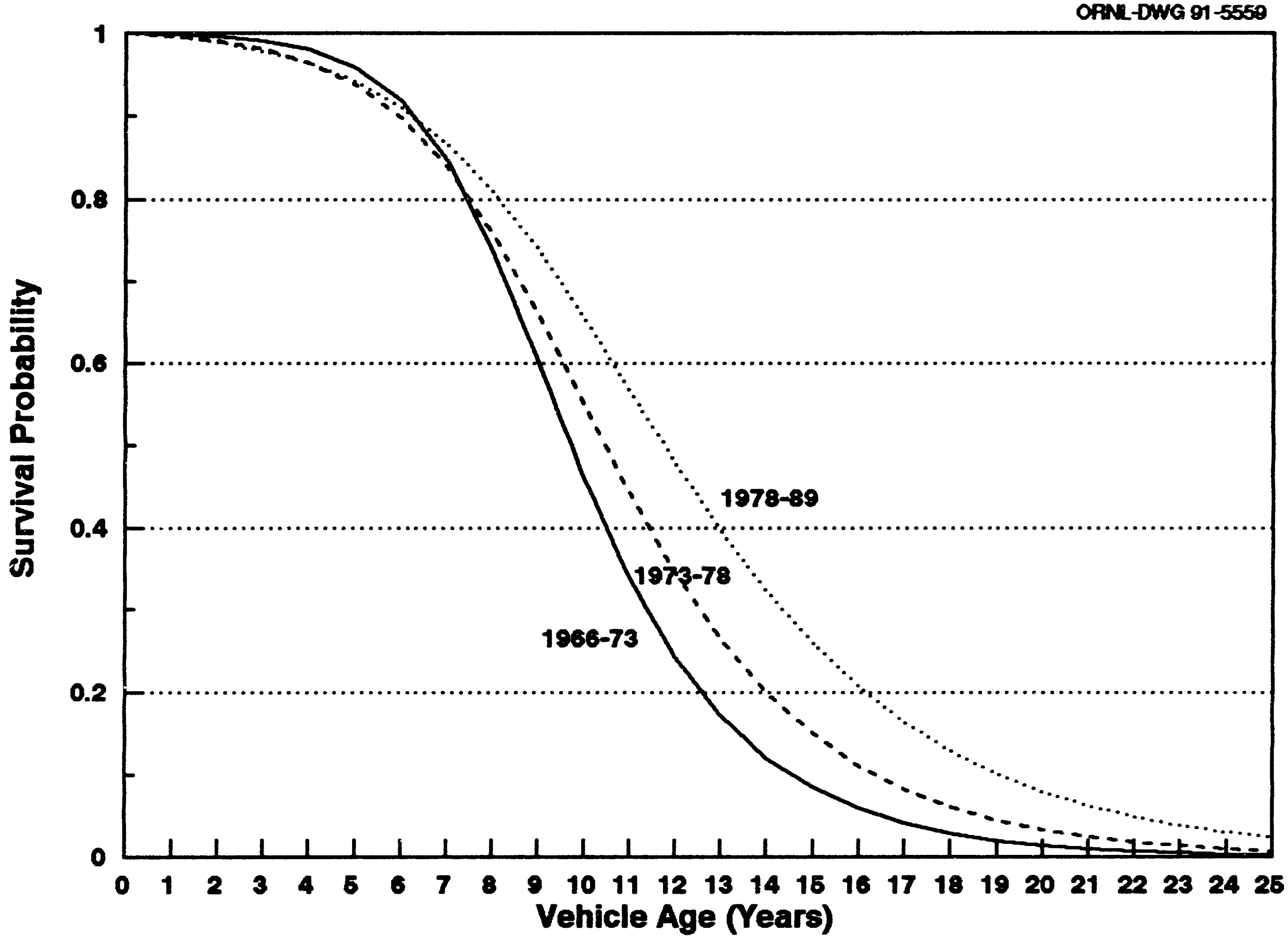
Source: See Table 3.6.

Table 3.7
Scrappage and Survival Rates for Automobiles

Vehicle Age (Years)	(1966-73) Scrappage Rate	(1966-73) Survival Rate	(1973-78) Scrappage Rate	(1973-78) Survival Rate	(1978-89) Scrappage Rate	(1978-89) Survival Rate
0	0.00000	1.00000	0.00000	1.00000	0.00000	1.00000
1	0.00115	0.99885	0.00347	0.99653	0.00441	0.99559
2	0.00244	0.99641	0.00589	0.99065	0.00674	0.98888
3	0.00513	0.99130	0.00993	0.98082	0.01025	0.97874
4	0.01069	0.98070	0.01656	0.96457	0.01546	0.96361
5	0.02182	0.95931	0.02714	0.93839	0.02303	0.94142
6	0.04283	0.91822	0.04329	0.89778	0.03368	0.90971
7	0.07844	0.84619	0.06633	0.83822	0.04803	0.86602
8	0.12895	0.73707	0.09627	0.75753	0.06629	0.80861
9	0.18510	0.60064	0.13071	0.65851	0.08790	0.73753
10	0.23288	0.46076	0.16524	0.54970	0.11137	0.65539
11	0.26512	0.33860	0.19538	0.44230	0.13460	0.56717
12	0.28362	0.24257	0.21867	0.34558	0.15557	0.47894
13	0.29327	0.17143	0.23503	0.26436	0.17300	0.39608
14	0.29804	0.12034	0.24577	0.19939	0.18650	0.32221
15	0.30034	0.08420	0.25251	0.14904	0.19641	0.25893
16	0.30144	0.05882	0.25662	0.11079	0.20339	0.20626
17	0.30196	0.04106	0.25908	0.08209	0.20818	0.16332
18	0.30221	0.02865	0.26054	0.06070	0.21140	0.12880
19	0.30232	0.01999	0.26140	0.04483	0.21353	0.10130
20	0.30238	0.01394	0.26190	0.03309	0.21493	0.07952
21	0.30240	0.00973	0.26220	0.02442	0.21585	0.06236
22	0.30241	0.00679	0.26237	0.01801	0.21644	0.04886
23	0.30242	0.00473	0.26247	0.01328	0.21683	0.03827
24	0.30242	0.00330	0.26253	0.00980	0.21708	0.02996
25	0.30242	0.00230	0.26257	0.00722	0.21724	0.02345

Source:
Miaou, Shaw-Pin, "Study of Vehicle Scrappage Rates," Oak Ridge National Laboratory, Oak Ridge, TN, August 1990.

Figure 3.5. Survival Probabilities of Automobiles



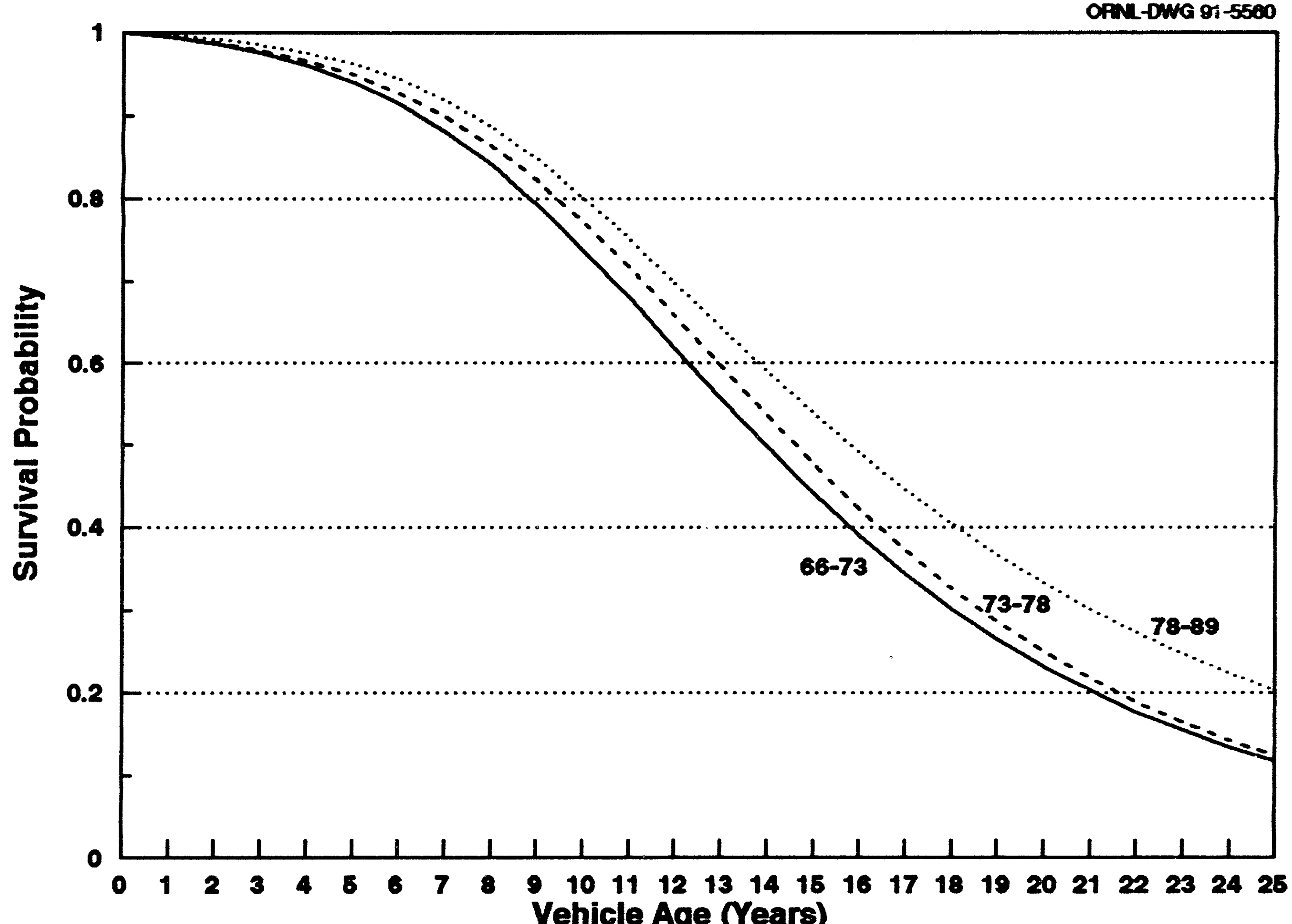
Source: See Table 3.7.

Table 3.8
Scrappage and Survival Rates for All Trucks

Vehicle Age (Years)	(1966-73) Scrappage Rate	(1966-73) Survival Rate	(1973-78) Scrappage Rate	(1973-78) Survival Rate	(1978-89) Scrappage Rate	(1978-89) Survival Rate
0	0.00000	1.00000	0.00000	1.00000	0.00000	1.00000
1	0.00582	0.99418	0.00505	0.99495	0.00312	0.99688
2	0.00814	0.98608	0.00698	0.98801	0.00461	0.99228
3	0.01129	0.97495	0.00958	0.97854	0.00676	0.98557
4	0.01550	0.95983	0.01306	0.96576	0.00980	0.97591
5	0.02101	0.93967	0.01762	0.94873	0.01399	0.96226
6	0.02798	0.91337	0.02347	0.92647	0.01957	0.94343
7	0.03649	0.88005	0.03073	0.89800	0.02663	0.91830
8	0.04638	0.83923	0.03943	0.86260	0.03507	0.88609
9	0.05730	0.79114	0.04940	0.81999	0.04445	0.84671
10	0.06863	0.73685	0.06026	0.77058	0.05408	0.80092
11	0.07970	0.67812	0.07147	0.71551	0.06320	0.75030
12	0.08987	0.61718	0.08239	0.65656	0.07121	0.69687
13	0.09872	0.55625	0.09247	0.59585	0.07776	0.64268
14	0.10605	0.49726	0.10130	0.53548	0.08285	0.58944
15	0.11189	0.44162	0.10871	0.47727	0.08662	0.53838
16	0.11638	0.39023	0.11468	0.42254	0.08932	0.49029
17	0.11976	0.34349	0.11936	0.37210	0.09122	0.44557
18	0.12225	0.30150	0.12294	0.32636	0.09253	0.40434
19	0.12406	0.26410	0.12562	0.28536	0.09343	0.36656
20	0.12536	0.23099	0.12761	0.24894	0.09403	0.33209
21	0.12629	0.20182	0.12906	0.21681	0.09444	0.30073
22	0.12696	0.17620	0.13012	0.18860	0.09471	0.27225
23	0.12743	0.15374	0.13089	0.16392	0.09490	0.24641
24	0.12776	0.13410	0.13144	0.14237	0.09502	0.22300
25	0.12799	0.11694	0.13183	0.12360	0.09510	0.20179

Source:
Miaou, Shaw-Pin, "Study of Vehicle Scrappage Rates," Oak Ridge National Laboratory, Oak Ridge, TN, August 1990.

Figure 3.6. Survival Probabilities of All Trucks



Source: See Table 3.8.

AIIM

Association for Information and Image Management

1100 Wayne Avenue, Suite 1100
Silver Spring, Maryland 20910

301/587-8202

Centimeter

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 mm

1 2 3 4 5

Inches

MANUFACTURED TO AIIM STANDARDS

BY APPLIED IMAGE, INC.

Table 3.9
Production of Automobiles and Trucks by State, Model Year 1992

State	Automobiles Number	Automobiles Percentage	Trucks Number	Trucks Percentage
California	298,559	5.3%		
Delaware	397,566	7.1%		
Georgia	337,600	6.0%		
Illinois	566,976	10.1%		
Indiana	58,728	1.0%	271,991	7.4%
Kansas	119,319	2.1%		
Kentucky	277,479	4.9%	472,771	12.9%
Louisiana			155,583	4.2%
Maryland			185,360	5.0%
Michigan	1,563,156	27.7%	600,273	16.3%
Minnesota			113,995	3.1%
Missouri	416,193	7.4%	625,176	17.0%
New Jersey			92,120	2.5%
New York			113,610	3.1%
North Carolina			16,591	0.5%
Ohio	914,951	16.2%	631,228	17.2%
Oklahoma	233,843	4.1%		
Oregon			11,061	0.3%
Pennsylvania			3,379	0.1%
South Carolina			7,884	0.2%
Tennessee	310,579	5.5%	137,893	3.8%
Texas	142,963	2.5%	5,346	0.1%
Utah			3,116	0.1%
Virginia			128,433	3.5%
Washington			6,044	0.2%
Wisconsin			89,575	2.4%
Total U.S.	5,637,912	100.0%	3,673,822[a]	100.0%

Source:
H. A. Stark (ed), Ward's Communications, Inc., Ward's Automotive Yearbook, Detroit, MI, 1993, pp. 188, 194.

[a]Total includes 2,393 miscellaneous medium and heavy-duty trucks.

Section 3.2.
Automobiles

Although the import share of total retail automobile sales dropped 7.6% from 1987 to 1992, the percentage of transplant sales increased by 8.9% in the same time period. Total sales in 1992 continued to be below 9 million autos.

Table 3.10
New Retail Automobile Sales in the United States, 1970-92

Calendar year	Domestic	Import[a]	Total	Percentage import	Percentage transplants[b] on model year basis	Percentage imports and transplants	Percentage diesel
		(thousands)					
1970	7,119	1,285	8,404	15.3	c	c	c
1971	8,681	1,568	10,249	15.3	c	c	0.06
1972	9,327	1,623	10,950	14.8	c	c	0.05
1973	9,676	1,763	11,439	15.4	c	c	0.06
1974	7,454	1,399	8,853	15.8	c	c	0.20
1975	7,053	1,571	8,624	18.2	c	c	0.31
1976	8,611	1,499	10,110	14.8	0.0	14.8	0.22
1977	9,109	2,074	11,183	18.5	0.0	18.5	0.34
1978	9,312	2,002	11,314	17.7	0.0	17.7	1.02
1979	8,341	2,332	10,673	21.8	1.3	23.1	2.54
1980	6,581	2,398	8,979	26.7	2.1	28.8	4.31
1981	6,209	2,327	8,536	27.3	1.8	29.1	6.10
1982	5,759	2,223	7,982	27.9	1.4	29.3	4.44
1983	6,795	2,387	9,182	26.0	1.3	27.3	2.09
1984	7,952	2,439	10,391	23.5	2.0	25.5	1.45
1985	8,205	2,838	11,043	25.7	2.2	27.9	0.82
1986	8,215	3,238	11,453	28.3	2.8	31.1	0.37
1987	7,081	3,197	10,278	31.1	5.2	36.3	0.16
1988	7,526	3,099	10,626	29.2	5.8	35.0	0.01
1989	7,073	2,825	9,898	28.5	7.3	35.8	0.13
1990	6,897	2,404	9,301	25.8	11.2	37.0	0.08
1991	6,137	2,038	8,175	24.9	13.7	38.6	0.11
1992	6,277	1,938	8,214	23.6	14.1	37.7	0.06
			Average annual percentage change				
1970-92	-0.6%	1.9%	-0.1%				
1982-92	0.9%	-1.4%	0.3%				

Sources:

Domestic and import data - American Automobile Manufacturers Association, Motor Vehicle Facts and Figures '93, Detroit, MI, 1993, p. 14, and annual.

Diesel data - H. A. Stark (ed), Ward's Communications, Inc., Ward's Automotive Yearbook, Detroit, MI, 1993, p. 50, and annual.

Transplant data - Oak Ridge National Laboratory, Light-Duty Vehicle MPG and Market Shares Data System, Oak Ridge, TN, 1994

[a]Does not include import tourist deliveries.

[b]A transplant is an automobile which was built in the U.S. by a foreign firm. Also included are joint ventures which are built in the U.S.

[c]Data are not available.

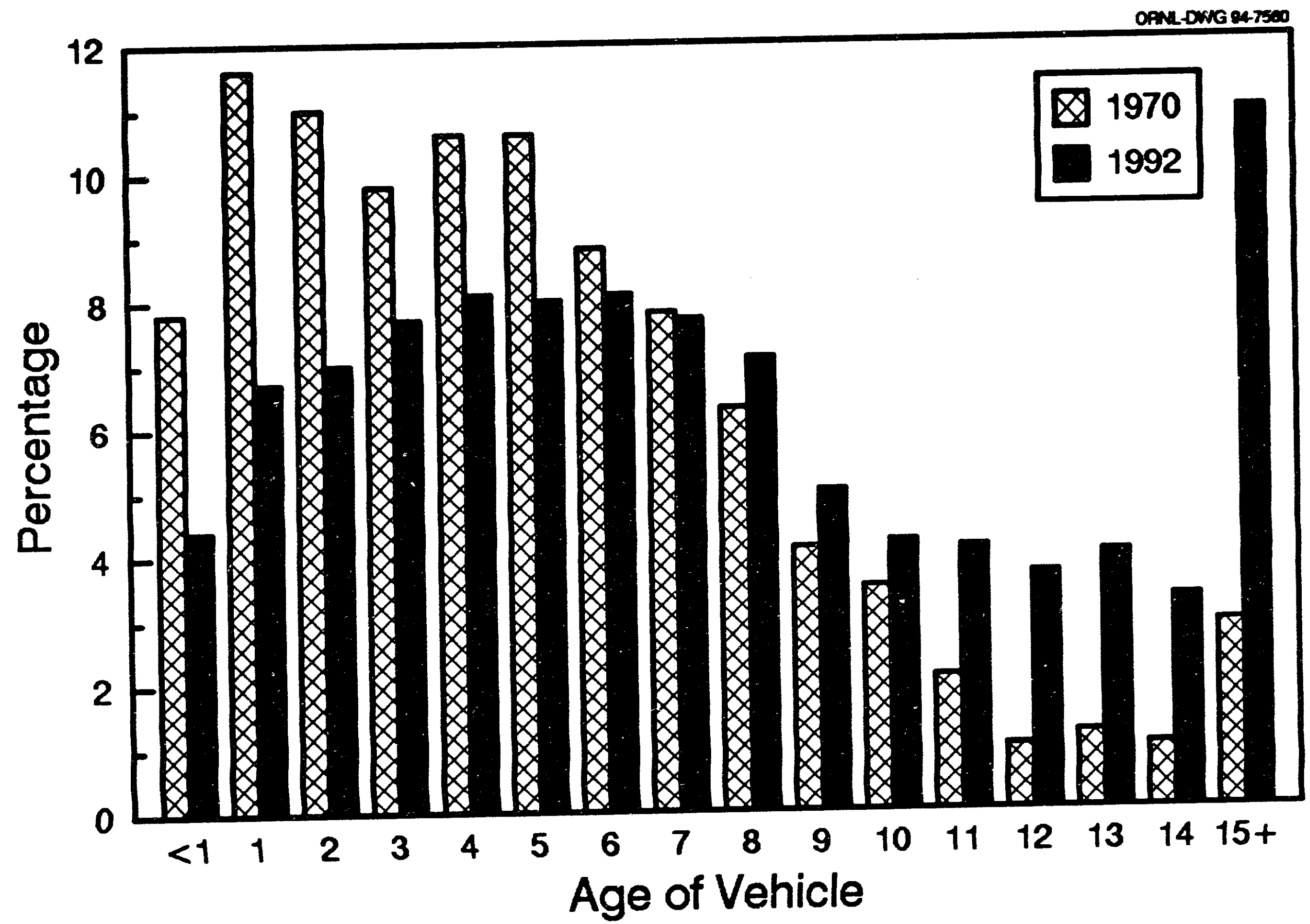
Table 3.11
Automobiles in Operation and Vehicle Travel by Age, 1970 and 1992

Age (years)	1970 Vehicles (thousands)	1970 Percentage	1970 Cumulative percentage	1992 Vehicles (thousands)	1992 Percentage	1992 Cumulative percentage	1992 Estimated vehicle travel Percentage	1992 Estimated vehicle travel Cumulative percentage
Under 1[a]	6,288	7.8	7.8	5,258	4.4%	4.4%	5.6%	5.6%
1	9,299	11.6	19.4	8,100	6.7%	11.1%	8.9%	14.5%
2	8,816	11.0	30.3	8,372	7.0%	18.1%	8.7%	23.2%
3	7,878	9.8	40.1	9,309	7.7%	25.8%	9.3%	32.5%
4	8,538	10.6	50.8	9,761	8.1%	33.9%	9.2%	41.7%
5	8,506	10.6	61.3	9,640	8.0%	41.9%	8.4%	50.1%
6	7,116	8.8	70.2	9,752	8.1%	50.0%	8.7%	58.8%
7	6,268	7.8	78.0	9,214	7.7%	57.7%	7.6%	66.4%
8	5,058	6.3	84.3	8,567	7.1%	64.8%	7.3%	73.7%
9	3,267	4.1	88.3	5,998	5.0%	69.8%	4.4%	78.1%
10	2,776	3.5	91.8	5,077	4.2%	74.0%	3.8%	81.8%
11	1,692	2.1	93.9	4,887	4.1%	78.1%	3.4%	85.2%
12	799	1.0	94.9	4,448	3.7%	81.8%	2.9%	88.1%
13	996	1.2	96.1	4,806	4.0%	85.8%	2.9%	91.0%
14	794	1.0	97.1	4,024	3.3%	89.1%	2.4%	93.4%
15 and older	2,336	2.9	100.0	13,072	10.9%	100.0%	6.6%	100.0%
Subtotal	**80,427**	**100.0**		**120,285**			**100.0%**	
Age not given	22			61				
Total	**80,449**			**120,346**				
Average age		5.5			8.1			
Median age		4.9			7.0			

Source:
R. L. Polk and Co., Detroit, MI. FURTHER REPRODUCTION PROHIBITED.
Vehicle travel - Average annual miles per auto by age were multiplied by the number of vehicles in operation by age to estimate the vehicle travel. Average annual miles per auto by age - generated by ORNL from the 1988 Residential Transportation Energy Consumption Survey public use tape, provided by the U.S. Department of Energy, Energy Information Administration, Office of Markets and End Use, Energy End Use Division, 1990.

[a]Automobiles sold as of July 1 of each year.

Figure 3.7. Automobiles in Use by Age, 1970 and 1992



Source: See Table 3.11.

Although registrations, vehicle travel, and fuel use of automobiles continued to climb in 1992, the fuel economy of the automobile population declined from 21.7 mpg in 1991 to 21.6 mpg in 1992. The fuel economy has increased significantly since 1970, largely due to older autos being scrapped and replaced with newer fuel-efficient autos, thus raising the population fuel economy.

Table 3.12
Summary Statistics for Passenger Cars, 1970-92

Year	Registrations[a] (thousands)	Vehicle travel (million miles)	Fuel use (million gallons)	Fuel economy[b] (miles per gallon)
1970	89,244	916,700	67,820	13.5
1971	92,718	966,340	71,351	13.5
1972	97,082	1,021,365	76,222	13.4
1973	101,985	1,045,981	78,668	13.3
1974	104,856	1,007,251	75,083	13.4
1975	106,704	1,033,950	76,447	13.5
1976	110,189	1,078,215	79,693	13.5
1977	112,288	1,109,243	80,397	13.8
1978	116,573	1,146,508	81,661	14.0
1979	118,429	1,113,640	77,304	14.4
1980	121,601	1,111,596	71,883	15.5
1981	123,098	1,130,827	70,954	15.9
1982	123,902	1,166,256	70,062	16.7
1983	126,444	1,198,023	69,906	17.1
1984	128,158	1,224,919	68,717	17.8
1985	131,864	1,260,565	69,268	18.2
1986	135,431	1,301,214	71,216	18.3
1987	137,208	1,335,330	70,573	19.2
1988	141,252	1,429,579	71,949	19.9
1989	143,026	1,477,769	72,749	20.3
1990	143,550	1,515,370	72,435	20.9
1991	142,569	1,533,552	70,692	21.7
1992	144,213	1,595,438	73,851	21.6
		Average annual percentage change		
1970-92	2.2%	2.6%	0.4%	2.2%
1982-92	1.5%	3.2%	0.5%	2.6%

Source:
U.S. Department of Transportation, Federal Highway Administration, Highway Statistics 1992, Washington, DC, 1993, Table VM-1, p. 207, and annual.

[a]This number differs from R. L. Polk's estimates of "number of automobiles in use." See Table 3.4.
[b]Fuel economy for automobile population.

The data from the Nationwide Personal Transportation Study (NPTS) is based on estimates by survey respondents. The Residential Transportation Energy Consumption Survey (RTECS) data, which represents actual odometer readings of automobiles, has little bias from respondent estimations and, therefore, is the preferred data.

Table 3.13
Average Annual Miles Per Automobile by Automobile Age

Vehicle age (years)	National Personal Transportation Study[a]		Residential Transportation Energy Consumption Survey[b]			
	1983	1990	1983	1985	1988	1991
Under 1	14,200	19,800	13,400	12,700	12,900	13,400
1	17,000	16,900	13,000	13,000	13,400	14,100
2	14,000	16,300	12,700	12,600	12,600	12,600
3	12,500	14,400	12,100	12,400	12,100	13,200
4	11,400	13,800	11,300	11,100	11,500	13,300
5	11,000	12,600	9,700	10,600	10,600	12,200
6	9,900	12,900	9,700	10,000	10,800	11,200
7	9,400	12,400	9,500	9,700	10,000	10,700
8	8,700	12,300	8,700	8,900	10,300	11,400
9	8,100	11,200	8,400	8,600	8,900	10,000
10 and older	6,900	9,300	8,700	8,400	7,500	7,200
All vehicles	**10,400**	**12,600**	**9,400**	**9,900**	**10,200**	**10,600**

Sources:

Nationwide Personal Transportation Study—1983: D. Klinger and J. Richard Kuzmyak, COMSIS Corproation, Personal Travel in the United States, Volume 1: 1983-84 Nationwide Personal Travel Study, prepared for the U.S. Department of Transportation, Washington, DC, August 1986, Table 4-22, p.4-21.

1990: Generated from the 1990 Nationwide Personal Transportation Study Public Use Tape, March 1992.

Residential Transportation Energy Consumption Survey—Energy Information Agency, Office of Markets and End Use, Energy End Use Division, 1983, 1985, 1988 and 1991 Residential Transportation Energy Consumption Survey, Public Use Tapes.

---

[a]Includes only auto vehicles (standard auto, station wagon, taxi, and van-bus/minibus) owned by or available to the household on a regular basis.

[b]Includes all household vehicles—automobiles, station wagons, pick-up trucks, vans, and utility vehicles.

The average weight of the domestic automobile has been reduced nearly 350 pounds from 1978 to 1993. Much of this weight reduction was due to the declining use of conventional steel and iron and the increasing use of aluminum and plastics. Conventional steel, however, remained the predominant component of automobiles in 1993 with a 43.7% share of total materials.

Table 3.14
Average Material Consumption for a Domestic Automobile, 1978, 1984, and 1993

	1978		1984		1993	
Material	Pounds	Percentage	Pounds	Percentage	Pounds	Percentage
Conventional steel	1,880.0	53.8	1,487.5	47.3	1,376.0	43.7
High-strength steel	127.5	3.6	214.0	6.8	259.0	8.2
Stainless steel	25.0	0.7	29.0	0.9	43.5	1.4
Other steels	56.0	1.6	45.0	1.4	48.0	1.5
Iron	503.0	14.4	454.5	14.5	411.5	13.1
Aluminum	112.0	3.2	137.0	4.4	177.0	5.6
Rubber	141.5	4.1	133.5	4.2	134.5	4.3
Plastics/Composites	176.0	5.0	206.5	6.6	243.0	7.7
Glass	88.0	2.5	87.0	2.8	88.5	2.8
Copper	39.5	1.1	44.0	1.4	43.5	1.4
Zinc die castings	28.0	0.8	17.0	0.5	16.0	0.5
Power metal parts	16.0	0.5	18.5	0.6	26.0	0.8
Fluids & lubricants	189.0	5.4	180.0	5.7	188.5	6.0
Other materials	112.5	3.2	88.0	2.8	92.5	2.9
Total	3,494.0	100.0	3,141.5	100.0	3,147.5	100.0

Source:
H. A. Stark (ed), Ward's Communications, Inc., Wards Automotive Yearbook, Detroit, MI, 1993, p. 28, and annual.

Table 3.15
Sales-Weighted Engine Size of Domestic and Import Automobiles by Size Class, Sales Periods 1976-92
(cubic inches -- 1 liter = 61.026 cubic inches)

Model year	Minicompact	Subcompact	Compact	Midsize	Large	Two seater	Fleet
76		163.1	304.9	357.0	414.2	176.2	298.5
77	120.8	166.4	292.4	333.5	367.2	171.6	278.3
78	125.5	162.8	241.0	298.6	376.3	183.8	264.4
79	113.2	146.0	228.5	268.9	339.4	168.8	230.8
80	115.8	128.2	184.8	237.9	312.3	170.0	196.5
81	96.1	124.6	134.2	221.2	304.8	151.7	182.0
82	93.5	127.2	129.3	212.0	288.4	147.2	176.1
83	97.8	133.6	134.3	210.3	302.0	153.8	182.1
84	132.7	135.3	135.1	207.3	297.1	152.4	181.2
85	118.8	139.8	138.8	205.5	283.6	150.9	178.3
86	88.4	133.6	134.6	194.9	267.3	172.5	168.3
87	90.2	133.4	134.4	182.4	266.3	157.1	163.5
88	92.5	125.0	135.1	183.1	263.4	167.9	162.2
89	155.2	127.0	128.8	183.5	263.1	171.3	163.5
90	147.7	119.6	137.5	190.7	264.3	157.0	166.1
91	132.6	120.2	135.8	192.9	268.3	163.1	166.2
92	111.9	122.7	141.9	192.8	265.2	182.2	168.7

Source:
Oak Ridge National Laboratory, Light-Duty Vehicle MPG and Market Shares System, Oak Ridge, TN, 1994.

Table 3.16
Sales-Weighted Curb Weight of Domestic and Import Automobiles by Size Class, Sales Periods 1976-92
(pounds)

Model year	Minicompact	Subcompact	Compact	Midsize	Large	Two seater	Fleet
76		2,577.2	3,608.7	4,046.1	4,562.7	2,624.1	3,608.0
77	2,228.0	2,586.3	3,549.8	3,900.3	4,025.8	2,608.1	3,424.4
78	2,199.6	2,444.3	3,137.5	3,426.8	3,955.7	2,762.5	3,196.5
79	2,120.1	2,366.7	3,048.0	3,286.7	3,763.4	2,699.1	3,000.4
80	2,154.3	2,270.4	2,812.5	3,080.9	3,667.4	2,713.6	2,790.3
81	1,919.8	2,370.5	2,381.7	2,995.7	3,671.8	2,583.0	2,744.3
82	2,002.1	2,301.7	2,421.8	2,991.9	3,702.8	2,524.8	2,729.8
83	2,072.0	2,333.9	2,441.3	3,026.5	3,779.0	2,662.5	2,787.9
84	2,375.9	2,380.4	2,453.7	2,990.0	3,733.6	2,559.3	2,787.7
85	2,210.8	2,391.8	2,464.3	2,953.6	3,575.4	2,538.6	2,743.4
86	2,120.3	2,414.8	2,431.5	2,856.7	3,451.2	2,574.5	2,675.3
87	1,959.7	2,422.5	2,474.0	2,856.8	3,483.0	2,601.8	2,688.5
88	1,932.7	2,346.3	2,558.1	2,880.3	3,487.3	2,693.0	2,716.8
89	2,575.8	2,357.3	2,517.1	2,984.5	3,495.7	2,734.9	2,759.6
90	2,650.7	2,368.4	2,637.2	3,065.3	3,593.9	2,656.3	2,827.7
91	2,583.6	2,405.8	2,652.1	3,084.7	3,649.6	2,707.3	2,848.2
92	2,358.2	2,454.9	2,680.2	3,130.0	3,670.1	2,775.7	2,885.0

Source:
Oak Ridge National Laboratory, Light-Duty Vehicle MPG and Market Shares System, Oak Ridge, TN, 1994.

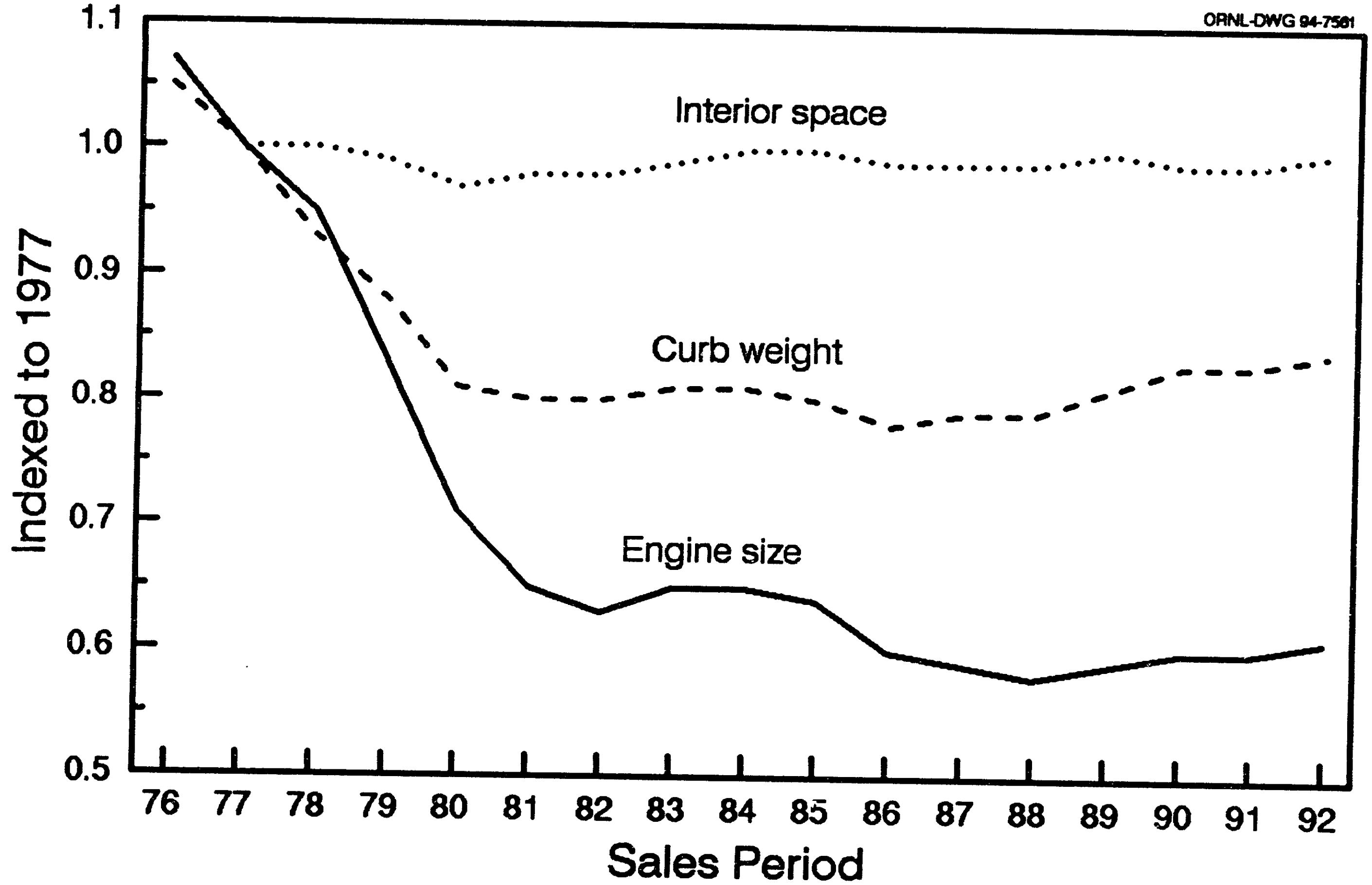
Table 3.17
Sales-Weighted Interior Space of Domestic and Import Automobiles by Size Class, Sales Periods 1976-92
(cubic feet)

Model year	Minicompact (< 85)	Subcompact (85-99)	Compact (100-109)	Midsize (110-119)	Large (> 120)	Fleet[a]
77	78.8	89.8	107.1	113.0	128.0	107.9
78	79.4	89.8	105.3	112.9	128.5	107.9
79	80.0	90.2	105.8	113.4	130.1	106.9
80	82.4	89.9	105.4	113.5	130.8	104.9
81	83.3	90.2	103.6	113.7	130.6	105.5
82	83.1	91.3	102.9	113.9	130.4	106.0
83	82.7	93.3	103.0	113.1	131.3	107.3
84	77.0	93.8	103.0	113.3	130.7	108.0
85	77.8	94.1	103.1	113.5	129.7	107.9
86	80.1	94.5	102.8	113.8	127.6	107.0
87	81.6	93.1	103.0	113.9	127.5	106.9
88	81.0	93.5	103.3	113.6	127.2	107.0
89	75.0	93.3	102.7	113.8	127.4	107.5
90	79.9	93.9	103.2	113.8	127.8	107.3
91	79.6	94.4	103.2	113.8	128.3	107.1
92	79.7	94.0	104.2	114.0	129.1	107.6

Source:
Oak Ridge National Laboratory, Light-Duty Vehicle MPG and Market Shares System, Oak Ridge, TN, 1994.

[a]Interior volumes of two seaters are not reported to EPA.

Figure 3.8. Engine Size, Curb Weight, and Interior Space of Domestic and Import Automobiles, 1976-92



Source: See Tables 3.15, 3.16, and 3.17.

Table 3.18
Period Sales, Market Shares, and Sales-Weighted Fuel Economies of New Domestic and Import Automobiles, Selected Sales Periods 1976-92[a]

	1976	1980	1982	1984	1986	1988	1989	1990	1991	1992
MINICOMPACT										
Total sales, units	b	428,346	221,699	41,368	191,490	84,186	20,677	76,698	73,562	100,504
Market share, %	b	4.7	2.9	0.4	1.7	0.8	0.2	0.8	0.9	1.2
Fuel economy, mpg	b	29.4	36.5	29.0	31.9	37.8	24.9	26.4	28.0	31.0
SUBCOMPACT										
Total sales, units	2,625,929	3,441,480	2,404,489	2,510,929	2,350,081	1,983,353	1,963,385	2,030,226	2,172,496	2,039,480
Market share, %	27.1	37.8	31.4	24.6	21.2	19.1	19.3	22.0	26.1	25.2
Fuel economy, mpg	23.5	27.3	30.2	30.5	30.7	31.7	31.3	31.3	31.5	31.8
COMPACT										
Total sales, units	2,839,603	599,423	1,300,372	2,768,056	3,829,093	4,199,638	3,690,419	3,156,481	2,458,967	2,478,485
Market share, %	29.3	6.6	17.0	27.1	34.5	40.5	36.3	34.2	29.5	30.6
Fuel economy, mpg	17.1	22.3	30.1	30.6	30.0	29.8	29.8	28.9	28.7	28.8
MIDSIZE										
Total sales, units	1,815,505	3,073,103	2,533,121	3,059,647	2,985,835	2,550,964	2,939,948	2,511,503	2,333,104	2,253,443
Market share, %	18.7	33.8	33.1	30.0	26.9	24.6	28.9	27.2	28.0	27.8
Fuel economy, mpg	15.3	21.3	24.1	24.1	25.6	26.9	26.4	25.9	25.8	25.8
LARGE										
Total sales, units	2,206,102	1,336,190	995,561	1,502,097	1,467,077	1,368,717	1,400,514	1,279,092	1,161,679	1,140,587
Market share, %	22.8	14.7	13.0	14.7	13.2	13.2	13.8	13.9	13.9	14.1
Fuel economy, mpg	13.9	19.3	20.6	20.2	23.8	24.2	23.9	23.5	23.4	23.7
TWO SEATER										
Total sales, units	199,716	215,964	202,929	328,968	275,470	186,127	158,884	170,465	139,296	88,612
Market share, %	2.1	2.4	2.6	3.2	2.5	1.8	1.6	1.8	1.7	1.1
Fuel economy, mpg	20.1	21.0	25.1	26.5	28.4	27.3	27.0	28.0	27.4	25.8
FLEET										
Total sales, units	9,686,855	9,094,506	7,658,171	10,211,065	11,099,046	10,372,985	10,173,827	9,224,465	8,339,104	8,101,111
Market share, %	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Fuel economy, mpg	17.2	23.2	26.3	26.3	27.9	28.5	28.0	27.6	27.6	27.7

Source:
Oak Ridge National Laboratory, Light-Duty Vehicle MPG and Market Shares System, Oak Ridge, TN, 1994

[a] These figures represent only those sales that could be matched to corresponding EPA fuel economy values.
[b] There were no minicompact automobiles sold in 1976.

Section 3.3
Trucks

Light trucks' share of light-duty vehicle sales rose above 35% for the first time in 1992. Although domestic light truck sales increased in 1992, import sales declined, evidenced by the 4.2% decline in the import share of total sales. Transports, however, have grown to 5.5% of the 1992 light truck sales.

Table 3.19
New Retail Sales of Light Trucks in the United States, 1970-92

		Percentages					
Calendar Year	Light truck sales[a]	Import	Transplants[b]	Diesel	Four-wheel drive on domestic light trucks	Light trucks of light-duty vehicle sales[c]	Light trucks of total truck sales
1970	1,463	4.5	[d]	[e]	[d]	14.8	80.4
1971	1,757	4.8	[d]	[e]	[d]	14.6	83.4
1972	2,239	6.4	[d]	[e]	[d]	16.7	83.3
1973	2,745	8.5	[d]	[e]	[d]	18.8	84.2
1974	2,338	7.5	[d]	[e]	18.0	20.3	84.2
1975	2,281	10.0	[d]	[e]	23.4	20.1	87.9
1976	2,956	8.0	0.0	[e]	23.8	22.0	89.8
1977	3,430	9.4	0.0	[e]	24.6	22.8	89.7
1978	3,808	8.8	0.0	1.0	28.5	24.5	89.2
1979	3,311	14.1	0.0	1.0	29.4	22.4	88.7
1980	2,440	19.7	0.9	3.2	20.7	19.8	88.9
1981	2,189	20.3	0.0	3.3	18.6	19.2	89.8
1982	2,470	16.5	0.0	5.0	16.8	23.0	92.8
1983	2,984	15.6	0.0	4.0	28.5	24.2	93.6
1984	3,863	15.7	2.0	3.8	27.0	26.9	93.0
1985	4,458	17.2	2.6	3.3	29.1	28.7	93.6
1986	4,594	20.1	2.3	2.6	27.0	28.6	94.3
1987	4,610	17.9	1.7	2.3	32.0	31.0	93.9
1988	4,800	12.6	2.4	2.0	32.1	31.1	93.2
1989	4,610	10.9	2.6	2.1	26.9[f]	31.8	93.3
1990	4,548	13.2	3.4	2.2[f]	19.8[f]	32.8	93.9
1991	4,123	12.8	4.5	2.2[f]	30.2[f]	33.5	94.5
1992	4,629	8.6	5.5	2.5[f]	31.6[f]	35.3	94.4
			Average annual percentage change				
1970-92	5.4%						
1982-92	6.5%						

Sources:

Four-wheel drive - 1970-88: H. A. Stark (ed.), Ward's Communication, Inc., Ward's Automotive Yearbook, Detroit, MI, 1989, p. 168, and annual. 1989-92: H. A. Stark (ed.), Ward's Communications, Inc., Ward's Automotive Reports, Factory Installation Report, Detroit, MI, 1993.

Transplants - Oak Ridge National Laboratory, Light-Duty Vehicle MPG and Market Shares System, Oak Ridge, TN, 1994.

All other - American Automobile Manufacturers Association, Motor Vehicle Facts and Figures '93, Detroit, MI, 1993, pp. 8, 18, 19, and annual.

---

[a]Includes all trucks of 10,000 pounds gross vehicle weight and less sold in the U.S.

[b]Based on model year data. A transplant is a light truck which was built in the U.S. by a foreign firm. Also included are joint ventures built in the U.S.

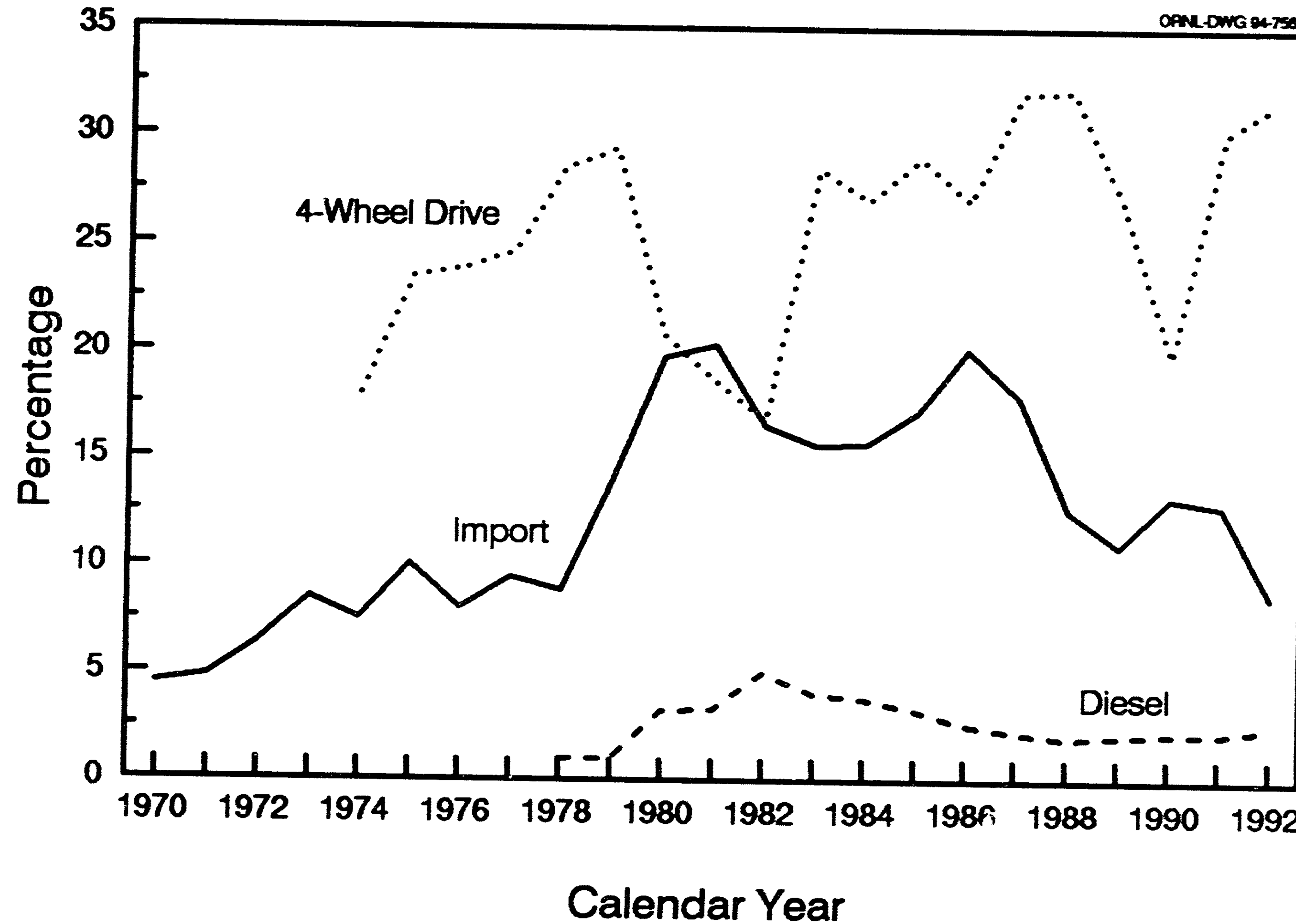
[c]Light-duty vehicles include cars and light trucks.

[d]Data are not available.

[e]Indicates less than 1 percent.

[f]Based on factory installations.

Figure 3.9. Import, Diesel, and Four-Wheel Drive Shares of Light Truck Sales, 1970-92



Source: See Table 3.19.

Table 3.20
New Retail Domestic Truck Sales by Gross Vehicle Weight, 1970-92[a]
(thousands)

Calendar Year	Class 1 6,000 lbs. or less	Class 2 6,001-10,000 lbs.	Class 3 10,001-14,000 lbs.	Class 4 14,001-16,000 lbs.	Class 5 16,001-19,500 lbs.	Class 6 19,501-26,000 lbs.	Class 7 26,001-33,000 lbs.	Class 8 33,001 lbs. and over	Total[b]
1970[c]	1,049	408	6	12	58	133	36	89	1,791
1971	1,185	488	6	15	46	140	34	99	2,013
1972	1,498	599	55	11	29	182	35	126	2,535
1973	1,754	758	50	3	16	236	37	155	3,009
1974	1,467	696	21	3	14	207	31	148	2,587
1975	1,101	952	23	1	9	159	23	83	2,351
1976	1,318	1,401	43	[d]	9	153	22	97	3,043
1977	1,306	1,803	36	3	5	163	28	141	3,485
1978	1,334	2,140	73	6	3	156	41	162	3,915
1979	1,271	1,574	15	3	3	146	50	174	3,236
1980	985	975	4	[d]	2	90	58	117	2,231
1981	896	850	1	[d]	2	72	51	100	1,972
1982	1,102	961	1	[d]	1	44	62	76	2,248
1983	1,314	1,207	[d]	[d]	1	47	59	82	2,710
1984	2,031	1,224	6	[d]	5	55	78	138	3,538
1985	2,408	1,280	11	[d]	5	48	97	134	3,983
1986	2,541	1,214	7	[d]	6	42	98	112	4,020
1987	2,697	1,175	7	[d]	6	41	98	131	4,155
1988	2,926	1,333	6	20	6	51	98	148	4,588
1989	2,809	1,297	7	26	4	34	81	145	4,403
1990	2,852	1,097	8	26	2	33	76	121	4,215
1991	2,719	876	11	23	[d]	19	67	98	3,813
1992	3,212	1,021	14	23	[d]	23	69	119	4,481
				Average annual percentage change					
1970-92	5.2%	4.3%	3.9%	3.0%	-33.6%	-7.7%	3.0%	1.3%	4.3%
1982-92	11.3%	0.6%	30.2%	46.6%	-39.1%	-6.3%	1.1%	4.6%	7.1%

Source:
American Automobile Manufacturers Association, Motor Vehicle Facts and Figures '93, Detroit, MI, 1993, p. 19, and annual.

[a]Sales include domestic-sponsored imports.
[b]Totals may not equal Motor Vehicle Manufacturers Association totals due to rounding.
[c]Data for 1970 is based on new truck registrations.
[d]Less than 500 trucks.

Table 3.21
Trucks in Operation and Vehicle by Age, 1970 and 1992

Age (years)	1970			1992			1992 Estimated vehicle travel		Average annual miles per vehicle
	Vehicles (thousands)	Percentage	Cumulative percentage	Vehicles (thousands)	Percentage	Cumulative percentage	Percentage	Cumulative percentage	
Under 1[a]	1,262	7.1	7.1	2,820	4.6%	4.6%	5.9%	5.9%	14,901
1	1,881	10.6	17.8	4,254	7.0%	11.6%	10.0%	15.9%	16,853
2	1,536	8.7	26.5	4,222	6.9%	18.5%	9.9%	25.7%	16,719
3	1,428	8.1	34.6	4,864	8.0%	26.4%	10.9%	36.7%	16,074
4	1,483	8.4	43.0	4,848	7.9%	34.4%	9.5%	46.1%	14,005
5	1,339	7.6	50.5	4,333	7.1%	41.5%	8.4%	54.6%	13,952
6	1,154	6.5	57.1	4,558	7.5%	48.9%	8.7%	63.3%	13,687
7	975	5.5	62.6	3,915	6.4%	55.3%	6.9%	70.2%	12,644
8	826	4.7	67.3	3,449	5.6%	61.0%	5.5%	75.7%	11,387
9	621	3.5	70.8	2,173	3.6%	64.5%	3.2%	78.9%	10,665
10	658	3.7	74.5	1,816	3.0%	67.5%	1.8%	80.7%	6,960
11	583	3.3	77.8	1,650	2.7%	70.2%	1.6%	82.3%	6,960
12	383	2.2	80.0	1,564	2.6%	72.7%	1.5%	83.8%	6,960
13	417	2.4	82.3	2,726	4.5%	77.2%	2.6%	86.5%	6,960
14	414	2.3	84.7	2,374	3.9%	81.1%	2.3%	88.8%	6,960
15 and older	2,710	15.3	100.0	11,556	18.9%	100.0%	11.2%	100.0%	6,960
Subtotal	**17,670**	**100.0**		**61,122**	**100.0%**		**100.0%**		
Age not given	15			51					
Total	**17,685**			**61,173**					
Average age		7.3			8.4				
Median age		5.9			7.2				

Source:

R. L. Polk and Co., Detroit, MI. **FURTHER REPRODUCTION PROHIBITED.**

Vehicle travel—The average annual vehicle miles per truck by age were multiplied by the number of trucks in operation by age to estimate the vehicle travel. Average annual miles per truck by age were generated by ORNL from the 1987 Truck Inventory and Use Survey public use tape provided by U.S. Department of Commerce, Bureau of the Census, Washington, DC, 1990.

[a]Trucks sold as of July 1 of each year.

Table 3.22
Period Sales, Market Shares, and Sales-Weighted Fuel Economies of New Domestic and Import Light Trucks, Selected Sales Periods 1976-92[a]

	1976	1980	1982	1984	1986	1988	1989	1990	1991	1992
SMALL PICKUP										
Total sales, units	170,351	516,412	579,263	1,012,298	1,225,570	1,026,551	877,839	678,488	609,814	586,752
Market share, %	7.1	23.3	27.2	28.0	27.0	21.6	18.4	15.0	14.9	13.4
Fuel economy, mpg	23.9	25.5	28.1	27.2	26.1	26.1	25.7	25.2	25.6	25.0
LARGE PICKUP										
Total sales, units	1,586,020	1,115,248	1,000,772	1,218,972	1,325,547	1,453,255	1,580,916	1,573,729	1,364,940	1,452,192
Market share, %	66.4	50.3	46.9	33.7	29.2	30.6	33.2	34.9	33.4	33.1
Fuel economy, mpg	15.1	17.0	18.6	17.5	18.4	18.5	18.2	18.9	18.9	18.9
SMALL VAN										
Total sales, units	18,651	13,649	11,964	222,798	640,936	851,384	859,311	932,693	886,841	961,348
Market share, %	0.8	0.6	0.6	6.2	14.1	18.0	18.0	20.7	21.7	21.9
Fuel economy, mpg	19.5	19.6	22.5	25.0	23.8	22.9	22.9	23.1	22.6	22.5
LARGE VAN										
Total sales, units	574,745	328,065	379,110	545,595	510,558	486,981	471,762	398,877	308,317	350,013
Market share, %	24.1	14.8	17.8	15.1	11.3	10.3	9.9	8.8	7.5	8.0
Fuel economy, mpg	15.4	16.3	17.0	16.3	17.3	17.0	16.7	16.9	17.1	16.9
SMALL UTILITY										
Total sales, units	4,716	75,875	28,376	398,000	598,652	701,005	747,550	738,294	782,125	854,572
Market share, %	0.2	3.4	1.3	11.0	13.2	14.8	15.7	16.4	19.2	19.5
Fuel economy, mpg	15.5	16.9	20.9	23.0	21.5	22.4	21.7	21.9	21.4	20.9
LARGE UTILITY										
Total sales, units	32,427	167,288	133,355	215,271	233,625	223,824	228,664	192,544	131,740	180,576
Market share, %	1.4	7.5	6.3	6.0	5.2	4.7	4.8	4.3	3.2	4.1
Fuel economy, mpg	14.7	14.6	16.9	15.7	15.9	16.2	16.2	16.1	16.4	17.2
FLEET										
Total sales, units	2,386,910	2,216,537	2,132,840	3,612,934	4,534,888	4,743,000	4,766,042	4,514,625	4,083,777	4,385,453
Market share, %	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Fuel economy, mpg	15.6	18.1	20.0	20.0	20.8	20.7	20.2	20.5	20.6	20.4

Source:
Hu, Patricia S. and An Lu, Light-Duty Vehicle Summary: First Six Months of Sales Period 1992," Working Paper, Oak Ridge National Laboratory, Oak Ridge, TN, July 1992, p. 20.

[a]These figures represent only those sales that could be matched to corresponding EPA fuel economy values.

Two-axle, four-tire truck average fuel economy exceeded 14 mpg for the first time in 1990. Because more fuel efficient trucks are entering the population, the fuel use for two-axle, four-tire trucks has grown at a slower rate than the vehicle travel. These trucks are being driven longer distances each year, as evidenced by a greater percentage increase in travel than in registrations.

Table 3.23
Summary Statistics for Two-Axle, Four-Tire Trucks, 1970-92

Year	Registrations (thousands)	Vehicle travel (million miles)	Fuel use (million gallons)	Fuel economy (miles per gallon)
1970	14,211	123,286	12,313	10.0
1971	15,181	137,870	13,484	10.2
1972	16,428	156,622	15,150	10.3
1973	18,083	176,833	16,828	10.5
1974	19,335	182,757	16,657	11.0
1975	20,418	200,700	17,903	11.2
1976	22,301	225,834	20,164	11.2
1977	23,624	250,591	24,055	11.4
1978	25,476	279,414	24,055	11.6
1979	27,022	291,905	24,742	11.8
1980	27,876	290,935	23,594	12.3
1981	28,928	296,343	23,697	12.5
1982	29,792	306,141	23,845	12.8
1983	31,214	327,643	25,556	12.8
1984	32,106	357,999	27,687	12.9
1985	33,865	373,072	29,021	12.9
1986	34,820	389,047	30,265	12.9
1987	35,841	415,449	32,266	12.9
1988	37,096	439,496	32,803	13.4
1989	37,918	454,339	33,005	13.8
1990	38,864	466,092	32,937	14.2
1991	39,067	472,848	32,531	14.5
1992	39,533	476,587	33,139	14.4
		Average annual percentage change		
1970-92	4.8%	6.3%	4.5%	1.7%
1982-92	2.9%	4.5%	3.3%	1.2%

Source:
U.S. Department of Transportation, Federal Highway Administration, Highway Statistics 1992, Washington, DC, 1993, Table VM-1, p. 207, and annual.

Table 3.24
Summary Statistics for Other Single-Unit and Combination Trucks, 1970-92

Year	Other single-unit trucks[a] Registrations (thousands)	Other single-unit trucks[a] Vehicle travel (million miles)	Other single-unit trucks[a] Fuel use (million gallons)	Other single-unit trucks[a] Fuel economy (miles per gallon)	Combination trucks[b] Registrations (thousands)	Combination trucks[b] Vehicle travel (million miles)	Combination trucks[b] Fuel use (million gallons)	Combination trucks[b] Fuel economy (miles per gallon)
1970	3,681	27,081	3,968	6.8	905	35,134	7,347	4.8
1971	3,770	28,985	4,212	6.9	919	37,217	7,595	4.9
1972	3,918	31,414	4,560	6.9	961	40,706	8,120	5.0
1973	4,131	33,661	4,859	6.9	1,029	45,649	9,026	5.1
1974	4,211	33,441	4,687	7.1	1,085	45,966	8,800	5.2
1975	4,232	34,606	4,825	7.2	1,131	46,724	8,653	5.4
1976	4,350	36,390	5,140	7.1	1,225	49,680	9,536	5.2
1977	4,450	39,339	5,559	7.1	1,240	55,683	10,673	5.2
1978	4,518	42,727	6,106	7.0	1,342	62,992	12,113	5.2
1979	4,505	42,012	6,036	7.0	1,386	66,992	12,864	5.2
1980	4,374	39,813	5,557	7.2	1,417	68,678	12,703	5.4
1981	4,455	39,568	5,574	7.1	1,261	69,134	12,960	5.3
1982	4,325	40,212	5,661	7.1	1,265	66,668	12,636	5.3
1983	4,204	43,409	6,118	7.1	1,304	69,754	13,447	5.2
1984	4,061	46,560	6,582	7.1	1,340	77,367	14,781	5.2
1985	3,927	46,980	6,735	7.0	1,403	79,600	15,280	5.2
1986	3,850	48,308	6,929	7.0	1,399	81,833	15,716	5.2
1987	3,884	49,537	7,091	7.0	1,419	86,064	16,493	5.2
1988	3,957	51,239	7,260	7.1	1,476	90,158	17,123	5.3
1989	4,103	52,969	7,413	7.2	1,589	95,349	17,495	5.5
1990	4,243	53,443	7,294	7.3	1,611	96,367	17,469	5.5
1991	4,265	53,787	7,181	7.5	1,604	96,942	17,157	5.7
1992	4,316	53,506	7,134	7.5	1,655	99,032	17,698	5.6
				Average annual percentage change				
1970-92	0.7%	3.1%	2.7%	0.4%	2.8%	4.8%	4.1%	0.7%
1982-92	0.0%	2.9%	2.3%	0.5%	2.7%	4.0%	3.4%	0.6%

Source:
U.S. Department of Transportation, Federal Highway Administration, Highway Statistics 1992, Washington, DC, 1993, Table VM-1, p. 207, and annual.

[a]Other single-unit trucks are defined as all single-unit trucks with more than two axles or more than four tires.
[b]The fuel economy for combination trucks is not the same as the fuel economy for Class 8 trucks. Fuel economy for Class 8 trucks is shown in Table 3.25.

Table 3.25
Truck Fuel Economy by Size Class, 1977, 1982, and 1987
(miles per gallon)

Size Class	Weight	1977 TIUS[a]	1982 TIUS[a]	1987 TIUS[a]
Class 1	6,000 pounds and less	13.2	14.2	15.0
Class 2	6,001-10,000 pounds	11.5	11.1	10.9
Class 3	10,000-14,000 pounds	9.4	8.1	8.1
Class 4	14,001-16,000 pounds	6.9	7.5	7.5
Class 5	16,001-19,500 pounds	7.6	7.2	7.1
Class 6	19,501-26,000 pounds	6.1	6.9	6.4
Class 7	26,001-33,000 pounds	5.3	6.2	6.1
Class 8	33,001 and over	4.8	5.2	5.3

Source:
Estimates are based on data provided on the following public use tapes: U.S. Department of Commerce, Bureau of the Census, 1977 Census of Transportation, Truck Inventory and Use Survey, Washington, DC, 1980; U.S. Department of Commerce, Bureau of the Census, 1982 Census of Transportation, Truck Inventory and Use Survey, Washington, DC, 1985; and U.S. Department of Commerce, Bureau of the Census, 1987 Census of Transportation, Truck Inventory and Use Survey, Washington, DC, 1990.

Table 3.26
Percentage of Trucks by Size Class, 1977, 1982, and 1987
(percentage)

Size Class	Weight	1977 TIUS[a]	1982 TIUS[a]	1987 TIUS[a]
Class 1	6,000 pounds and less	66.0	77.8	85.4
Class 2	6,001-10,000 pounds	17.9	11.6	6.5
Class 3	10,000-14,000 pounds	3.1	1.6	1.2
Class 4	14,001-16,000 pounds	1.3	0.9	0.5
Class 5	16,001-19,500 pounds	2.1	1.0	0.6
Class 6	19,501-26,000 pounds	3.4	2.4	1.7
Class 7	26,001-33,000 pounds	1.5	1.0	0.8
Class 8	33,001 and over	4.6	3.8	3.3

Source:
Estimates are based on data provided on the following public use tapes: U.S. Department of Commerce, Bureau of the Census, 1977 Census of Transportation, Truck Inventory and Use Survey, Washington, DC, 1980; U.S. Department of Commerce, Bureau of the Census, 1982 Census of Transportation, Truck Inventory and Use Survey, Washington, DC, 1985; and U.S. Department of Commerce, Bureau of the Census, 1987 Census of Transportation, Truck Inventory and Use Survey, Washington, DC, 1990.

[a]Truck Inventory and Use Survey.

Section 3.4
Buses

Table 3.27
Summary Statistics on Buses by Type, 1970-91

Year	Transit motor bus[a]	Intercity bus	School bus
	Number in Operation		
1970	49,700	22,000	288,700
1975	50,811	20,500	368,300
1980	59,411	21,400	418,255
1985	64,258	20,200	480,400
1990	58,714	20,680	508,261
1991	57,865	21,158	513,227
	Vehicle-miles (millions)		
1970	1,409	1,209	2,100
1975	1,526	1,126	2,500
1980	1,677	1,162	2,900
1985	1,863	933	3,448
1990	2,123	991	3,800
1991	2,182	1,013	4,300
	Passenger-miles (millions)		
1970	18,210	25,300	[b]
1975	18,300	25,400	[b]
1980	21,790	27,400	[b]
1985	21,161	23,800	[b]
1990	20,981	23,000	74,200
1991	21,150	23,500	83,300
	Energy Use (trillion Btu)		
1970	44.8	26.6	37.5
1975	51.5	24.8	42.6
1980	61.3	29.3	47.5
1985	72.4	31.5	57.0
1990	78.9	21.7	62.2
1991	80.9	22.6	70.6

Source:
See Appendix A for Table 3.27.

[a]Data for Transit buses after 1983 is not comparable with prior data. Data for prior years were
provided voluntarily and statistically expanded, but in 1984 reporting became mandatory.

[b]Data are not available.

Section 3.5
Fleets

Table 3.28
Automobile Fleets by Use, 1970-92
(thousands)

Year	Cars in fleets of 10 or more								Cars in fleets of 4 or more
	Business fleets[a]	Individual leased	Government[b]	Utilities	Police	Taxi	Daily rental	Total cars	
1970	2,529	803	674	416	207	171	314	5,114	9,992
1971	2,573	834	695	421	218	174	319	5,234	10,070
1972	2,664	925	670	438	236	177	341	5,451	10,094
1973	2,890	974	686	467	249	182	364	5,812	10,214
1974	2,928	1,008	701	482	261	185	361	5,926	10,324
1975	2,934	1,072	715	497	278	193	354	6,043	10,398
1976	3,066	1,217	727	508	286	202	373	6,379	10,403
1977	3,093	1,385	735	518	292	202	385	6,610	10,414
1978	3,148	1,610	747	523	294	205	448	6,975	10,423
1979	3,195	1,690	752	529	291	207	462	7,126	10,428
1980	3,279	1,708	752	532	288	205	500	7,264	10,433
1981	3,306	1,713	757	537	284	198	462	7,257	10,436
1982	3,324	1,645	603	530	223	141	457	6,923	10,076
1983	3,383	1,653	606	533	221	139	466	7,001	10,400
1984	3,422	1,657	638	540	228	140	755[c]	7,380	10,475
1985	3,484	1,800	643	540	233	140	760	7,600	10,508
1986	3,530	1,975	647	545	238	143	790	7,868	10,560
1987	3,564	2,098	650	550	240	144	800	8,046	10,578
1988	3,689	2,160	658	553	242	144	870	8,314	10,597
1989	3,787	2,140	658	553	244	144	907	8,431	10,592
1990	3,823	2,020	657	551	249	141	990	8,427	10,607
1991	3,466	2,008	617	544	250	141	1,160	8,188	10,514
1992	3,460	2,126	629[d]	548	264	140	1,448	8,502	10,468
	Average annual percentage change								
1970-92	1.4%	4.5%	0.4%	1.3%	1.1%	-0.9%	7.2%[e]	2.3%	0.2%
1982-92	0.4%	2.6%	-0.3%	0.3%	1.7%	-0.1%	12.2%[e]	2.1%	0.4%

Source:
Bobit Publishing Company, Automotive Fleet Research Department, 1993 Automotive Fleet Fact Book, Redondo Beach, CA, 1993, pp. 15, 20, and annual.

[a]Includes driver schools.

[b]Data from Automotive Fleet Fact Book does not include all Federal Government fleet vehicles. Federal fleet data are added from Federal Motor Vehicle Fleet Report, General Services Administration, Table 1 (all agencies - domestic sedans and station wagons).

[c]Major adjustment by Automotive Fleet Fact Book with new data for 1984. Daily rentals were underestimated from 1970 to 1983.

[d]Federal government data for 1992 are not available; therefore, the data are assumed to be equal to the 1991 federal government figures.

[e]Average annual percentage change is misleading due to the data change in daily rentals in 1984.

Table 3.29
Federal Government Vehicles by Agency, Fiscal Year 1991

Department or Agency	Autos	Buses	Trucks and Truck Tractors[a] 8,500 lbs. or less[b]	8,501 to 23,999 lbs.	24,000 lbs. or over	Total
CIVILIAN AGENCIES	93,923	3,396	118,789	17,547	6,613	240,268
Government Printing Office	3	0	51	0	0	54
Nuclear Regulatory Commission	0	0	3	3	0	6
Department of the State	1,227	0	1,245	851	74	3,397
Department of the Treasury	10,903	12	2,791	80	4	13,790
Department of Justice	16,693	172	6,614	584	88	24,151
Department of the Interior	1,838	111	8,412	3,010	1,692	15,063
Department of Agriculture	3,790	57	24,889	5,121	586	34,443
Department of Commerce	96	5	393	206	14	714
Department of Labor	21	11	113	8	1	154
Department of Health & Human Services	111	12	261	114	45	543
Department of Transportation	19	15	374	150	32	590
Department of Energy	1,824	200	6,741	1,864	712	11,341
International Development Cooperation Agency	322	34	512	58	18	944
American Battle Monuments Commission	14	0	37	11	0	62
Environmental Protection Agency	61	0	202	263	3	529
Federal Communications Commission	68	0	36	2	0	106
Federal Emergency Management Agency	31	9	86	24	0	150
General Services Administration	54,245	2,568	62,156	3,702	2,864	125,535
International Boundary & Water Commission	0	0	8	9	24	41
Merit Systems Protection Board	0	0	1	0	0	1
National Aeronautics & Space Administration	125	9	540	210	42	926
Small Business Administration	1	0	1	0	0	2
National Science Foundation	22	7	131	25	3	188
Pension Benefit Guaranty Corp.	1	0	0	0	0	1
Panama Canal Commission	186	18	499	84	63	850
Peace Corps	152	12	391	6	0	561
Railroad Retirement Board	1	0	0	0	0	1
Smithsonian Institution	75	4	191	57	16	343
Tennessee Valley Authority	1,330	4	1,042	906	262	3,544
United States Information Agency	446	14	291	21	1	773
U.S. Soldiers' and Airmen's Home	11	7	24	6	9	57
Department of Veterans Affairs	307	115	754	172	60	1,408
UNITED STATES POSTAL SERVICE	8,899	18	156,093	8,758	3,951	177,719
MILITARY AGENCIES	17,866	5,601	92,650	10,745	7,722	134,584
Army	4,665	1,588	15,307	2,657	1,636	25,853
Navy	3,329	1,075	25,031	2,703	2,413	34,551
Marine Corps	708	364	'4,819	815	411	7,117
Air Force	5,450	2,523	42,239	3,622	3,018	56,852
Corps of Engineers	598	19	4,213	900	230	5,960
Other Defense Agencies	3,116	32	1,041	48	14	4,251
TOTAL	120,688	9,015	367,532	37,050	18,286	552,571

Source:
U.S. General Services Administration, Federal Supply Service, Federal Motor Fleet Report, Washington, DC, 1993, p. 27.

[a]Based on gross vehicle weight rating (GVWR).
[b]Includes ambulances.

Although sedans comprised only 20% of the vehicles in large domestic federal fleets in 1991, they accounted for 33% of the miles driven. Sedans were driven on average nearly twice as much as trucks were in 1991.

Table 3.30
Operating and Cost Data for Large Domestic Federal Fleets, 1986-91[a]

Year	Number of Vehicles	Miles Operated (thousands)	Average Annual Miles per Vehicle	Fleet Average Cost per Mile (dollars)
		Sedans		
1986	86,069	1,130,843	13,139	0.21
1987	89,894	1,069,124	11,893	0.20
1988	85,928	1,119,343	13,027	0.19
1989	90,254	1,170,370	12,968	0.20
1990	93,510	1,226,674	13,118	0.22
1991	98,259	1,297,651	13,206	0.23
		Trucks		
1986	292,256	2,095,079	7,168	0.43
1987	303,275	2,195,017	8,238	0.45
1988	316,443	2,242,075	7,085	0.44
1989	336,617	2,292,593	6,811	0.43
1990	354,392	2,423,131	6,837	0.44
1991	266,471	2,498,190	6,818	0.45
		All Vehicles[b]		
1986	403,855	3,477,730	8,611	0.36
1987	414,575	3,461,332	8,349	0.37
1988	424,286	3,576,421	8,429	0.36
1989	448,836	3,681,314	8,202	0.35
1990	467,678	3,855,984	8,245	0.38
1991	484,552	3,984,175	8,222	0.38

Source:

U.S. General Services Administrations, Federal Supply Service, Federal Motor Fleet Report, Washington, DC, 1993, p. 26.

[a]Agencies or bureaus with 2,000 or more vehicles.
[b]Includes sedans, station wagons, ambulances, buses and all trucks.

Fleet Vehicle Study

"As fleets become a larger proportion of the new vehicle population on the road, they have more influence on the characteristics of the total U.S. motor vehicle population. One of the characteristics which fleets are expected to have the most influence on is the overall vehicle fuel economy. In addition, because of the relatively large market share and the high turnover rate of fleet vehicles, fleets have been considered as a useful initial market for alternative fuel vehicles. In order to analyze fleet market potential and likely market penetration of alternative fuel vehicles and to assess infrastructure requirements for successful operations of these vehicles in the future, information on fleet sizes and composition, fleet vehicle operating characteristics (such as daily/annual miles of travel), fuel efficiency, and refueling practices, is essential." The Office of Transportation Technologies and the Office of Policy, Planning, and Analysis of the Department of Energy jointly sponsored a study which was conducted by Oak Ridge National Laboratory. The purpose of the study was to gather and summarize information from the latest data sources available pertaining to fleet vehicles in the U.S. A report was published which presents fleet vehicle data on composition, operating characteristics, and fueling practices. The questions these data are intended to address include: (1) How are fleet vehicles operated? (2) Where are they located? and (3) What are their usual fueling practices? Since a limited number of alternative fuel fleet vehicles are already in use, data on these vehicles are also included in the report.[a]

The following tables present data from the report: Fleet Vehicles in the United States: Composition, Operating Characteristics, and Fueling Practices," by Shaw-Pin Miaou, Patricia S. Hu, and Jennifer R. Young, ORNL-6717, 1992.

---

[a]Miaou, et. al., "Fleet Vehicles in the United States: Composition, Operating Characteristics, and Fueling Practices", (ORNL-6717), Oak Ridge National Laboratory, Oak Ridge, Tenn., May 1992, p. ix.

Table 3.31
Vehicle Composition by Vehicle Type
(percent)

Fleet type	Cars	Light trucks and vans	Medium trucks	Heavy trucks	Total
Business	24.2	21.1	45.8	8.9	100
Utility	22.6	39.0	15.0	23.4	100
Government	48.5	42.8	6.8	1.8	100

Source: See page 3-47.

Table 3.32
Average Length of Time Vehicles are Kept Before Sold to Others
(months)

	Business	Utility	Government
Cars	35	68	81
Light trucks	56	60	82
Medium trucks	83	86	96
Heavy trucks	103	132	117

Source: See page 3-47.

Table 3.33
Average Annual/Daily Vehicle Miles of Travel

Vehicle type	Business		Utility		Government	
	Miles/Yr (000)	Miles/Day @250 Days/Yr	Miles/Yr (000)	Miles/Day @250 Days/Yr	Miles/Yr (000)	Miles/Day @250 Days/Yr
Cars	29.2	117	14.5	58	13.7	55
Light trucks	26.6	106	17.5	70	13.9	56
Medium trucks	17.5	70	11.8	47	11.9	48
Heavy trucks	64.4	258	13.8	55	10.7	43

Source: See page 3-47.

Table 3.34
Fueling Practices of Five Business Fleet Types-Easton Consultants, Inc. [1991].
(percent)

Fleet Type	Have On-Site Fueling Facilities	% of Fuel Taken from Company's Own Facilities	Have Alternative Fuel Vehicles[a]
Transit Bus	97	95	18
School Bus	93	93	8
Taxi/Limo	36	74	6
Service/Heavy Delivery	65	89	18
Food/Vending	60	92	20
Routine	69	79	38
Materials	77	86	11
Other Service	46	78	22
Beverage	68	94	23
Institutional Food	80	89	10
Other Food/Grocery	67	89	12
Other Heavy Delivery	72	88	12
Repair Service	44	82	9
Appliance	36	75	5
Plumbing/Water Heating/Pool	41	77	8
Outside/Landscape/Etc.	60	78	10
Construction Trades	46	86	12
Other Repair	51	87	6

Source: See page 3-47.

[a]Most of the alternative fuel vehicles are powered with propane.

Section 3.6
Federal Standards and
Motor Vehicle Fuel Economy

Except for the automobile fuel economy in model year 1984, the sales-weighted fuel economies of automobiles and light trucks have, on average, met the fuel economy standards set by the federal government. This does not mean, however, that each manufacturer is meeting the standards each year. Some manufacturers still fall short, while others exceed the standards. The domestic automobile CAFE estimate did not meet the 1992 standard, but the import estimate exceeded the standard, pulling the combined automobile CAFE estimate above the standard.

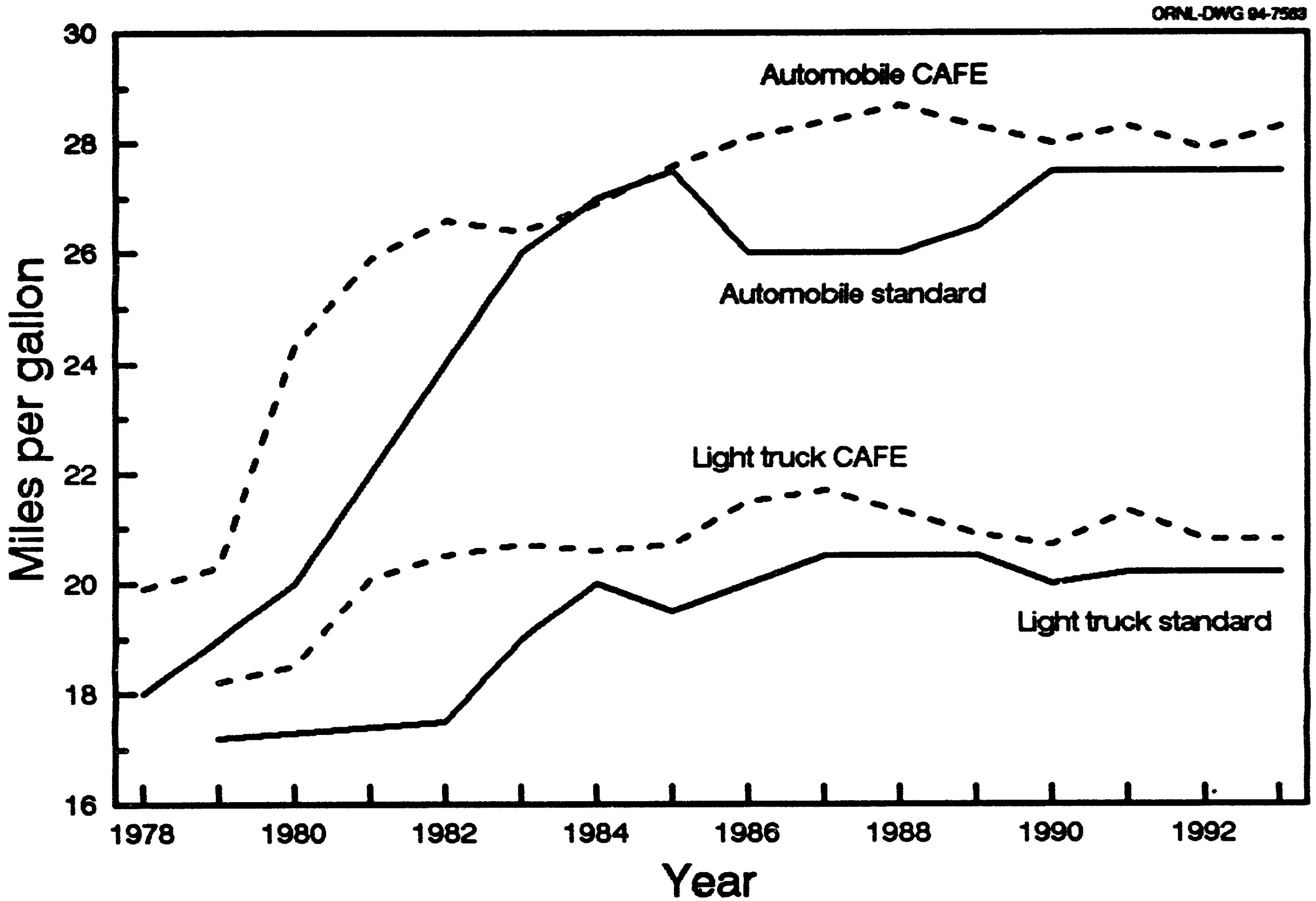
Table 3.35
Corporate Average Fuel Economy (CAFE)
Standards versus Sales-Weighted Fuel Economy Estimates
for Automobiles and Light Trucks, 1978-93[a]
(miles per gallon)

	Automobiles				Light Trucks[b]			
Model	CAFE	CAFE Estimates[c]			CAFE	CAFE Estimates[c]		
Year	Standards	Domestic	Import	Combined	Standards	Domestic	Import	Combined
1978	18.0	18.7	27.3	19.9	[d]	[e]	[e]	[e]
1979	19.0	19.3	26.1	20.3	17.2	17.7	20.8	18.2
1980	20.0	22.6	29.6	24.3	[d]	16.8	24.3	18.5
1981	22.0	24.2	31.5	25.9	[d]	18.3	27.4	20.1
1982	24.0	25.0	31.1	26.6	17.5	19.2	27.0	20.5
1983	26.0	24.4	32.4	26.4	19.0	19.6	27.1	20.7
1984	27.0	25.5	32.0	26.9	20.0	19.3	26.7	20.6
1985	27.5	26.3	31.5	27.6	19.5	19.6	26.5	20.7
1986	26.0	26.9	31.6	28.2	20.0	19.9	25.9	21.5
1987	26.0	27.0	31.2	28.5	20.5	20.5	25.2	21.7
1988	26.0	27.4	31.5	28.8	20.5	20.6	24.6	21.3
1989	26.5	27.2	30.8	28.4	20.5	20.4	23.5	20.9
1990	27.5	26.9	29.9	28.0	20.0	20.3	23.0	20.7
1991	27.5	27.3	30.0	28.3	20.2	20.9	23.0	21.3
1992	27.5	27.1	29.1	27.9	20.2	20.5	22.4	20.8
1993	27.5	27.7	29.5	28.3	20.2	20.4	22.6	20.8

Source:
U.S. Department of Transportation, NHTSA, "Summary of Fuel Economy Performance," Washington, DC, September 1993.

[a]Only vehicles with at least 75 percent domestic content can be counted in the average domestic fuel economy for a manufacturer.
[b]Represents two- and four-wheel drive trucks combined. Gross vehicle weight of 0-6,000 pounds for model year 1979 and 0-8,500 pounds for subsequent years.
[c]All CAFE calculations are sales-weighted.
[d]Standards were set for two-wheel drive and four-wheel drive light trucks separately, but no combined standard was set in this year.
[e]Data are not available.

Figure 3.10. Corporate Average Fuel Economy Standards and Sales-Weighted Fuel Economies for Automobiles and Light Trucks, 1978-93



Source: See Table 3.35.

Table 3.36
Corporate Average Fuel Economy (CAFE) Fines Collected, 1983-92
(Thousands)

Model year	Current dollars	1990 constant dollars[a]
1983	58	76
1984	5,958	7,496
1985	15,565	18,908
1986	29,872	35,603
1987	31,261	35,945
1988	44,519	49,181
1989	47,381	49,946
1990	48,449	48,449
1991	39,178	37,572
1992[b]	525	489
Total	262,766	283,663

Source:
U.S. Department of Transportation, National Highway Traffic Safety Administration, Office of Vehicle Safety Compliance, Washington, DC, October 1993.

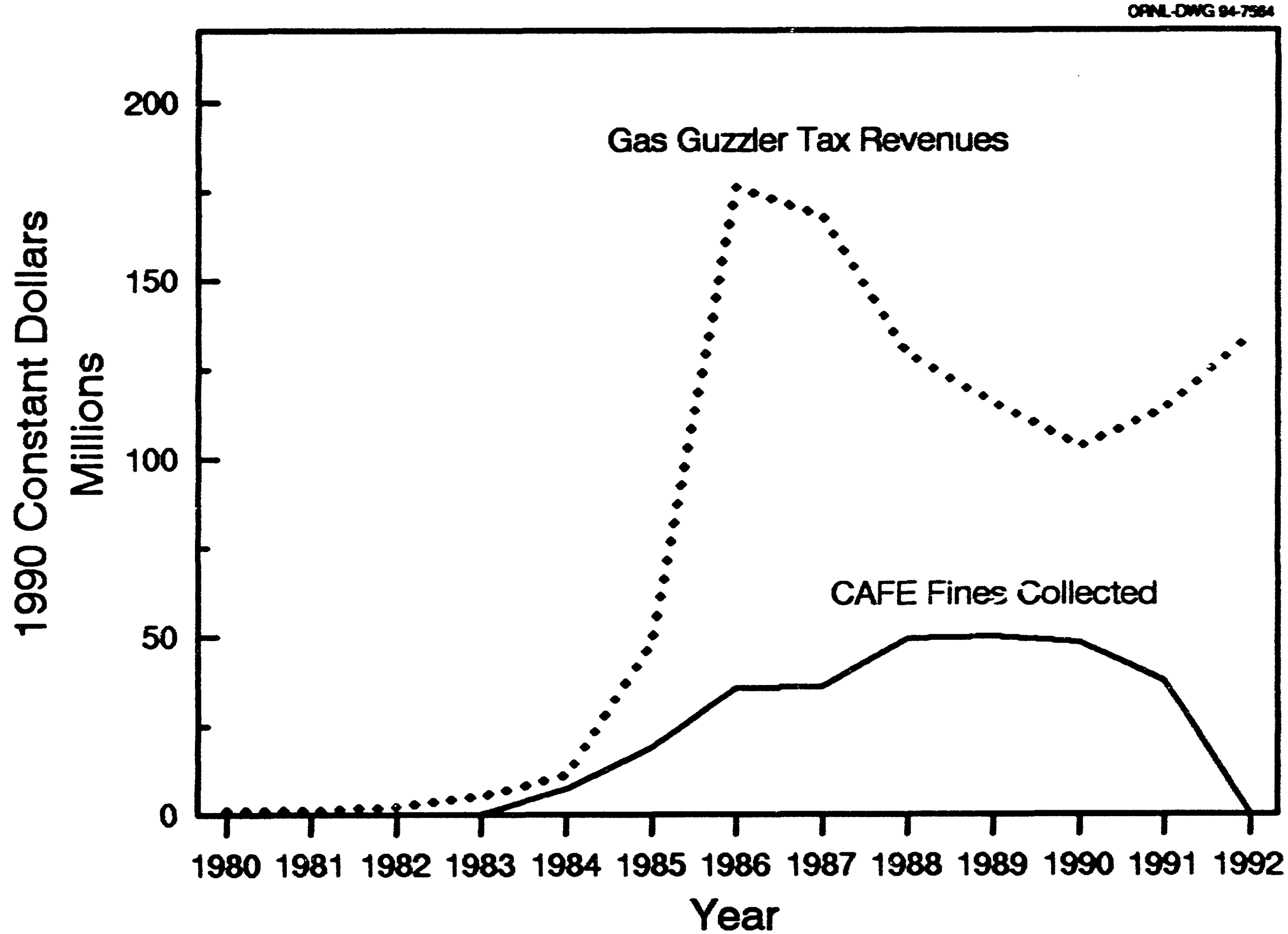
Table 3.37
Tax Receipts from the Sale of Gas Guzzlers, 1980-92
(Thousands)

Fiscal year	Current dollars	1990 constant dollars[a]
1980	740	1,174
1981	780	1,121
1982	1,720	2,329
1983	4,020	5,273
1984	8,820	11,097
1985	39,790	48,336
1986	147,660	175,987
1987	145,900	167,759
1988	116,780	129,008
1989	109,640	115,575
1990	103,200	103,200
1991	118,400	113,546
1992	144,200	134,250
Total	941,650	1,008,654

Source:
Motor Vehicle Manufacturers Association, Motor Vehicle Facts and Figures '93, Detroit, MI, 1993, p. 87.

[a]Adjusted using the Consumer Price Inflation Index.
[b]Includes only those fines collected through October 1993.

Figure 3.11. CAFE Fines and Gas Guzzler Tax Revenues, 1980-92



Source: See Tables 3.36 and 3.37.

Consumers must pay the Gas Guzzler Tax when purchasing an automobile that has an Environmental Protection Agency (EPA) fuel economy rating less than that stipulated in the table below. The Gas Guzzler Tax doubled in 1991 after remaining constant from 1986 to 1990.

Table 3.38
The Gas Guzzler Tax on New Cars
(dollars per vehicle)

Vehicle fuel economy (mpg)	1980	1981	1982	1983	1984	1985	1986-90	1991+
Over 22.5	0	0	0	0	0	0	0	0
22.0-22.5	0	0	0	0	0	0	500	1000
21.5-22.0	0	0	0	0	0	0	500	1000
21.0-21.5	0	0	0	0	0	0	650	1300
20.5-21.0	0	0	0	0	0	500	650	1300
20.0-20.5	0	0	0	0	0	500	850	1700
19.5-20.0	0	0	0	0	0	600	850	1700
19.0-19.5	0	0	0	0	450	600	1050	2100
18.5-19.0	0	0	0	350	450	800	1050	2100
18.0-18.5	0	0	200	350	600	800	1300	2600
17.5-18.0	0	0	200	500	600	1000	1300	2600
17.0-17.5	0	0	350	500	750	1000	1500	3000
16.5-17.0	0	200	350	650	750	1200	1500	3000
16.0-16.5	0	200	450	650	950	1200	1850	3700
15.5-16.0	0	350	450	800	950	1500	1850	3700
15.0-15.5	0	350	600	800	1150	1500	2250	4500
14.5-15.0	200	450	600	1000	1150	1800	2250	4500
14.0-14.5	200	450	750	1000	1450	1800	2700	5400
13.5-14.0	300	550	750	1250	1450	2200	2700	5400
13.0-13.5	300	550	950	1250	1750	2200	3200	6400
12.5-13.0	550	650	950	1550	1750	2650	3200	6400
Under 12.5	550	650	1200	1550	2150	2650	3850	7700

Source:
Internal Revenue Service, Form 6197, "Gas Guzzler Tax" and annual.

Two separate studies by the Federal Highway Administration have measured the effects of speed on fuel economy of automobiles. (The 1984 study also included light trucks.) The fuel economy loss will vary for each individual vehicle; these data are averages for the tested vehicles. Both studies indicated that maximum fuel efficiency was achieved at speeds of 35 to 40 mph.

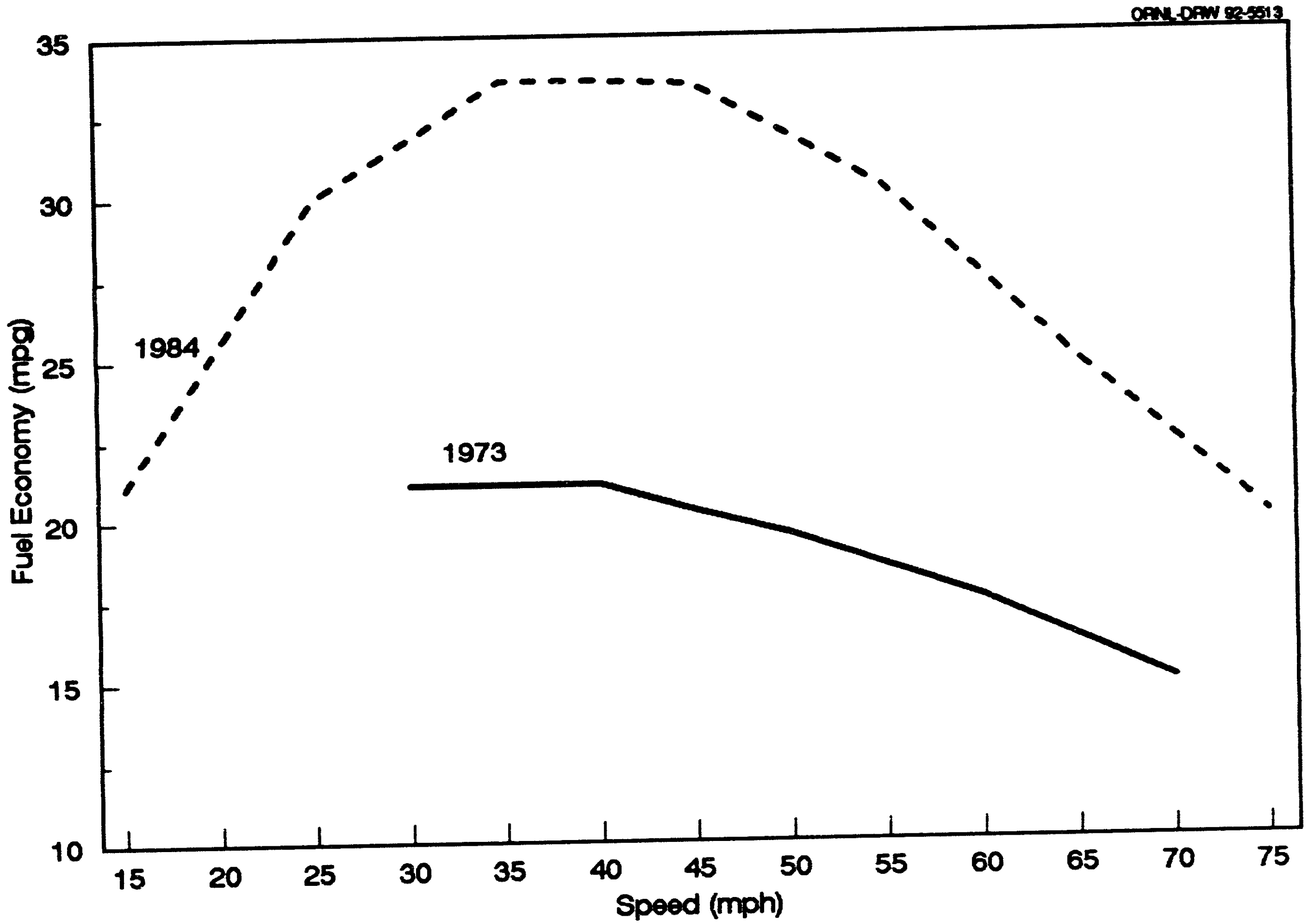
Table 3.39
Fuel Economy by Speed, 1973 and 1984
(miles per gallon)

Speed (miles per hour)	1973[a]	1984[b]
15	[c]	21.1
20	[c]	25.5
25	[c]	30.0
30	21.1	31.8
35	21.1	33.6
40	21.1	33.6
45	20.3	33.5
50	19.5	31.9
55	18.5	30.3
60	17.5	27.6
65	16.2	24.9
70	14.9	22.5
75	[c]	20.0
	Fuel economy loss	
55-65 mph	12.4%	17.8%
65-70 mph	8.0%	9.6%
55-70 mph	19.5%	25.7%

Sources:
1973- U.S. Department of Transportation, Federal Highway Administration, Office of Highway Planning, The Effect of Speed on Automobile Gasoline Consumption Rates, Washington, DC, October 1973.
1984 - U.S. Department of Transportation, Federal Highway Administration, Fuel Consumption and Emission Values for Traffic Models, Washington, DC, May 1985.

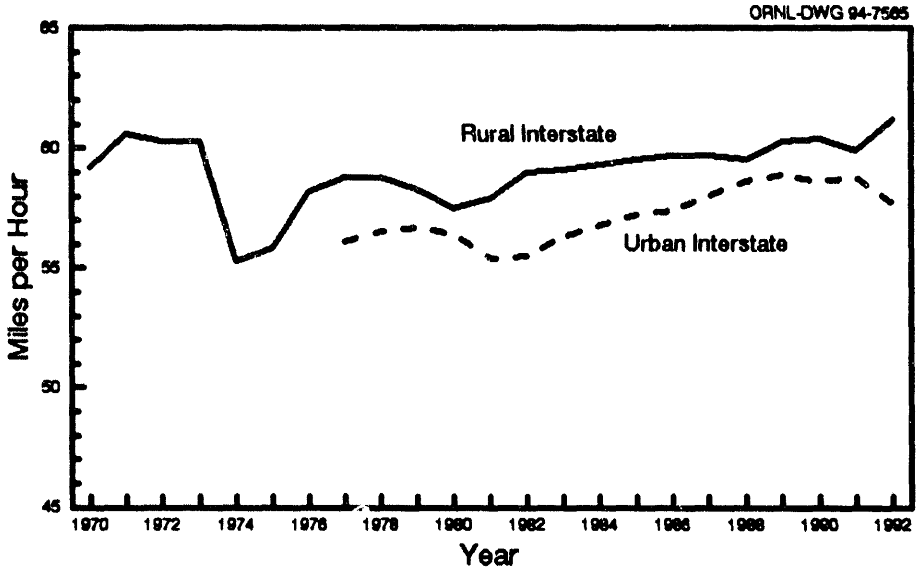
[a]Model years 1970 and earlier automobiles.
[b]Model years 1981-84 automobiles and light trucks.
[c]Data are not available.

Figure 3.12. Fuel Economy by Speed, 1973 and 1984



Source: See Table 3.39.

Figure 3.13. Average Interstate Speeds, 1970-91



Source: See Table 3.40

Table 3.40
Average Urban and Rural Interstate Speeds, 1970-91[a]
(miles per hour)

Year	Urban Interstate	Rural Interstate
1970	[b]	59.2
1971	[b]	60.6
1972	[b]	60.3
1973	[b]	60.3
1974	[b]	55.3
1975	[b]	55.8
1976	56.1	58.2
1977	56.5	58.8
1978	56.7	58.8
1979	56.4	58.3
1980	55.4	57.5
1981	55.5	57.9
1982	56.3	59.0
1983	56.8	59.1
1984	57.2	59.3
1985	57.2	59.5
1986	57.4	59.7
1987	58.0	59.7
1988	58.6	59.5
1989	58.9	60.3
1990	58.6	60.4
1991	58.8	59.9
1992	57.7	61.2

Source:
U.S. Department of Transportation, Federal Highway Administration, Highway Statistics 1991, Washington, DC, 1992, Table VS-1, p. 199, and annual.

[a]Data from 1970-79 represent only free-moving traffic, on level, straight, uncongested sections of Interstate. Beginning with fiscal year 1980, the data show the speeds of all vehicular traffic.
[b]Data are not available.

The Environmental Protection Agency (EPA) tests new vehicles to determine the fuel economy ratings. The city and highway fuel economies that are posted on the windows of new vehicles are determined by testing the vehicle during these driving cycles. The driving cycles simulate the performance of an engine while driving in the city or on the highway. Once the urban cycle is completed, the engine is stopped, then started again for the 8.5 minute hot start cycle.

ORNL-DWG89-14608

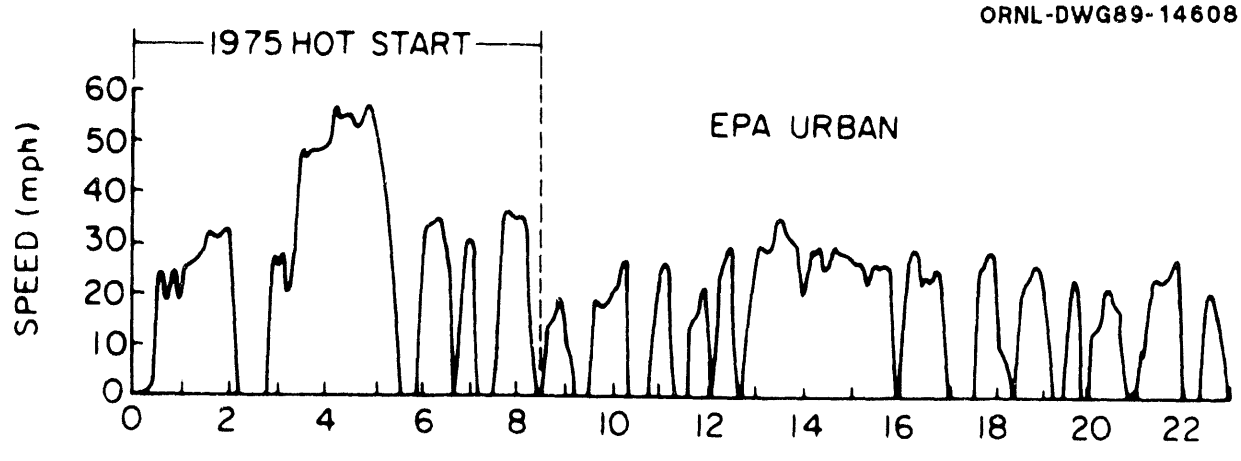


Figure 3.14. Urban Driving Cycle
Length of cycle: 1870 seconds, including idle time.
Average speed: 21.3 mph with idle; 26.5 mph without idle.

ORNL-DWG89-14609

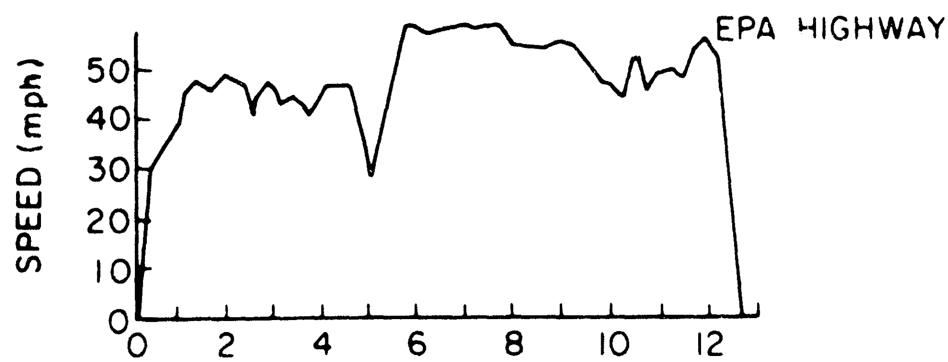


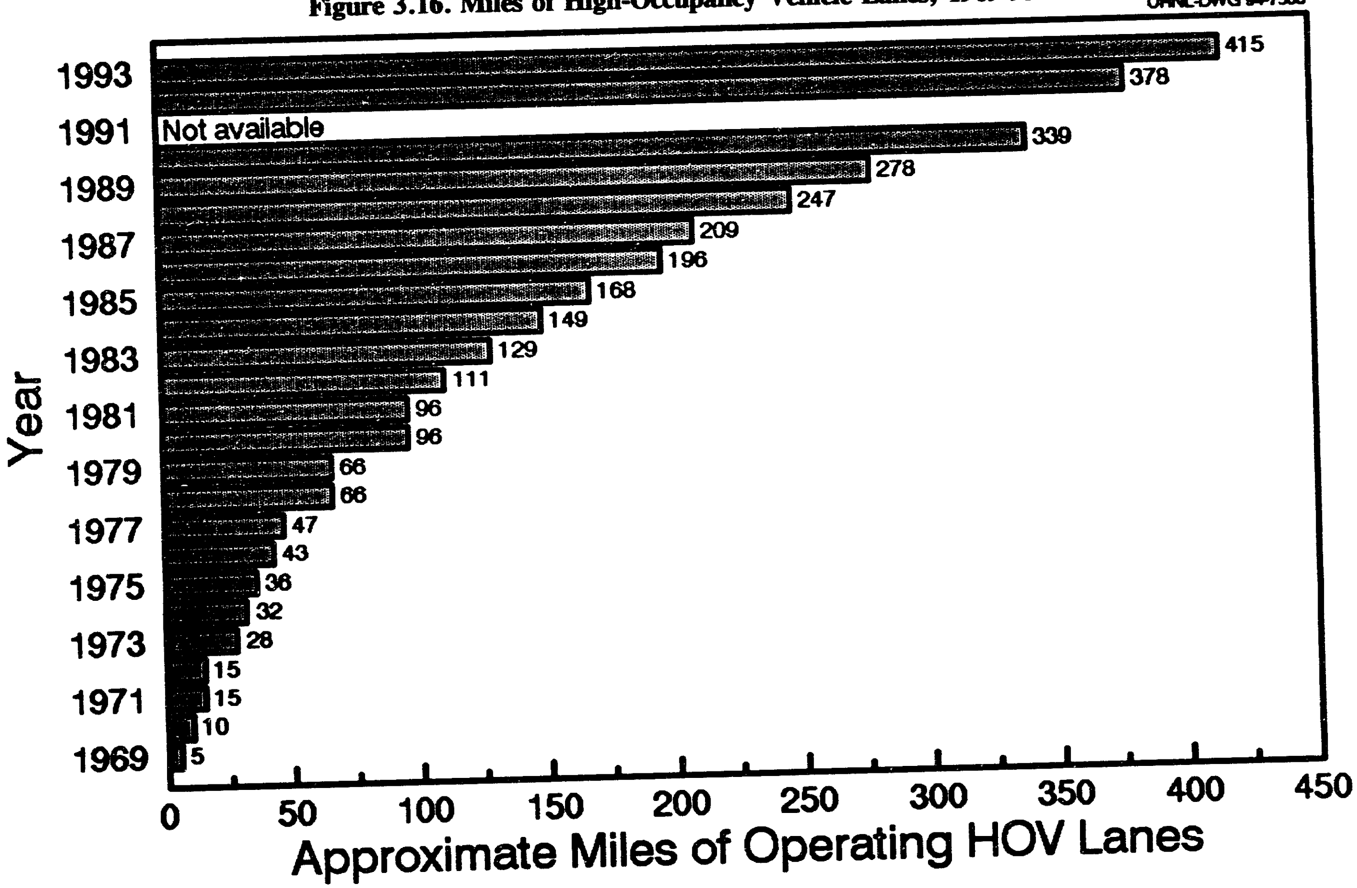
Figure 3.15. Highway Driving Cycle
Length of cycle: 765 seconds.
Average speed: 48.5 mph.

Source:
Code of Federal Regulations, 40CFR, "Subpart B - Fuel Economy Regulations for 1978 and Later Model Year Automobiles - Test Procedures," July 1, 1988 edition, p. 676.

Section 3.7
High-Occupancy Vehicle Lanes

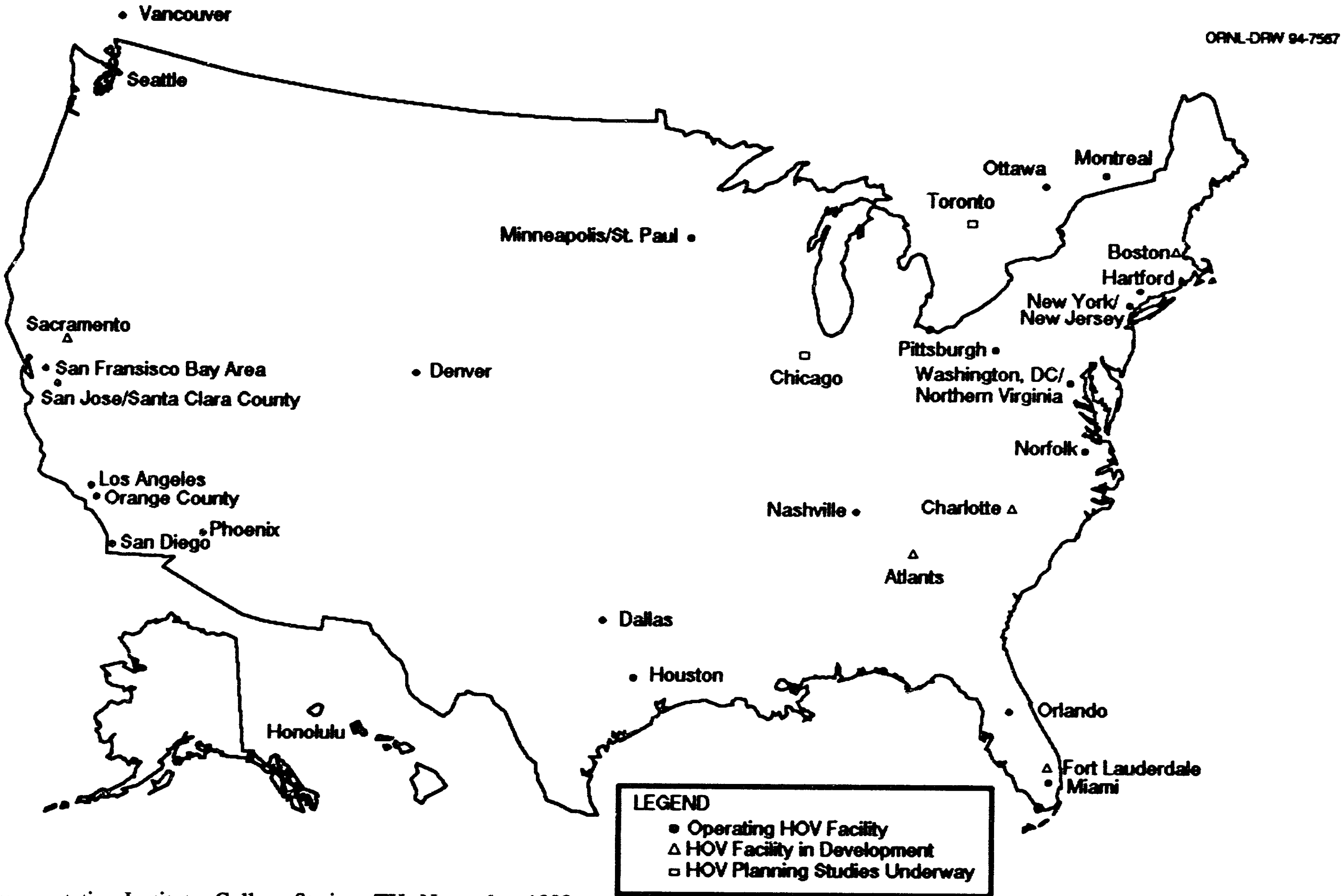
High-occupancy vehicle (HOV) lanes are special highway lanes meant for the exclusive use of vehicles with a specified number of passengers. Vehicles that use HOV lanes are usually guaranteed a shorter and less congested trip than those using regular traffic lanes. In 1993 there were 415 miles of HOV lanes in operation in the U.S. Twenty areas had HOV facilities in 1993, and 5 more areas had HOV facilities in development at that time.

Figure 3.16. Miles of High-Occupancy Vehicle Lanes, 1969-93



Source:
Texas Transportation Institute, College Station, TX, December 1993.

Figure 3.17. U.S. Urban Areas Where HOV Facilities Were in Operation or Development as of 1993



Source:
Texas Transportation Institute, College Station, TX, November 1993.

CHAPTER 4

PERSONAL TRAVEL STATISTICS

From 1950 to 1990, the average annual rate of increase in the number of vehicles surpasses the increases in population, households, licensed drivers, and employed persons. Since 1985 there has been more than one vehicle for every licensed driver in the U.S. (Table 4.1).

In 1990, 73% of U.S. workers commuted to work alone in a private vehicle, which is 9% more than in 1980 (Table 4.3). The "journey to work" data found in table 4.3 to 4.6 were collected by the U.S. Bureau of the Census in the Decennial Census of the population.

Another source of "journey to work" data is the Nationwide Personal Transportation Survey (NPTS). The NPTS is a national survey designed to collect data on the nature and characteristics of personal travel. The definition of a trip in the NPTS is "any one-way travel from one address (place) to another by private motor vehicle, public transportation, bicycle, or walking." Excluded from the survey are jogging and walking for exercise, as well as all bicycling and walking for individuals under 5 years of age. The survey collects detailed data on household trips, their purposes and the transportation modes used. The NPTS is sponsored by several agencies of the U.S. Department of Transportation and is conducted approximately every seven years. Since each of the surveys differ somewhat in terminology, survey procedure, and target population, one should be cautious when comparing statistics from one survey to the next.

Results from the Residential Transportation Energy Consumption Survey (RTECS) are also presented in this chapter. The RTECS has been conducted five times since 1978 by the Department of Energy's Energy Information Administration. The survey focuses on vehicle miles traveled, energy end-use consumption and expenditures by households for personal transportation. Vehicle travel information is collected by actual odometer readings instead of survey respondents estimates as in the NPTS. There were no major changes in survey methodology between the 1988 and 1991 surveys, but the 1985 and previous RTECS had different estimation procedures for vehicle fuel economy and fuel prices. Therefore, caution should be used when comparing the 1988 and 1991 RTECS to previous years.

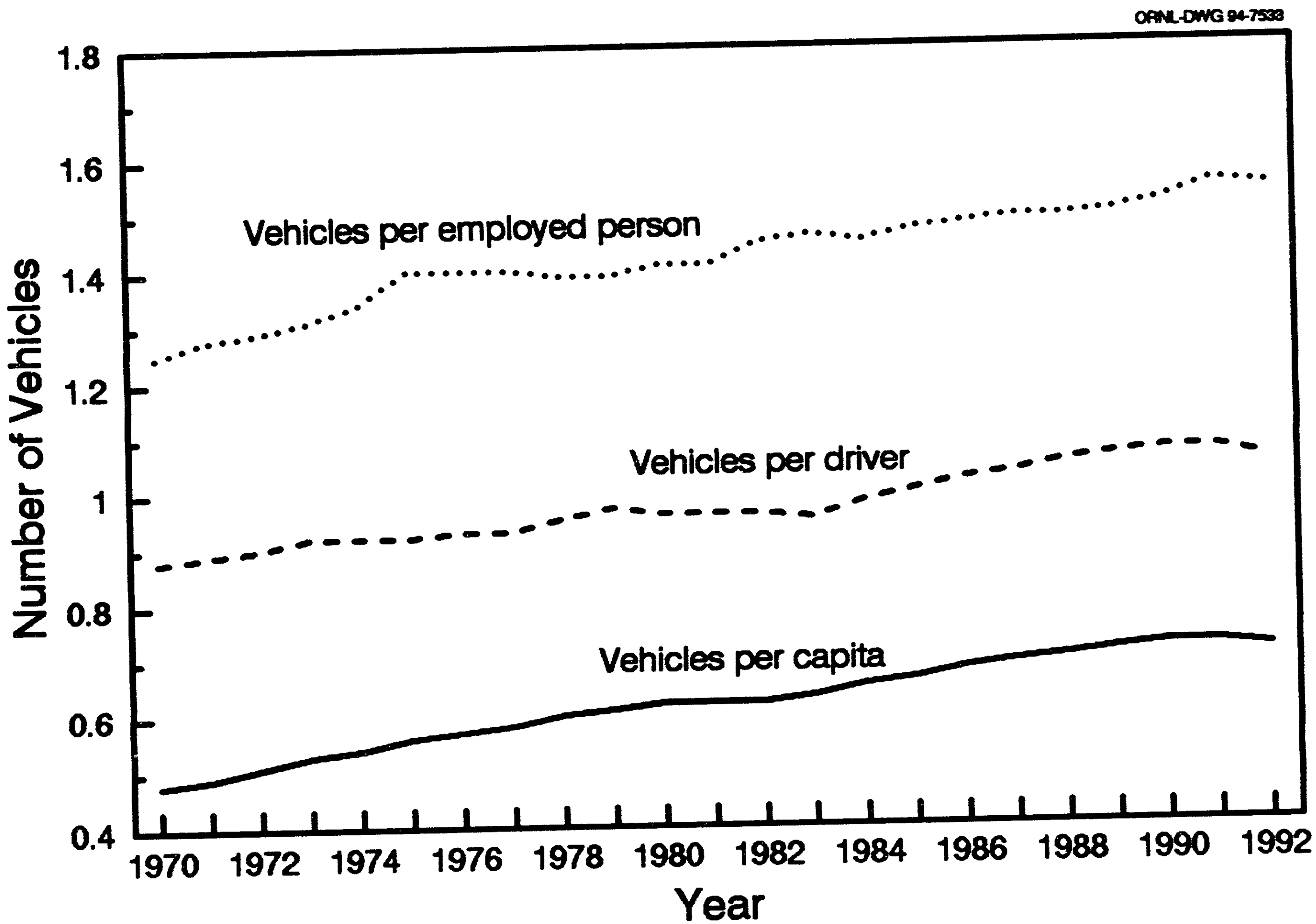
Table 4.1
Population and Vehicle Profile, 1950-92

Year	Resident population[a] (thousands)	Total households (thousands)	Number of vehicles in operation (thousands)	Number of licensed drivers (thousands)	Number of civilian employed persons (thousands)	Vehicles per capita	Vehicle miles per capita	Licensed drivers per household	Vehicles per licensed driver	Vehicles per civilian employed persons
1950	151,271	43,554	43,256	62,194	58,918	0.29	3,029	1.43	0.70	0.73
1955	165,069	47,874	55,804	74,686	62,170	0.34	3,656	1.56	0.75	0.90
1960	179,979	52,799	66,582	87,253	65,778	0.36	3,994	1.65	0.76	1.01
1965	193,526	57,251	82,067	98,502	71,088	0.42	4,587	1.72	0.83	1.15
1970	203,984	63,401	98,136	111,543	78,678	0.48	5,440	1.76	0.88	1.25
1975	215,465	71,120	120,054	129,791	85,846	0.56	6,162	1.82	0.92	1.40
1980	227,225	80,776	139,832	145,295	99,303	0.62	6,722	1.80	0.96	1.41
1981	229,466	82,368	141,908	147,075	100,397	0.62	6,767	1.79	0.96	1.41
1982	231,664	83,527	143,854	150,234	99,526	0.62	6,885	1.80	0.96	1.45
1983	233,792	83,918	147,104	154,389	100,834	0.63	7,069	1.83	0.95	1.46
1984	235,825	85,407	152,162	155,424	105,005	0.65	7,295	1.82	0.98	1.45
1985	237,924	86,789	157,048	156,868	107,150	0.66	7,457	1.81	1.00	1.47
1986	240,133	88,458	162,094	159,487	109,597	0.68	7,655	1.80	1.02	1.48
1987	242,289	89,479	167,193	161,975	112,440	0.69	7,929	1.81	1.03	1.49
1988	244,499	91,061	171,741	162,853	114,968	0.70	8,286	1.79	1.05	1.49
1989	246,819	92,830	175,960	165,555	117,342	0.71	8,494	1.78	1.06	1.50
1990	249,391	93,347	179,299	167,015	117,914	0.72	8,598	1.79	1.07	1.52
1991	252,160	94,312	181,438	168,995	116,877	0.72	8,614	1.79	1.07	1.55
1992	255,082	95,669	181,519	173,125	117,598	0.71	8,781	1.81	1.05	1.54
					Average annual percentage change					
1950-92	1.3%	1.9%	3.5%	2.5%	1.7%	2.2%	2.6%	0.6%	1.0%	1.8%
1970-92	1.0%	1.9%	2.8%	2.0%	1.8%	1.8%	2.2%	0.1%	0.8%	1.0%
1982-92	1.0%	1.4%	2.4%	1.4%	1.7%	1.4%	2.5%	0.1%	0.9%	0.6%

Sources:
Resident population, total households, and civilian employed persons - U.S. Department of Commerce, Bureau of the Census, Statistical Abstract of the United States, 113th edition, 1993, Washington, DC, pp. 8, 55, 395, and annual.
Vehicles in operation - R. L. Polk and Company. **FURTHER REPRODUCTION PROHIBITED.**
Licensed drivers and vehicle miles - U.S. Department of Transportation, Federal Highway Administration, Highway Statistics 1992, Table DL-1, and annual.

[a]Estimates as of July 1. Includes Armed Forces stationed in the United States.

Figure 4.1. Population and Vehicle Profile, 1970-92



Source: See Table 4.1.

Transportation (17.1%) is second only to housing (31.2%) as the largest expenditure for the average household. In 1992, approximately 19% of transportation expenditures were for purchasing gasoline and motor oil.

Table 4.2
Average Annual Expenditures of Households by Income, 1992[a]

	All households	Income before taxes								
		Less than $5000	$5,000-$9999	$10,000-$14999	$15,000-$19,999	$20,000-$29,999	$30,000-$39,999	$40,000-$49999	$50,000-$69,999	$70,000 and over
Total expenditures	$30,527	$13,300	$12,250	$17,391	$21,360	$26,071	$31,381	$39,983	$46,735	$69,207
	Percentage of total expenditures[b]									
Food[c]	15.3	18.3	18.5	17.8	18.2	16.4	15.5	15.0	14.4	12.2
Housing	31.2	34.8	39.0	35.6	33.1	31.3	30.4	29.8	29.5	29.7
Apparel and services	5.7	5.8	5.2	5.1	5.1	6.0	5.1	5.7	5.9	5.9
Transportation	17.1	15.9	13.5	16.4	15.9	18.8	18.6	17.8	17.4	16.5
Vehicle purchases (net outlay)	**7.1**	**6.2**	**4.8**	**6.9**	**4.9**	**7.9**	**7.8**	**7.5**	**7.2**	**7.4**
Gasoline and motor oil	**3.2**	**3.7**	**3.5**	**3.5**	**3.9**	**3.7**	**3.5**	**3.3**	**3.1**	**2.3**
Other vehicle expenditures	**5.9**	**5.0**	**4.4**	**5.2**	**6.3**	**6.3**	**6.4**	**6.1**	**6.2**	**5.7**
Public transportation	**0.9**	**1.0**	**0.8**	**0.7**	**0.8**	**0.9**	**0.8**	**0.9**	**0.9**	**1.2**
Health care	5.4	5.8	8.5	8.1	7.7	6.3	5.5	4.9	4.3	3.7
Entertainment	5.0	5.6	3.6	3.7	4.8	4.4	5.0	5.9	5.7	5.1
Personal Insurance & pensions	10.1	1.9	2.3	3.5	5.2	7.7	10.4	10.9	13.2	15.1
Others[d]	10.1	11.9	9.3	9.7	9.9	8.9	9.6	10.1	9.6	11.9

Source:
U.S. Department of Labor, Bureau of Labor Statistics, Consumer Expenditure Survey: Interview Survey, 1990, detailed computer printout, November 1991 .

[a]In some cases average annual expenditures may exceed the reported amount of income. This is due to several factors such as incorrect reporting of income, indebtedness, student status, etc. Public assistance monies are included in reported income.
[b]Percentages may not sum to totals due to rounding.
[c]Includes alcoholic beverages.
[d]Includes personal care, reading, education, tobacco and smoking supplies, cash contributions, and miscellaneous items.

> *According to the U.S. Census data, the percentage of workers who carpooled has dropped from 19.7% in 1980 to 13.4% in 1990. The percent of workers using public transit declined from 6.4% to 5.3% during the same time period. The average travel time increased by 0.7 minutes from 1980 to 1990.*

Table 4.3
Means of Transportation to Work for the United States: 1980 and 1990 Census

	1980 Census		1990 Census	
Means of Transportation	Number of Workers	Percentage	Number of Workers	Percentage
Private vehicle	81,258,496	84.1	99,592,932	86.5
Drove alone	62,193,449	64.4	84,215,298	73.2
Carpooled	19,065,047	19.7	15,377,634	13.4
Public Transportation	6,175,061	6.4	6,069,589	5.3
Bus or trolley bus[a]	3,924,787	4.1	3,445,000	3.0
Streetcar or trolley car[a]	[b]	[b]	78,130	0.1
Subway or elevated	1,528,852	1.6	1,755,476	1.5
Railroad	554,089	0.6	574,052	0.5
Ferryboat	[b]	[b]	37,497	0.0
Taxicab	167,133	0.2	179,434	0.2
Other Means	703,273	0.7	808,582	0.7
Motorcycle	419,007	0.4	237,404	0.2
Bicycle	468,348	0.5	466,856	0.4
Walked only	5,413,248	5.6	4,488,886	3.9
Worked at home	2,179,863	2.3	3,406,025	3.0
Total Workers	96,617,296	100.0	115,070,274	100.0
Average travel time (minutes)	21.7		22.4	

Source:
Data provided by the Journey-to-Work and Migration Statistics Branch, Population Division, U.S. Bureau of the Census.

[a] This category was "Bus or streetcar" in 1980.
[b] Data are not available.

Since 1970 over three-fourths of the workers in the U.S. travel to work in private vehicles. The share of workers traveling by private vehicle increased 19% from 1960 to 1990. The percentage of workers traveling by public transit declined by 8% in this same period. The number of households owning three or more vehicles has increased by from 2.53% in 1960 to 17.33% in 1990.

Table 4.4
Workers by Major Mode of Transportation to Work, 1960-90 Census
(percentage)

	Private vehicle[a]	Public transit	Walked	Worked at home	Total workers
1960	69.48%	12.62%	10.37%	7.54%	64,656,805
1970	80.63%	8.48%	7.40%	3.49%	76,852,389
1980	85.92%	6.22%	5.60%	2.26%	96,617,296
1990	88.02%	5.12%	3.90%	2.96%	115,070,274

Source:
U. S. Department of Transportation, Volpe National Transportation Systems Center, Journey to Work Trends in the United States and its Major Metropolitan Area, 1960-1990, Cambridge, MA, 1994, p. 2-2.

Table 4.5
Household Vehicle Ownership, 1960-90 Census
(percentage)

	No vehicles	One vehicle	Two vehicles	Three or more vehicles	Total vehicles
1960	21.53%	56.94%	19.00%	2.53%	54,766,718
1970	17.47%	47.71%	29.32%	5.51%	79,002,052
1980	12.92%	35.53%	34.02%	17.52%	129,747,911
1990	11.53%	33.74%	37.35%	17.33%	152,380,479

Source:
U. S. Department of Transportation, Volpe National Transportation Systems Center, Journey to Work Trends in the United States and its Major Metropolitan Area, 1960-1990, Cambridge, MA, 1994, p. 2-2.

---

[a]Includes cars, trucks, vans, bicycles, motorcycles, taxicabs, and all other means.

Table 4.6
National and Metropolitan Area Comparisons of Journey-to-Work Statistics, 1990 Census

	National	Metropolitan areas[a]
Workers per household	1.25	1.31
Workers per vehicle	0.76	0.82
Average travel time (minutes)	22.38	25.20
Commute Length (percentage)		
Less than 15 minutes	15.87%	11.45%
15 - 29 minutes	51.64%	49.22%
30 - 39 minutes	14.66%	17.48%
40 - 59 minutes	9.01%	11.77%
60 minutes or more	5.86%	7.52%
Mode (percentage)		
Drive alone	73.19%	70.75%
Percentage carpooled	13.36%	12.69%
Public transit	5.27%	8.98%
Motorcycle	0.21%	0.21%
Walk	3.90%	3.76%
Bicycle	0.41%	0.43%
Other	0.70%	0.62%
Work at home	2.96%	2.57%
Time Workers Leave Home (percentage)		
5:00 AM - 6.59 AM	26.04%	25.49%
7:00 AM - 8:29 AM	41.87%	42.44%
8:30 AM - 9:59 AM	10.28%	11.57%
All other departures	18.85%	17.93%

Source:
U. S. Department of Transportation, Volpe National Transportation Systems Center, Journey to Work Trends in the United States and its Major Metropolitan Area, 1960-1990, Cambridge, MA, 1994, p. 2-6.

[a]Metropolitan areas over 1 million population. There were 39 such areas in the 1990 Census.

The average commute trip length increased by 7% from 1983 to 1990, from 9.9 miles to 10.6 miles. The shortest commuter trips (distancewise) each year were taken by bus, and the longest by truck.

Table 4.7
Journey-to-Work Trip Distance by Mode
1969, 1977, 1983, and 1990 Series of the NPTS

					Change	
Mode	1969	1977	1983	1990	69-90[a]	69-90[b]
			Average Commute Trip Distance (Miles)			
Auto	9.4	9.2	9.9	10.4	0.5	11
Truck[c]	14.2	10.6	11.4	13.0	-0.4	-8
Bus	8.7	7.2	8.6	9.3	0.3	7
ALL	**9.9**	**9.2**	**9.9**	**10.6**	**0.3**	**7**

Source: U.S. Department of Transportation, Federal Highway Administration, 1990 Nationwide Personal Transportation Survey: Summary of Travel Trends, Table 10, Washington, DC, March 1992.

[a]Compounded annual percentage change rate.
[b]Percentage change rate.
[c]Household-based trucks, primarily pickups.

Table 4.8
Distribution of Journey-to-Work Trips by Worker Age and Mode, 1990 NPTS
(percentage)

Age (years)	Automobile	Truck	Van	Bus	Train[a]	Walk	Other[b]	Total
5 - 15	56.5	8.8	6.4	6.7	0.0	12.3	9.3	100
16 - 19	76.3	10.0	1.5	2.7	1.1	6.6	1.8	100
20 - 29	72.3	15.0	2.2	2.5	2.3	4.6	1.1	100
30 - 39	69.2	16.7	5.9	1.8	2.0	3.7	0.8	100
40 - 49	70.4	16.8	5.4	2.4	1.1	3.0	0.9	100
50 - 59	67.1	20.2	4.6	2.2	1.4	3.6	0.9	100
60 - 64	71.5	17.3	2.9	3.3	0.9	3.6	0.4	100
65 and over	71.1	13.8	2.1	6.2	2.2	3.6	1.0	100
Total	**70.4**	**16.3**	**4.3**	**2.4**	**1.7**	**4.0**	**1.0**	**100**

Source:
Generated from the U.S. Department of Transportation, Federal Highway Administration, 1990 Nationwide Personal Transportation Study, Public Use tape, March 1992.

[a]Includes Amtrak, commuter train, streetcar, trolley, elevated rail, and subway.
[b]Includes recreational vehicle, motorcycle, moped, bicycle, taxi, and other.

Table 4.9
Distribution of Journey-to-Work Trips by Trip Distance and Mode, 1990 NPTS
(percentage)

Trip Distance (miles)	Auto	Truck	Van	Bus	Train[a]	Walk	Other[b]	Total	Distribution by distance
Less then 1/2	45.8	7.7	2.3	1.6	1.1	40.0	1.6	100	7.4
1/2 - 5	73.2	15.1	4.2	2.4	0.9	2.5	1.7	100	39.0
6 - 10	74.7	16.6	4.0	2.6	1.3	0.3	0.6	100	21.5
11 - 15	74.3	18.0	4.0	2.1	1.2	0.0	0.4	100	12.4
16 - 20	70.3	20.3	5.1	2.0	1.9	[c]	0.1	100	7.1
21 - 30	69.9	19.7	5.9	1.5	2.7	0.0	0.3	100	6.7
31 - 40	66.1	23.5	4.7	0.9	4.1	[c]	0.5	100	2.9
41 - 50	65.9	21.0	4.3	1.6	6.4	0.0	0.7	100	1.5
51 - 60	55.1	19.7	17.1	4.5	2.0	0.0	1.6	100	0.7
61 - 70	64.9	23.4	7.9	0.0	3.8	0.0	0.0	100	0.3
71 - 80	51.4	27.6	10.7	4.2	6.1	0.0	0.0	100	0.2
81 - 90	82.0	4.9	0.0	0.0	13.1	0.0	0.0	100	0.1
91 - 100	59.0	18.9	14.4	0.0	7.7	0.0	0.0	100	0.1
Over 100	47.7	43.7	5.3	1.4	1.9	0.0	0.0	100	0.2
Total	**70.6**	**16.4**	**4.3**	**2.2**	**1.5**	**4.0**	**1.0**	**100**	**100.0**

Source:
Generated from the U.S. Department of Transportation, Federal Highway Administration, 1990 Nationwide Personal Transportation Study, Public Use tape, March 1992.

[a]Includes Amtrak, commuter train, streetcar, trolley, elevated rail, and subway.
[b]Includes recreational vehicle, motorcycle, moped, bicycle, taxi, and other.
[c]Insufficient data reported.

Both annual VMT and annual vehicle trips per household increased by 22% between 1969 and 1990. Work trips continue to account for the largest proportion of household travel, both in terms of miles and in number of trips. Average vehicle trip lengths, which had been decreasing from 1969 to 1983, showed increases in 1990. The largest increase in trip length was in work trips.

Table 4.10
Average Annual VMT, Vehicle Trips and Trip Length Per Household for Selected Trip Purposes 1969, 1977, 1983, and 1990 Series of the NPTS

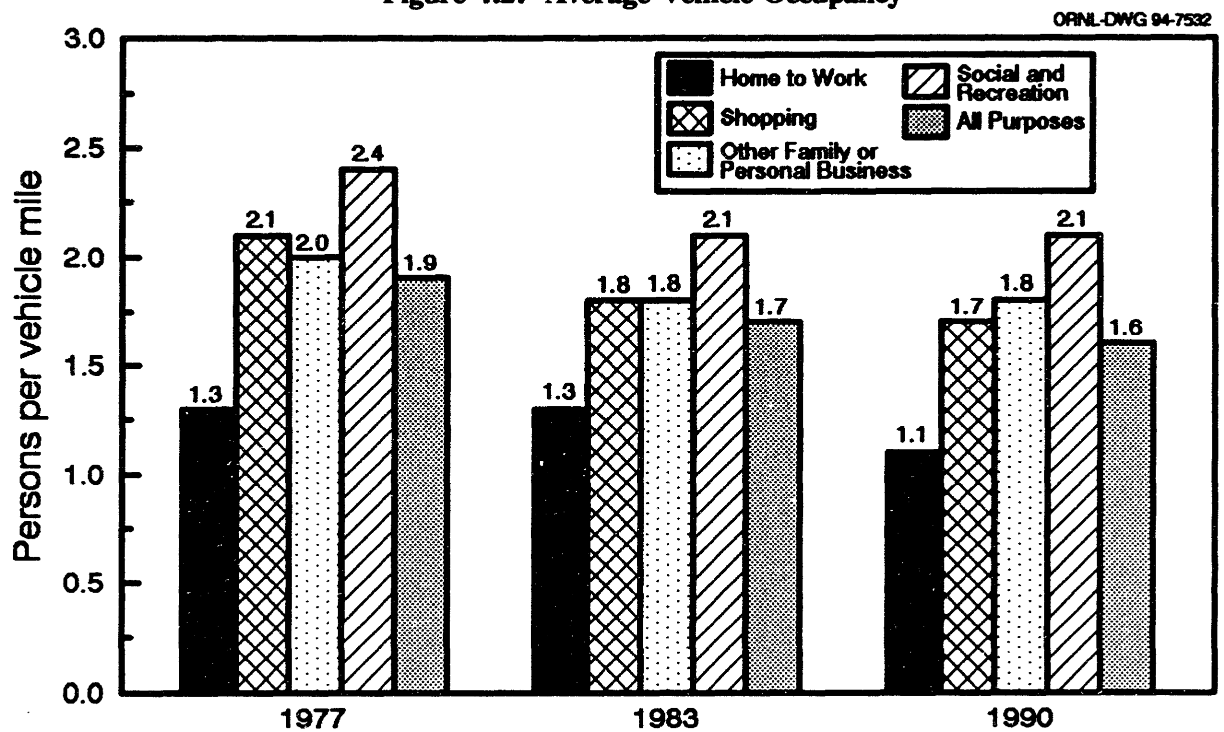
Trip Purpose	1969	1977	1983	1990	Percent Change 69-90
Average Annual VMT					
Home to Work	4,183	3,815	3,538	4,853	16
Shopping	929	1,336	1,567	1,743	88
Other Family or Personal Business	1,270	1,444	1,816	3,014	137
Social and Recreation	4,094	3,286	3,534	4,060	-1
All[a]	**12,423**	**12,036**	**11,739**	**15,100**	**22**
Average Annual Vehicle Trips					
Home to Work	445	423	414	448	0.7
Shopping	213	268	297	345	62
Other Family or Personal Business	195	215	272	411	111
Social and Recreation	312	320	335	349	12
All[a]	**1,396**	**1,442**	**1,486**	**1,702**	**22**
Average Vehicle Trip Length (Miles)					
Home to Work	9.4	9.1	8.5	11.0	17
Shopping	4.4	5.0	5.3	5.1	16
Other Family or Personal Business	6.5	6.8	6.7	7.4	14
Social and Recreation	13.1	10.3	10.5	11.8	-10
All[a]	**8.9**	**8.4**	**7.9**	**9.0**	**1**

Source: U.S. Department of Transportation, Federal Highway Administration, 1990 Nationwide Personal Transportation Survey: Summary of Travel Trends, Table 7, Washington, DC, March 1992.

[a]Includes trip purposes not shown above.

The average vehicle occupancy, calculated as person miles per vehicle mile, was at its lowest level since 1977 for every trip purpose. Several factors contributed to this decline in the vehicle occupancy rate, including the increased number of vehicles per household and the decrease in average household size.

Figure 4.2. Average Vehicle Occupancy



Source:

U.S. Department of Transportation, Federal Highway Administration, 1990 Nationwide Personal Transportation Survey: Summary of Travel Trends, Figure 6, Washington, DC, March 1992.

Table 4.11
Summary Statistics from the 1983, 1985, 1988, and 1991 RTECS

	RTECS Survey year				Average annual percentage change		
	1983	1985	1988	1991	1983-85	1985-88	1988-91
Number of households with vehicles (millions)	72.2	77.7	81.3	84.6	3.7%	1.5%	1.3%
Number of household vehicles (millions)	129.3	137.3	147.5	151.2	3.0%	2.4%	0.8%
Total vehicle miles traveled (billions)	1,215	1,353	1,511	1,602	5.5%	3.8%	2.0%
Vehicle miles traveled per household with vehicles	16,800	17,400	18,600	18,900	1.7%	2.2%	0.6%
Vehicle miles traveled per vehicle	9,400	9,900	10,200	10,600	2.4%	1.3%	1.3%

Source:
U.S. Department of Energy, Energy Information Administration, Household Vehicles Energy Consumption 1991, Washington, DC, December 1993, p. 15.

Table 4.12
Average Number of Vehicles and Vehicle Travel per Household, 1991 RTECS

	Average number of vehicles per household	Average vehicle miles traveled per household
Number of Drivers		
1	1.2	10,900
2	2.0	21,400
3	2.6	30,700
4 or more	3.1	36,700
Household size		
1 person	1.2	10,600
2 persons	1.8	17,700
3 persons	2.0	22,300
4 persons	2.2	26,200
5 persons	2.1	23,600
6 or more persons	1.9	22,600
Household urban status		
Urban	1.8	18,800
Central city	1.6	15,900
Suburban	1.9	20,400
Rural	1.9	19,500
Household composition		
With children	2.0	22,800
Without children	1.7	16,500
Total	**1.8**	**18,900**

Source:
U.S. Department of Energy, Energy Information Administration, Household Vehicles Energy Consumption 1991, Washington, DC, December 1993, pp. 48, 49.

Table 4.13
Statistics for Household Vehicles by Vehicle Type, 1985, 1988, and 1991 RTECS

Type of vehicle	Number of vehicles[a] (millions)			Average annual miles per vehicle (thousands)			Average fuel economy (mpg)		
	1985	1988	1991	1985	1988	1991	1985[b]	1988	1991
Passenger car	106.6	109.3	108.3	9.9	10.4	10.6	17.2	19.7	21.1
Pickup truck	21.2	25.9	25.9	9.4	9.4	10.0	13.5	15.3	15.8
Mini van	[c]	2.2	5.1	[c]	12.7	12.7	[c]	19.4	19.6
Large van	4.7	4.7	2.6	10.5	9.8	10.1	13.2	13.1	13.7
Utility vehicle	3.7	4.8	7.3	10.6	11.8	11.6	12.7	15.4	16.2
Other[d]	1.1	0.7	[c]	6.0	4.9	[c]	9.6	8.3	[c]

Sources:
1985 and 1988 estimates are based on data provided on the following public use tapes: U.S. Department of Energy, Energy Information Administration, 1985 Residential Transportation Energy Consumption Survey, and 1988 Residential Transportation Energy Consumption Survey, Washington, DC, 1987 and 1990.
1991 estimates: U.S. Department of Energy, Energy Information Administration, Household Vehicles Energy Consumption 1991, Washington, DC, 1993, pp. 29, 46, 52.

[a]These data are survey estimates; data are not the same as R. L. Polk estimates of the number of vehicles.
[b]Fuel economy data from the 1985 RTECS is not **directly** comparable to data from later years because of a change in methodology.
[c]Data are not available.
[d]Includes motor homes.

Table 4.14
Number of Vehicles, Vehicle Miles, and Fuel Economy, 1991 RTECS

	Number of vehicles (millions)	Average vehicle miles traveled	Miles per gallon
Total	**151.2**	**10,600**	**19.3**
Model Year			
1991 to 1992	5.5	14,000	21.8
1990	10.5	12,600	21.5
1989	12.5	13,200	21.8
1986 to 1988	39.0	12,300	22.0
1983 to 1985	31.1	10,800	20.6
1980 to 1982	17.5	9,200	19.1
1977 to 1979	16.7	8,100	14.1
1974 to 1976	7.3	7,200	12.6
1973 or earlier	11.1	5,800	12.2
1990 Family income			
Less than $5,000	3.6	9,100	18.4
$5,000 to $9,999	9.1	8,400	17.7
$10,000 to $14,999	13.5	8,900	18.2
$15,000 to $19,999	10.9	9,700	18.6
$20,000 to $24,999	15.6	9,800	17.9
$25,000 to $34,999	27.5	10,300	19.0
$35,000 to $49,999	32.1	11,200	20.3
$50,000 to $74,999	22.9	11,900	20.1
$75,000 or more	16.0	12,300	20.3

Source:
U.S. Department of Energy, Energy Information Administration, Household Vehicles Energy Consumption 1991, Washington, DC, December 1993, p. 51.

For incomes of greater than $20,000, there are more households with two vehicles than with one vehicle. For households with $50,000 or more income, there are more households with three vehicles than with one vehicle. There are more vehicles in both two and three (+) vehicle households than in one vehicle households.

Table 4.15
Households by Number of Vehicles and 1990 Family Income, 1991 RTECS

1990 Annual family income	Total households (millions)	Number of Vehicles			
		None	One	Two	Three or more
		Percentage			
Less than $5,000	5.2	50.0%	36.5%	11.5%	1.9%
$5,000 to $9,999	10.4	31.7%	51.9%	14.4%	1.9%
$10,000 to $19,999	19.8	16.2%	54.0%	23.2%	7.1%
$20,000 to $34,999	25.1	5.6%	37.8%	40.2%	16.3%
$35,0000 to $49,999	16.7	5.4%	26.3%	45.5%	22.2%
$50,000 or more	17.3	1.7%	15.6%	50.3%	32.4%
Total	**94.6**	**12.4%**	**36.6%**	**35.0%**	**16.0%**

Source:
U.S. Department of Energy, Energy Information Administration, Household Vehicles Energy Consumption 1991, Washington, DC, December 1993, p. 8.

CHAPTER 5

ALTERNATIVE FUELS STATISTICS

In 1992, the transportation sector alone used 21.8 quads of petroleum fuels, accounting for 65.1% of total petroleum consumed in the United States. With decreasing domestic oil production and rising demand, the amount of imported crude oil and petroleum products has increased at an average rate of 6.4% per year since 1985. In 1991, 46% of the petroleum consumed in the U.S. was imported. These statistics suggest that addressing the nation's dependence on petroleum will be through reducing the transportation sector's dependence on petroleum fuels.

In 1988 the Alternative Motor Fuels Act (AMFA) was established to encourage the use of alternative fuels in the U.S. transportation sector. As a result of the AMFA, the Alternative Fuels Data Center (AFDC) was established by the Department of Energy. The AFDC distributes information about alternative fuel vehicles as well as data on refueling sites around the nation. Information about the AFDC, and statistics and maps generated by the AFDC, are presented in this chapter.

Since the AMFA, government and industry have made major efforts to advance our knowledge of alternative fuels and alternative fuel vehicles. The U.S. Advanced Battery Consortium (USABC) was established in January 1991 to concentrate efforts on battery development for electric vehicles. The goals of the USABC are presented in Table 5.7.

The Energy Policy Act (EPAct) of 1992 included alternative fuel mandates. Purchase requirements were set from 1993 forward for the federal and state governments, fuel providers (e.g., natural gas and electric utilities), and the private sector. The federal fleet purchase requirements have already been updated by Executive Order 12844 (see Figure 5.4). Additional rulemaking is required for the private sector alternative fuel vehicle mandates to take effect.

Also in this chapter are statistics on the characteristics of selected alternative fuels, taxation of all motor fuels, and utilization of gasohol (a blend of ethanol and gasoline).

THE ALTERNATIVE FUELS DATA CENTER

The Department of Energy (DOE) has established the Alternative Fuels Data Center (AFDC) in support of its work aimed at fulfilling the Alternative Motor Fuels Act (AMFA) directives. The AFDC is operated and managed by the National Renewable Energy Laboratory (NREL) in Golden, Colorado.

The purposes of the AFDC are

- to gather and analyze information on the fuel consumption, emissions, operation, and durability of alternative fuel vehicles, and
- to provide unbiased, accurate information on alternative fuels and alternative fuel vehicles to government agencies, private industry, research institutions, and other interested organizations.

The data are collected for three specific vehicle types: (1) light-duty vehicles, including automobiles, light trucks, and mini-vans; (2) heavy-duty vehicles such as tractor trailers and garbage trucks; and (3) urban transit buses. An Oracle Relational Database Management System is used to manage the data, along with a statistical software package capable of providing statistical, graphic, and textual information to users. The next two tables and four graphs contain statistics which were generated by the AFDC. Future editions of the Transportation Energy Data Book will continue to present graphical and statistical information from the AFDC.

The Department of Energy is now sponsoring the **National Alternative Fuels Hotline** for Transportation Technologies in order to assist the general public and interested organizations in improving their understanding of alternative transportation fuels. The Hotline can be reached by dialing **1-800-423-1DOE**.

In fiscal year (FY) 1992, there were 81 AMFA Federal vehicles being monitored at four geographic locations in the U.S. Of these 81 vehicles, 16 were conventional gasoline fuel vehicles (control vehicles) and 65 were alternative fuel vehicles (AFVs) which were capable of operating on any mixture of gasoline and methanol, up to a mixture of 85% methanol (M85).

Table 5.1
On-Road Fuel/Energy Economy Summary for the AMFA Federal Vehicles, FY 1991 and 1992[a]

Vehicle site and type	Number of vehicles	Miles per gallon		Mpg-gasoline energy equivalent[b]		Btu/mile	
		1991	1992	1991	1992	1991	1992
Washington, DC							
M85 AFVs	21	10.9	11.7	19.3	20.7	5,959	5,580
Conventional gasoline vehicles	4	c	22.8			c	5,060
Detroit, MI							
M85 AFVs	18	14.1	15.9	24.8	28.1	4,536	4,110
Conventional gasoline vehicles	4	22.5	24.9			5,404	4,640
Los Angeles, CA							
M85 AFVs	9	13.5	13.9	23.7	24.5	4,672	4,710
Conventional gasoline vehicles	4	24.6	25.5			4,771	4,530
San Diego, CA							
M85 AFVs	9	14.7	15.8	25.9	27.9	4,265	4,140
Conventional gasoline vehicles	4	21.6	24.3			5,249	4,750

Source:
Office of Transportation Technologies, U.S. Department of Energy, Federal Alternative Fuel Program Light Duty Vehicle Operations, Washington, DC, July 1992, pp. 4, 25-32. (Generated by the Alternative Fuels Data Center, Golden, CO.)

[a]Based on 115,400 Btu/gal for gasoline and 65,400 Btu for M85.
[b]Gasoline energy equivalent miles per gallon is the M85 alternative fuel vehicle fuel economy adjusted for the difference in fuel energy content between gasoline and M85 (e.g., M85 has 56 percent of the energy of unleaded gasoline).
[c]No information was collected on these vehicles in FY 1991.

Table 5.2
Number of Known Alternative Fuel Vehicles in the U.S. by Type, 1993[a]

State	Compressed natural gas (CNG)	Liquified petroleum gas (Propane)	Methanol (M85)	Ethanol (E85)
Alabama	450	3,500		
Alaska				
Arizona	187			
Arkansas	122			
California	2,401	40,000	10,600	6
Colorado	1,500	8		
Connecticut	77			
Delaware	15	50		
District of Columbia	10	3	200	25
Florida	1,370			
Georgia	407			
Hawaii				
Idaho	50			15
Illinois	852		3	31
Indiana	1,240			10
Iowa	68			59
Kansas	232	1,100		
Kentucky	170	300		
Louisiana	57			
Maine	37			
Maryland	300		50	
Massachusetts	170			
Michigan	262		20	
Minnesota	235	80		
Mississippi	450	4,920		
Missouri	30	22		15
Montana	279			
Nebraska	15			13
Nevada	485			
New Hampshire	37	325		
New Jersey	130	20		
New Mexico	133			
New York	1,493	1,448	46	
N. Carolina				
N. Dakota	215			
Ohio	1,192		1	
Oklahoma	1,383			
Oregon	84			
Pennsylvania	500	75	200	
Rhode Island	125	25		
S. Carolina				
S. Dakota	250			6
Tennessee	216			
Texas	4,000	30,000		
Utah	700			
Vermont	4	300		
Virginia	250		150	
Washington	878	4,945		
W. Virginia	150		50	
Wisconsin	448	177	12	12
Wyoming		2		
Total	23,609	87,300[a]	11,332	192

Source:
Alternative Fuels Data Center, Golden, CO, 1993.

[a]There may be many LPG (Propane) vehicles in states which are shown as blanks in this table.

In 1993 there were 3,851 alternative refuel sites in the United States. This list includes public and private refuel sites; however, not all of these sites are available to the public.

Table 5.3
Number of Alternative Refuel Sites by State and Fuel Type, 1993

State	CNG Sites	Propane Sites	M85 Sites	E85 Sites	Total
Alabama	7	85			92
Alaska		8			8
Arizona	10	45	1		56
Arkansas	6	104			110
California	38	214	34		286
Colorado	41	47	1		89
Connecticut	4	19			23
Delaware	2	6			8
District of Columbia	1		1	1	3
Florida	27	222	1		250
Georgia	18	80			98
Hawaii					
Idaho	1	20			21
Illinois	14	165	1	3	183
Indiana	24	124			148
Iowa	2	108			110
Kansas	6	38			44
Kentucky	6	35			41
Louisiana	5	44			49
Maine		12			12
Maryland	6	21	1		28
Massachusetts	7	41			48
Michigan	11	182	1		194
Minnesota	10	125			135
Mississippi		75			75
Missouri	2	83			85
Montana	4	48			52
Nebraska	9	47		1	57
Nevada	2	20			22
New Hampshire		31			31
New Jersey	7	36			43
New Mexico	3	46			49
New York	23	100	4		127
N. Carolina	1	72			73
N. Dakota	4	17			21
Ohio	34	98	2		134
Oklahoma	22	56			78
Oregon	4	21			25
Pennsylvania	28	132			160
Rhode Island	1	5			6
S. Carolina		43			43
S. Dakota	3	24		1	28
Tennessee	4	80	1		85
Texas	26	202			228
Utah	5	20			25
Vermont	1	33			34
Virginia	6	38			44
Washington	24	37	1		62
W. Virginia	9	16	1		26
Wisconsin	27	139		1	167
Wyoming	2	33			35
Total	497	3,297	50	7	3,851

Source:
Alternative Fuels Data Center, Golden, CO, 1993.

A comparison of fuel prices by "Natural Gas Fuels" in January 1994 showed that, on average, consumers saved 22% by using compressed natural gas (CNG) instead of unleaded regular gasoline as a vehicle fuel. The average savings of using CNG over diesel fuel was even greater (33%).

Table 5.4
Comparison of Station Prices: Compressed Natural Gas, Regular Unleaded Gasoline, Diesel Fuel, January 1994
(Dollars per gallon or equivalent gallons)

Region	Station	CNG	Unleaded gasoline	Percentage CNG to gasoline	Diesel	Percentage CNG to diesel
West Coast	Shell - Sacramento, CA	$0.668	$1.079	61.9%	[a]	[a]
	Unocal - Vista, CA	$0.859	$1.059	81.1%	$1.399	61.4%
Southwest	Shell - Houston, TX	$0.899	$0.959	93.7%	[a]	[a]
	Mobil - Garland, TX	$0.799	$0.979	81.6%	$1.099	72.7%
Midwest	Vickers - Denver, CO	$0.809	$1.125	71.6%	$1.179	68.6%
	Amoco - Topeka, KS	$0.859	$0.939	91.4%	[a]	[a]
	Amoco - Naperville, IL	$0.959	$1.089	89.7%	[a]	[a]
East Coast	Amoco - Atlanta, GA	$0.799	$0.839	95.2%	[a]	[a]
	Mobil - Brooklyn, NY	$0.909	$1.199	75.8%	[a]	[a]
Canada	Petro-Canada - Vancouver, BC	$0.260[b]	$0.519[b]	50.0%	[a]	[a]
	Shell - Etobicoke, Ontario	$0.337[b]	$0.479[b]	70.3%	[a]	[a]
			Average	78.3%		67.5%

Source:
"Natural Gas Fuels," March 1994, p. 8.

[a]Not available.
[b]Canadian dollars per liter or equivalent liters.

The number of alternative fuel vehicles purchased by the General Services Administration (GSA) has increased substantially in recent years, and the number is expected to double in 1994. GSA, which purchases and leases vehicles to the federal fleet, is working with DOE to place alternative fuel vehicles in fleets around the nation to meet environmental and energy regulations. Federal mandates require the addition of 11,250 alternative fuel vehicles to the federal fleet in 1994. GSA expects to acquire more than two-thirds of those federally mandated vehicles.

Table 5.5
Alternative Fuel Vehicles Purchased by the U.S. General Services Administration, Model Years 1991-93

Model year	Methanol (M85)	Ethanol (E85)	Compressed natural gas	Total
1991	25 Variable-Fuel Chevrolet Luminas; 40 Flexible-Fuel Ford Tauruses		2 Flexible-Fuel Chrysler vans	67
1992	20 Flexible-Fuel Ford Econoline vans; 2,500 Flexible-Fuel Dodge Spirits	25 Variable-Fuel Chevrolet Luminas	600 3/4-Ton dedicated Chevrolet pickup trucks; 75 dedicated eight-passenger Chrysler vans	3,220
1993	300 Flexible-Fuel Ford Tauruses; 50 Variable-Fuel Chevrolet Luminas; 2,500 Flexible-Fuel Dodge Spirits	50 Variable-Fuel Chevrolet Luminas	50 Chrysler vans	2,950
Total	**5,435**	**75**	**727**	**6,237**

Source:
Alternative Fuels Data Center, Golden, CO, 1993.

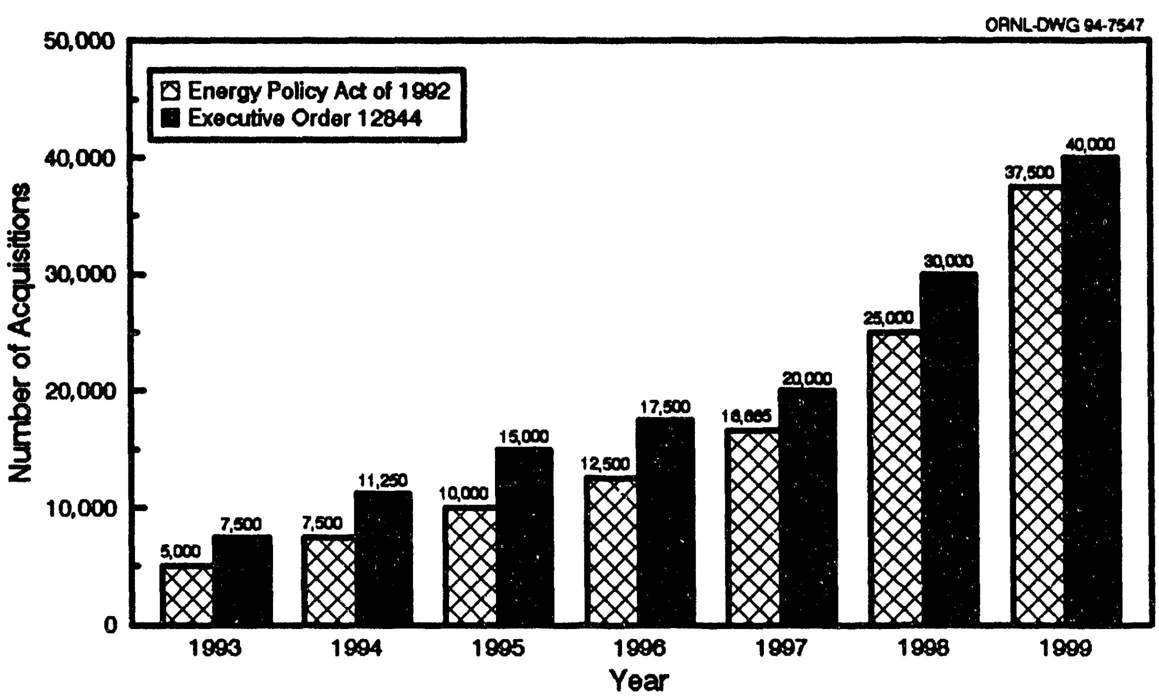
Although the Energy Policy Act of 1992 (EPAct) set alternative fuel vehicle purchase requirements for Federal and State Governments, fuel providers and the private sector, the Federal fleet requirements have since been increased by Executive Order 12844. A comparison of the two requirements is shown in the graph below.

Table 5.6
Energy Policy Act Purchase Requirements of Light-Duty Alternative Fuel Vehicles

Year	Federal	State	Fuel providers	Private[a]
1993	5,000	-	-	-
1994	7,500	-	-	-
1995	10,000	-	-	-
1996	25%	10%	30%	-
1997	33%	15%	50%	-
1998	50%	25%	70%	-
1999	75%	50%	90%	20%
2000	75%	75%	90%	20%
2001	75%	75%	90%	20%
2002	75%	75%	90%	30%
2003	75%	75%	90%	40%
2004	75%	75%	90%	50%
2005	75%	75%	90%	60%
2006 on	75%	75%	90%	70%

Source:
National Alternative Fuels Hotline for Transportation Technologies, 1993.

Figure 5.1. Federal Fleet Alternative Fuel Vehicle Purchase Requirements[b]



[a]Under the early rulemaking scenario. Additional rulemaking is required by December 15, 1996 for this to take effect.

[b]Based on 50,000 vehicle acquisitions per year.

U.S. ADVANCED BATTERY CONSORTIUM

Electric vehicles are the subject of intense research and development because they are required to be sold in California in 1998 (2% rising to 10% in 2003) under the California Low-Emission Vehicle (LEV) program. Other states have indicated that they will also enforce the LEV program. One of the greatest advantages in using electric vehicles is that there are no vehicle emissions. The U.S. Advanced Battery Consortium (USABC) was established in January 1991 to concentrate efforts on battery development for future electric vehicles. The USABC consists of the Big Three U.S. auto manufacturers (Chrysler, Ford, General Motors), the Electric Power Research Institute, the electric utility industry, and the U.S. Department of Energy.

The USABC has established research contracts with several companies for the development of advanced batteries. Also, a series of Cooperative Research and Development Agreements (CRADAs) with several DOE National Laboratories have been established.

Table 5.7
U.S. Advanced Battery Consortium Research Agreements

Battery type	Organization
	Research contracts
Nickel-metal hydride	Ovonic Battery Corporation, Troy, MI
Sodium-sulfur	Silent Power GmbH, Essen, Germany
Nickel-metal hydride	Saft America, Cockeysville, MD
Lithium-iron disulfide	Saft America, Cockeysville, MD
Lithium-polymer	W. R. Grace, Boca Raton, FL
	CRADAs
Lithium-polymer	Lawrence Berkeley Laboratory, Berkeley, CA
Advanced battery thermal enclosure	National Renewable Energy Laboratory, Golden, CO
Nickel-metal hydride	Argonne National Laboratory, Argonne, IL
Sodium-sulfur	Argonne National Laboratory, Argonne, IL
Lithium-iron disulfide	Argonne National Laboratory, Argonne, IL
Sodium-beta sulfur	Argonne National Laboratory, Argonne, IL
Lithium-polymer	Sandia National Laboratory, Albuquerque, NM
Sodium-sulfur	Sandia National Laboratory, Albuquerque, NM

Source: U.S. Adanced Battery Consortium Fact Sheet.

In FY 1992 the USABC reviewed the development criteria for mid-term goals. Reassessment of these criteria, which were originally defined in early 1991, resulted in no significant changes. Concerns about the potential for advanced batteries to meet the high power requirements demanded by the automotive customer and the ability of batteries to rapidly recharge are reflected in the revised goals.

Table 5.8
Advanced Battery Technology Goals of the U.S. Advanced Battery Consortium

	Mid-term goal (1995-1998)	Long-term goal[a]
Power density W/L	250	600
Specific power (charge) W/kg (80% DoD/30 sec)	150 (200 desired)	400
Specific power (recharge) W/kg (20% DoD/10 sec)	75	
Energy density Wh/L (C/3 discharge rate)	135	300
Specific energy Wh/kg (C/3 discharge rate)	80 (100 desired)	200
Power/energy ratio	1.5-2.5	
Life (years)	5	10
Cycle life (cycles) (80% DoD)	600	1000
Power and capacity degradation (% of rated spec)	20%	20%
Ultimate price ($/kWh) (10,000 units @ 40 kWh)	<$150	<$100
Operating environment	-30 to 65° C	-40 to 85° C
Normal recharge time	<6 hours	3 to 6 hours
Fast recharge time	50% of capacity in <30 minutes	
Continuous discharge in 1 hour (no failure) energy	75% (of rated energy capacity)	75% (of rated capacity)

Note: w=watt; kg=kilogram; L=liter; DoD=depth of discharge; wh=watt-hour; kwh=kilowatt-hour

Source:
U.S. Department of Energy, Office of Transportation Technologies, Washington, DC, 1991.

[a]Competitive with today's internal combustion engine vehicles.

> *While properties such as Reid vapor pressure and octane number can be determined for neat oxygenates, these values do not represent their behavior in a final gasoline blend.* ***Blending numbers*** *are therefore used for this purpose. The blending numbers vary by oxygenate type, concentration, and basestock composition. The blending numbers on this table are directly related to the basestock tested and should not be used out of context.*

Table 5.9
Basic Chemistry of Various Transportation Fuels

Chemical Formulae

Ethanol (Ethyl Alcohol)	CH_3CH_2OH (or C_2H_5OH)
Methanol (Methyl Alcohol)	CH_3OH
Ethane	CH_3CH_3 (or C_2H_6)
Methane	CH_4
Gasoline	C_4H_{10} to $C_{12}H_X$

Physical Properties

	Ethanol	Methanol	Gasoline
Molecular Weight (MW)	46.07	32.04	[a]
Specific Gravity (60°F/60°F)	0.794	0.796	0.72-0.78
Density (lb/gal @ 60°F)	6.61	6.63	6.0-6.5
Boiling Point	78°C (173°F)	65°C (149°F)	27-225°C (80-437°F)
Reid Vapor Pressure (RVP)			
Neat (psi)	2.3	4.6	[a]
Blending number(psi)	12-27	93-98	8-15
Octane Number			
Neat	97	98	[a]
Blending number	111[b]	115[c]	84-93
Water solubility (volume % @ 70°F)	100%	100%	[d]
Latent heat of vaporization			
Btu/gal @ 60°F	2,378	3,340	900
Btu/lb @ 60°F	396	506	150
Heating Value (lower)			
Btu/lb	11,500	8,570	18,000-19,000
Btu/gal @ 60°F	76,000	56,800	109,000-119,000
Energy Release (Btu/ft^3)	94.7	94.5	95.2
Stoichiometric air/fuel weight	9.00	6.45	14.7

Source:
Tshiteya, Rene M. and Ezio N. Vermiglio, Properties of Alcohol Transportation Fuels, Alcohol Fuels Reference Work #1, prepared for the Biofuels Systems Division, U.S. Department of Energy, by Meridian Corporation, Alexandria, VA, July 1991, pp. 2-i, 2-8.

[a]Not applicable.
[b]For 10% ethanol blending with gasoline.
[c]For 5% methanol blending with gasoline.
[d]Negligible.

The warranties of most passenger vehicles sold in the United States cover up to the following fuel concentrations in gasoline: Ethanol, 10%; ETBE, 17%; Methanol, 3-5%; MTBE, up to 15%.

Table 5.10
Reid Vapor Pressure of Various Alcohol/Ether/Gasoline Blends

% of Gasoline	% of Alcohol/Ether	Blending Agent			
		Ethanol	ETBE[a]	Methanol	MTPE[b]
100	0	9.00	9.00	9.00	9.00
95	5	10.10	8.80	12.30	9.40
90	10	10.00	8.60	12.40	9.20
85	15	9.90	8.30	12.30	9.10
80	20	9.75	8.10	12.20	9.10
75	25	[c]	7.90	[c]	[c]
70	30	9.50	[c]	12.05	[c]
50	50	8.70	[c]	11.40	8.80
30	70	7.00	[c]	10.00	[c]
15	85	5.00[d]	[c]	7.90[d]	[c]
10	90	4.30	[c]	7.20	8.10
0	100	2.30	4.40	4.60	7.80

Source:
Tshiteya, Rene M. and Ezio N. Vermiglio, <u>Properties of Alcohol Transportation Fuels</u>, Alcohol Fuels Reference Work #1, prepared for the Biofuels Systems Division, U.S. Department of Energy, by Meridian Corporation, Alexandria, VA, July 1991, p. 4-i.

[a]Ethyl-tertiary-butyl ether.
[b]Methyl-tertiary-butyl ether.
[c]Data are not available.
[d]Estimated.

Table 5.11
U.S. Production of Methanol and Ethanol, 1978-93
(million gallons)

Year	Ethanol	MTBE[a]
1978	20	[b]
1979	40	[b]
1980	80	[b]
1981	85	122
1982	234	132
1983	443	134
1984	567	235
1985	793	302
1986	798	359
1987	825	[b]
1988	800	[b]
1989	750	[b]
1990	756	[b]
1991	875	[b]
1992	1,080	1,542
1993	1,156	2,081
	Average annual percentage change	
1978-93	31.1%	[b]
1982-93	15.6%	28.5%

Sources:
1992-93 Ethanol and MTBE - U.S. Department of Energy, Energy Information Administration, *Petroleum Supply Monthly*, January 1994, Tables D.2 and D.3.
1978-90 Ethanol - Information Resources, Inc., Washington, DC, 1991.
1981-86 MTBE - EA-Mueller,Inc., Baltimore, MD, 1992.

[a]Methyl Tertiary Butyl.
[b]Data are not available.

Table 5.12
Federal and State Taxes on Motor Fuels[a]

State	Gasoline	Diesel fuel	Gasohol	CNG	Propane	Methanol	Ethanol	Electricity
Alabama	0.18	0.19	0.18	[b]	[b]	0.19	0.19	
Alaska	0.08	0.08	0.0					
Arizona	0.18	0.18	0.18	0.01	0.18			
Arkansas	0.185	0.185	0.185	0.0	0.165			
California	0.16	0.16	0.16	[b]		0.08	0.08	
Colorado	0.22	0.205	0.22	[b]	0.205	0.205	0.205	
Connecticut	0.28	0.18	0.27	0.28	0.28	0.27	0.27	
Delaware	0.19	0.19	0.19	0.19	0.19	0.19	0.19	
District of Columbia	0.20	0.20	0.20	0.20	0.20	0.20	0.20	
Florida	0.116	0.116	0.116	0.116	0.116	0.116	0.116	
Georgia	0.075	0.075	0.075	0.075	0.075	0.075	0.075	
Hawaii	0.16	0.16	0.16		0.16			
Idaho	0.21	0.21	0.21	0.19	0.152			
Illinois	0.19	0.215	0.173	0.215	0.215	0.215	0.215	
Indiana	0.15	0.16	0.15	[b]				
Iowa	0.20	0.225	0.19	0.16	0.20			
Kansas	0.18	0.20	0.18	0.17	0.17	0.20	0.20	
Kentucky	0.15	0.12	0.15	0.12	0.15			
Louisiana	0.20	0.20	0.20	0.20	0.20	0.20	0.20	
Maine	0.19	0.20	0.19	0.18	0.18	0.18	0.18	
Maryland	0.235	0.1925	0.235	0.1925	0.1925	0.1925	0.1925	0.1925
Massachusetts	0.21	0.21	0.21	0.087	0.087			
Michigan	0.15	0.15	0.15	0.0	0.15	0.15	0.15	
Minnesota	0.20	0.20	0.18			0.20		
Mississippi	0.18	0.18	0.18	0.18	0.17			
Missouri	0.13	0.13	0.11					
Montana	0.214	0.214	0.214	0.07	[b]			
Nebraska	0.246	0.246	0.246	0.246	0.246	0.246	0.246	
Nevada	0.205	0.245	0.205	0.245	0.245	0.245	0.245	
New Hampshire	0.18	0.18	0.18	0.18	0.18			
New Jersey	0.145	0.175	0.145	0.0525	0.0925			
New Mexico	0.17	0.17	0.17	0.17	0.17	0.17	0.17	
New York	0.228	0.248	0.228	0.08	0.08			
N. Carolina	0.219	0.219	0.219	0.219	0.219	0.219	0.219	
N. Dakota	0.17	0.17	0.17	0.17	0.17	0.17	0.17	
Ohio	0.21	0.21	0.195	0.21	0.21	0.21		
Oklahoma	0.16	0.13	0.16	[b]	[b]	0.16	0.16	
Oregon	0.22	0.22	0.17	0.22	0.22	0.22		
Pennsylvania	0.224	0.224	0.224	0.224	0.224	0.224	0.224	
Rhode Island	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26
S. Carolina	0.16	0.16	0.16	0.16	0.16	0.16	0.16	
S. Dakota	0.18	0.18	0.16	0.18	0.16		0.18	
Tennessee	0.214	0.174	0.214	0.13	0.14	0.214	0.214	
Texas	0.20	0.20	0.20	[b]	[b]	0.20	0.20	
Utah	0.19	0.19	0.19	[b]	[b]			
Vermont	0.16	0.17	0.16					
Virginia	0.172	0.162	0.172	0.162	0.162	0.162	0.162	
Washington	0.23	0.23	0.193	[b]	[b]			
W. Virginia	0.2035	0.2035	0.2035	0.2035	0.2035	0.2035	0.2035	
Wisconsin	0.222	0.222	0.222	0.222	0.222	0.222	0.222	
Wyoming	0.09	0.09	0.05	0.0	0.0			
Federal	**0.141**	**0.201[c]**	**0.087**	**0.0[d]**	**0.14**	**0.0805[e]**	**0.0865**	

Source:
J. E. Sinor Consultants, Inc., "The Clean Fuels Report," February 1993, pp. 69, 70.

---

[a]All prices are per gallon or gallon equivalent. In some states, a state or local sales tax may be added.
[b]Annual flat fee.
[c]Marine fleets pay $0.151; railroads pay $0.026; municipal bus and government fleets are exempt.
[d]LNG pays $0.14.
[e]Qualified alcohol.

As of October 1993, only six states offered tax exemptions to encourage the use of gasohol for transportation purposes. This list is quite short compared to the 30 states which offered gasohol tax exemptions ten years ago. In the past year, three states, Idaho, Nebraska, and Oregon, have discontinued the exemption.

Table 5.13
State Tax Exemptions for Gasohol
October 1993

State	Exemption (cents/gallon of gasohol)
Alaska	8.0
Connecticut	1.0
Iowa	1.0
South Dakota	2.0
Washington	2.3
Wyoming	4.0

Source:
U.S. Department of Transportation, Federal Highway Administration, "Monthly Motor Fuel Reported by the States, July 1993," October 1993, Washington, DC, Table MF-121T.

Table 5.14
Gasohol Consumption by Reporting States, 1980-92[a]
(thousands of gallons)

	1980	1982	1984	1986	1988	1990	1991	1992[b]
Alabama		11,522	34,899	261,286	416,308	197,856	194,733	280,700
Alaska				171	215			
Arizona	2,798	5,096						
Arkansas	8,250	8,462	28,871			62,004	38,638	24,541
California	147,795	464,004	401,837	189,046	489,235	479,716	596,859	59,488
Colorado	3	23,990	82,233	70,462	50,707	97,263	100,844	141,984
Connecticut	15,849	4,461	5,421	5,323			13,520	50,016
Delaware	1,512							
District of Columbia	124	34	84	205	446		324	
Florida	14,359	103,053	508,751	334,041	76,312	77,558	95,556	78,800
Georgia	11,063	148	18		6,291	88,672	94,980	22,973
Hawaii	1,095	368						
Idaho		2,464	8,067	22,016	45,012	70,199	78,432	43,997
Illinois	15,088	251,200	562,036	1,286,828	1,406,620	1,341,148	1,516,997	1,567,122
Indiana		120,569	587,396	668,638	651,544	638,337	750,348	642,291
Iowa	155,947	498,636	457,125	385,130	402,844	374,897	461,975	514,418
Kansas	37,786	7,448	273,077	232,604	120,763	73,971	71,367	62,979
Kentucky	4,763	18,872	328,238	736,349	656,845	355,987	346,130	364,841
Louisiana			24,424	336,187	79,635	38,760	71,470	83,603
Maine	2,634							
Maryland	18,549	107	82	501				
Massachusetts	16,209	290						
Michigan	29,924	206,794	577,723	382,010	499,565	510,447	662,986	514,813
Minnesota	11,776	4,653	2,707	374,032	171,929	244,336	461,613	761,288
Missouri		9,000	13,860	14,316	134,832	267,408	239,040	252,984
Montana	158	10,170	10,181	3,454	257	1,423	5,626	5,005
Nebraska	30,067	89,698	208,455	216,356	258,073	300,632	350,616	371,792
Nevada	641	964		18,650	56,716	49,167	66,229	71,687
New Hampshire	3,642							
New Jersey	6,567							
New Mexico		1,082	63,756	58,752	147,656	156,935	152,856	108,560
N. Carolina	10,688	7,456	34,037				50,574	29,312
N. Dakota	13,491	6,499	5,469	65,327	44,317	35,821	53,356	55,769
Ohio	16,726	91,679	495,595	814,579	981,874	1,072,040	1,116,757	1,249,017
Oklahoma	28,910	155,053	23,620	26,994				
Oregon		2,073	296					
Rhode Island	1,763	22						
S. Carolina	11,608	59,688	154	15,550	102,333	62,549	72	
S. Dakota	10,507	13,808	41,343	63,484	58,150	60,000	136,249	159,474
Tennessee			264,167	394,469	580,227	246,713	178,373	194,319
Texas		38,142	207,152	362,243	341,682	247,384	244,095	247,821
Utah		500	26,358	2,409	358	485	300	2,530
Virginia	1,991	30,834	131,618	423,709	282,181	161,202	152,968	103,384
Washington	14,063	7,230	9,143	26,797	54,519	86,847	101,009	422,804
W. Virginia	692							41,979
Wisconsin		2,718	1,962	15,312	20,175	82,961	204,978	160,048
Wyoming	611	259	309	55	62	9,513	34,498	51,682
Total	**497,222**	**2,259,046**	**5,420,464**	**7,807,285**	**8,137,683**	**7,492,231**	**8,644,368**	**8,933,217**

Sources:
1980-1991: U.S. Department of Transportation, Federal Highway Administration, Highway Statistics 1991, Washington, DC, 1992, Table MF-33GLA, p. 11, and annual.
1992: U.S. Department of Transportation, Federal Highway Administration, "Monthly Motor Fuel Reported by States, May 1993," Washington, DC, August 1993, Table MF-33GLA.

[a] The data reflect gallons of gasohol reported by the distributors in each of the selected states. Blanks indicate data were not reported for the state that year.

[b] Preliminary data.

CHAPTER 6

NONHIGHWAY MODES

This chapter presents statistics for four major nonhighway transportation modes: air, water, pipeline, and rail. The combined energy use for these four modes accounted for over 22% of the total energy use in the transportation sector in 1992 (Table 6.1). Air transportation accounted for the largest share (41%) of nonhighway transportation energy consumption (Figure 6.1).

Section 6.1 discusses data on air transportation. Statistics on water transportation are included in Section 6.2; and rail data in Section 6.3.

Table 6.1
Nonhighway Energy Use by Mode, 1970-92

Year	Air	Water	Pipeline	Rail	Nonhighway transportation energy use	Transportation energy use[a] (trillion Btu)
	(percent of total)					
1970	8.5%	4.9%	6.4%	3.8%	23.7%	15,305
1971	8.2%	4.4%	6.3%	3.5%	22.4%	15,907
1972	7.8%	4.1%	6.1%	3.6%	21.7%	16,949
1973	7.7%	4.6%	5.6%	3.7%	21.6%	17,813
1974	7.3%	4.7%	5.5%	3.8%	21.3%	17,088
1975	7.4%	4.9%	4.8%	3.4%	20.5%	17,329
1976	7.2%	5.4%	4.4%	3.4%	20.4%	18,389
1977	7.4%	5.8%	4.1%	3.3%	20.6%	19,071
1978	7.3%	6.5%	3.9%	3.1%	20.9%	20,035
1979	7.8%	7.7%	4.3%	3.3%	23.0%	20,101
1980	7.9%	8.7%	4.6%	3.3%	24.5%	19,317
1981	7.6%	8.2%	4.7%	3.3%	23.8%	19,065
1982	7.9%	6.9%	4.6%	3.1%	22.6%	18,589
1983	8.0%	6.3%	3.9%	3.1%	21.4%	18,728
1984	8.5%	6.5%	4.0%	2.7%	21.7%	19,310
1985	8.5%	6.7%	3.9%	2.5%	21.6%	19,659
1986	9.0%	6.4%	3.6%	2.4%	21.5%	20,229
1987	9.2%	6.4%	3.7%	2.4%	21.7%	20,704
1988	9.3%	6.3%	4.1%	2.4%	22.1%	21,278
1989	9.2%	6.4%	4.1%	2.4%	22.1%	21,598
1990	9.5%	6.8%	4.3%	2.3%	22.8%	21,778
1991	9.1%	7.4%	4.1%	2.3%	22.7%	21,261
1992	9.0%	7.5%	3.9%	2.3%	22.6%	21,944

Source:
See Appendix A for Table 2.10.

[a]Does not include off-highway and military transportation energy use.

Section 6.1
Air

Air transportation activities can be categorized into two types: air carrier and general aviation. General aviation aircraft serve a variety of purposes, such as business and flight instruction, and include all aircraft which do not belong to the air carrier fleet. Since most of the aircraft in this category are used for personal activities, they do not provide commercial passenger or freight services. Although general aviation aircraft account for the majority of the number of aircraft in operation and fly almost five times as many hours as their counterparts in the air carrier category, the lower speeds and the smaller loads of general aviation aircraft resulted in a significantly smaller share of total aircraft energy use than that of the air carrier fleet, 5.7% and 94.3%, respectively (Tables 6.2 and 6.3).

Domestic and international[a] certificated route air carriers experienced declines in all activities in 1991--aircraft-miles, passenger-miles, available seat-miles and cargo ton-miles. Energy use followed suit, declining to 2,069 trillion Btu in 1991 from 2,191 trillion Btu in 1990. Almost three-quarters of total energy use was consumed by domestic carriers in 1991, although the domestic share has been declining since 1986 when it was 81.4%. Average passenger trip length continued its upward trend, but increased by only 3 miles from 1990 to 1991.

Intercity passenger travel by general aviation continued to decline in 1992 to 12.2 billion passenger-miles from a high in 1989 of 13.1 billion passenger-miles. In 1992 the number of hours flown by general aviation was at its lowest point in twenty years. Following the decline in hours flown, energy use declined by 13% from 1991 to 1992.

---

[a]Operating outside the territory of the U.S., including operations between the U.S. and foreign countries and the U.S. and its territories or possessions.

Table 6.2
Summary Statistics for Domestic and International Certificated Route Air Carriers (Combined Totals), 1970-91

Year	Number of aircraft	Revenue aircraft-miles (millions)	Average passenger trip length[a] (miles)	Revenue passenger-miles (millions)	Available seat-miles (millions)	Available seats per aircraft[b]	Passenger load factor (percentage)[c]	Revenue cargo ton-miles (millions)	Energy use (trillion Btu)[d]	Percent domestic of total energy use (percentage)
1970	2,437	2,383	678	131,719[e]	264,904[e]	111	49.7[e]	4,994	1,363.4	f
1971	2,389	2,344	681	135,658[e]	279,823[e]	119	48.5[e]	5,120	1,370.5	f
1972	2,361	2,337	685	152,406[e]	287,411[e]	122	53.0[e]	5,506	1,374.3	f
1973	2,361	2,402	689	174,352	322,992	129	54.0	6,046	1,444.5	f
1974	2,237	2,351	684	174,052	310,130	126	56.1	6,133	1,289.8	f
1975	2,261	2,241	698	173,324	315,823	135	54.9	5,944	1,283.4	f
1976	2,261	2,320	704	191,823	338,349	139	56.7	6,222	1,324.1	f
1977	2,254	2,418	704	206,082	361,172	143	57.1	6,587	1,386.2	f
1978	2,346	2,608	719	236,998	381,113	147	62.2	7,395	1,436.3	82.0%
1979	2,466	2,859	714	269,719	425,411	146	63.4	7,580	1,534.8	82.5%
1980	2,425	2,924	736	267,722	448,479	148	59.7	7,515	1,489.6	82.4%
1981	2,523	2,703	749	260,063	438,778	157	59.3	7,917	1,429.3	f
1982	2,468	2,804	766	272,435	455,938	157	59.8	7,807	1,406.6	81.1%
1983	2,618	2,923	765	295,144	480,977	159	61.4	8,497	1,439.2	84.4%
1984	2,692	3,264	759	319,504	534,104	164	59.8	9,328	1,607.4	f
1985	2,860	3,462	758	351,073	565,677	163	62.1	9,048	1,701.5	f
1986	2,993[g]	3,873	767	378,923	623,073	161	60.8	10,987	1,847.1	81.4%
1987	3,195[g]	4,182	779	417,830	670,871	160	62.3	13,130	1,945.4	80.4%
1988	3,448[g]	4,355	786	437,649	696,337	160	62.9	14,633	2,049.4	78.5%
1989	3,520[g]	4,442	792	447,480	703,888	158	63.6	16,347	2,087.4	77.0%
1990	3,704[g]	4,724	803	472,236	753,211	159	62.7	16,411	2,191.3	75.9%
1991	3,689[g]	4,648	806	462,492	736,833	159	62.8	16,095	2,069.2	74.5%
				Average annual percentage change						
1970-91	2.0%	3.2%	0.8%	6.2%	5.0%	1.7%		5.7%	2.0%	
1982-91	4.6%	5.8%	0.6%	6.1%	5.5%	0.1%		8.4%	4.4%	

Sources:
U.S. Department of Transportation, Federal Aviation Administration, FAA Statistical Handbook of Aviation, 1991 Edition, Washington, DC, 1993, pp. 5-3, 6-4, 6-7, and annual.
1970-81 Energy Use - Department of Transportation, Civil Aeronautics Board, Fuel Cost and Consumption, Washington, DC, 1981, and annual.
1982-91 Energy Use - Department of Transportation, Research and Special Programs Administration, "Fuel Cost and Consumption Tables," Washington, DC, monthly. Annual totals are derived by summing monthly totals for domestic and international air carriers.

[a]Scheduled services of domestic operations only. The average passenger trip length for international operations is approximately three times longer than for domestic operations.
[b]Available seats per aircraft is calculated as the ratio of available seat-miles to revenue aircraft-miles.
[c]Passenger load factor is calculated as the ratio of revenue passenger-miles to available seat-miles for scheduled and nonscheduled services.
[d]Energy use includes fuel purchased abroad for international flights.
[e]Scheduled services only.
[f]Data are not available.
[g]Estimated as 61% of total fixed-wing aircraft.

Table 6.3
Summary Statistics for General Aviation, 1970-92

Calendar year	Percentage of total aircraft: Piston	Turboprop	Turbojet	Rotary wing	Other	Total number of aircraft	Hours flown (thousands)	Intercity passenger travel (billion passenger-miles)	Energy use (trillion btu)
1970	[a]	[a]	[a]	[a]	[a]	131,700[b]	26,030[c]	9.1	94.4
1971	[a]	[a]	[a]	[a]	[a]	131,100[b]	25,512[c]	9.2	91.6
1972	[a]	[a]	[a]	[a]	[a]	145,000[b]	26,974[c]	10.0	103.4
1973	[a]	[a]	[a]	[a]	[a]	148,000[b]	28,599	10.7	90.4
1974	93.9	1.3	1.0	2.2	1.6	161,502	29,758	11.2	101.4
1975	93.4	1.5	1.1	2.4	1.7	168,475	30,298	11.4	121.5
1976	93.3	1.4	1.1	2.5	1.8	177,964	31,950	12.1	130.3
1977	92.7	1.6	1.2	2.6	2.0	184,294	33,679	12.8	149.7
1978	92.5	1.6	1.2	2.7	2.0	199,178	36,844	14.1	159.4
1979	92.0	1.7	1.3	2.8	2.3	210,339	40,432	15.5	167.2
1980	91.5	1.9	1.4	2.8	2.3	211,045	41,016	14.7	169.0
1981	90.7	2.2	1.5	3.3	2.4	213,226	40,704	14.6	162.4
1982	90.2	2.5	1.9	2.9	2.5	209,779	36,457	13.1	170.5
1983	89.8	2.6	1.8	3.1	2.8	213,293	35,249	12.7	143.9
1984	89.4	2.6	2.0	3.2	2.8	220,943	36,119	13.0	148.9
1985	89.3	2.6	2.1	3.0	3.0	210,654	34,063	12.3	144.0
1986	88.9	2.7	2.0	3.2	3.2	220,044	34,416	12.4	148.0
1987	89.5	2.4	2.0	2.9	3.1	217,183	33,443	12.1	139.1
1988	89.2	2.5	2.0	3.0	3.3	210,266	33,593	12.6	148.6
1989	88.2	2.9	2.0	3.4	3.5	219,737	35,012	13.1	134.0
1990	88.5	2.7	2.1	3.5	3.3	212,211	34,756	13.0	131.9
1991	88.3	2.5	2.2	3.2	3.8	198,475	30,067	12.6	120.4
1997	87.9	2.6	2.2	3.1	4.2	184,433	26,493	12.2	104.7
						Average Annual Percentage Change			
1970-92						2.0%	0.7%	1.6%	1.2%
1982-92						-0.6%	-2.1%	-0.4%	-3.8%

Sources:

Aircraft and hours flown - U.S. Department of Transportation, Federal Aviation Administration, FAA Statistical Handbook of Aviation, Calendar Year 1991, Washington, DC, 1993, pp. 8-4, 8-6, and annual.

Intercity passenger miles - Eno Foundation for Transportation, Transportation in America, 11th edition, Washington, DC, 1993, p.47.

Energy use - U.S. Department of Transportation, Federal Aviation Administration, General Aviation Activity and Avionics Survey: Calendar Year 1991, Table 5.1, p. 5-6.

[a]Data are not available.
[b]Active fixed-wing general aviation aircraft only.
[c]Include rotocraft.

Section 6.2
Water

Domestic marine traffic includes all movements between points in the United States, Puerto Rico, and the Virgin Islands. All movements between the United States and foreign countries are classified as foreign traffic. Although declining from 1986 to 1989, domestic traffic still accounted for more than half of the total tons shipped in waterborne commerce; the domestic share of commerce increased in 1990 to 51.8%. The combined foreign and domestic tonnage in 1990 continued to be over 2.1 billion tons (Table 6.4).

The average length of haul for domestic waterborne commerce dropped in 1989 to its lowest point since 1977, but rose slightly in 1990. The number of tons shipped and ton-miles for domestic waterborne commerce also rose slightly from 1989 to 1990, but energy use declined slightly, showing an improvement in energy intensity in 1990 (Table 6.5).

The commodities most often moved by domestic commerce in 1990 were petroleum and products (40.5%) and coal and coke (20.3%). The longest average haul per ton for a known product in total domestic commerce in 1990 was food and farm products, which had an average of 1,097 miles (Table 6.6).

Over 1 billion tons were shipped in international waterborne commerce in 1990. Domestic commerce accounted for 51.8% of total tonnage, which is only 0.8% above the lowest domestic share in 1977.

Table 6.4
Tonnage Statistics for Domestic and International Waterborne Commerce, 1970-90
(million tons shipped)

Year	Foreign and domestic total	Foreign total[a]	Domestic total[b]	Percent domestic of total
1970	1,532	581	951	62.1%
1971	1,510	566	944	62.6%
1972	1,615	630	985	61.0%
1973	1,757	767	989	56.4%
1974	1,743	764	979	56.3%
1975	1,692	749	944	55.8%
1976	1,832	856	976	53.4%
1977	1,905	935	969	51.0%
1978	2,018	946	1,072	53.2%
1979	2,070	993	1,076	52.1%
1980	1,995	921	1,074	53.9%
1981	1,938	887	1,051	54.3%
1982	1,774	820	954	53.9%
1983	1,705	751	953	56.0%
1984	1,833	803	1,029	56.3%
1985	1,785	774	1,011	56.7%
1986	1,871	837	1,033	55.3%
1987	1,963	891	1,072	54.7%
1988	2,083	976	1,107	53.3%
1989	2,135	1,038	1,097	51.5%
1990	2,159	1,042	1,118	51.8%
	Average annual percentage change			
1970-90	1.7%	3.0%	0.8%	
1982-90	2.5%	3.0%	2.0%	

Source:
U.S. Department of the Army, Corps of Engineers, Waterborne Commerce of the United States, Calendar Year 1990, Part 5: National Statistics, New Orleans, Louisiana, 1993, p. 1-6.

[a]All movements between the U.S. and foreign countries and between Puerto Rico and Virgin Islands and foreign countries are classified as foreign trade.
[b]All movements between U.S. ports, continental and noncontiguous, and on the inland rivers, canals, and connecting channels of the U.S., Puerto Rico, and the Virgin Islands, excluding the Panama Canal.

The average length of haul grew only 2.5 miles from 1989 to 1990. This, combined with a slight increase in the number of tons shipped resulted in an increase in ton-miles for 1990.

Table 6.5
Summary Statistics for Domestic Waterborne Commerce, 1970-90

Year	Number of vessels[a]	Ton-miles (billions)	Tons shipped (millions)[b]	Average length of haul (miles)	Energy intensity (Btu/ton-mile)	Energy use (trillion Btu)
1970	25,832	596	949	628.2	545	324.8
1971	26,063	593	944	628.1	506	300.0
1972	27,347	604	985	612.8	522	315.1
1973	28,431	585	990	590.7	576	337.0
1974	29,328	586	979	599.1	483	283.3
1975	31,666	566	944	599.9	549	311.0
1976	33,204	592	976	606.3	468	277.3
1977	35,333	599	969	618.0	458	274.3
1978	35,723	827	1,072	771.6	383	316.6
1979	36,264	829	1,076	770.0	457	378.7
1980	38,792	922	1,074	856.4	358	329.8
1981	42,079	929	1,051	884.0	360	334.5
1982	42,079	886	954	929.0	310	274.9
1983	41,784	920	953	964.6	319	293.7
1984	41,784	888	1,029	862.5	346	307.3
1985	41,672	893	1,011	883.5	446	398.6
1986	40,308	873	1,033	845.3	463	404.0
1987	40,000	895	1,072	835.0	402	370.7
1988	39,192	890	1,112	804.3	361	321.3
1989	39,209	816	1,097	743.2	403	328.6
1990	39,233	834	1,118	745.7	388	323.2
			Average annual percentage change			
1970-90	2.1%	1.7%	0.8%	0.9%	-1.7%	0.0%
1982-90	-0.9%	-0.8%	2.0%	-2.7%	2.8%	2.0%

Sources:
Number of Vessels - U.S. Department of the Army, Corps of Engineers, "Summary of U.S. Flag Passenger and Cargo Vessels, 1992," New Orleans, LA, 1993, and annual.
Ton-miles, tons shipped, average length of haul - U.S. Department of the Army, Corps of Engineers, Waterborne Commerce of the United States, Calendar Year 1990, Part 5: National Statistics, New Orleans, LA, 1993, pp. 1-6,1-7, and annual.
Energy Use - See Appendix A for Table 2.7.

[a]Grand total for self-propelled and nonself-propelled.
[b]These figures are not consistent with the figures on Table 6.5 because intraterritory tons are not included in this table.

Sixty-one percent of all domestic marine cargo in 1990 were energy-related products (petroleum, coal, coke). The majority of the energy-related products were shipped coastwise (52%) and internal and local (47%). Barge traffic accounted for 95% of all internal and local waterborne commerce.

Table 6.6
Breakdown of Domestic Marine Cargo by Commodity Class, 1990

	Coastwise		Lakewise		Internal and local		Total domestic		
Commodity class	Tons shipped (millions)	Average haul per ton (miles)	Tons shipped (millions)	Average haul per ton (miles)	Tons shipped (millions)	Average haul per ton (miles)	Tons shipped (millions)	Percentage	Average haul per ton (miles)
Petroleum and products	237	1,720	2	268	214	195	453	40.5	993
Chemicals and related products	14	1,686	[a]	306	53	537	67	6.0	777
Crude materials	13	729	84	566	126	262	223	19.9	403
Coal and coke	13	617	20	558	194	428	227	20.3	451
Primary manufactured goods	5	1,001	3	313	17	673	25	2.2	692
Food and farm products	8	1,825	1	972	90	1,035	99	8.9	1,097
Manufactured equipment & products	6	1,375	1	27	2	139	9	0.8	1,060
Waste and scrap	1	154	[a]	[a]	12	157	13	1.2	157
Unknown	2	1,331	[a]	22	[a]	13	2	0.2	1,280
Total	299	1,604	110	553	709	414	1,118	100.0	746
Barge traffic (million tons)	96.2		2.2		673.4		771.8		
Percentage by barge	32.2%		2.0%		95.0%		69.0%		

Source:
U.S. Department of the Army, Corps of Engineers, Waterborne Commerce of the United States, Calendar Year 1990, Part 5: National Statistics, New Orleans, Louisiana, 1993, pp. 2-1 through 2-9

Note:
Coastwise applies to domestic traffic receiving a carriage over the ocean or between the Great Lakes ports and seacoast ports when having a carriage over the ocean. Lakewise applies to traffic between United States ports on the Great Lakes. Internal applies to traffic between ports or landing wherein the entire movement takes place on inland waterways. Local applies to movements of freight within the confines of a port.

[a]Negligible.

Section 6.3
Railroad

Thirteen railroad systems in 1992 were designated by the Interstate Commerce Commission (ICC) as Class I freight railroads (Table 6.7). This designation was assigned on the basis of the annual gross revenue of the railroad. A railroad whose revenues were 251.4 million dollars or more in 1991 was designated as a Class I railroad in 1992. The threshold for 1991 designation was set at 94.4 million dollars, and there were fourteen Class I railroads. The Class I designation is dropped if the railroad fails to meet the annual earnings threshold for three consecutive years. The 166% increase in the threshold had little effect on the Class I railroads. What it did, however, was keep the larger Class II railroads from moving into the Class I category.

The revenue ton-miles for Class I freight railroads continued to be over 1 trillion ton-miles in 1992, as the average length of haul and number of tons rose slightly from 1991 to 1992. Train-miles and car-miles declined slightly from 1990 to 1991, but rose again in 1992. The number of Class I railroad locomotives and freight cars continued to decline in 1992 (Table 6.8).

The railroad freight industry experienced a 21% drop in its revenue carloadings from 1974 to 1992. During this 18-year period, coal has not only remained the major commodity being hauled by the railroads, but its share of revenue carloads also increased by 23% from 1974 to 1992. The largest decline, on the other hand, was for metallic ores, which dropped 75% during the period (Table 6.9).

Revenue passenger-miles for the National Railroad Passenger Corporation (Amtrak) continued to be more than 6 billion passenger-miles in 1992, despite a slight decline from 1991 to 1992. Train-miles and average trip length were relatively constant from 1991 to 1992, while car-miles declined in this period. Energy use rose slightly in 1992 to 15.9 trillion Btu (Table 6.10).

Although transit rail vehicle-miles declined slightly in 1992, passenger-miles increased for the first time since 1989. The average trip length for transit rail passengers in 1992 was 4.8 miles. Energy use declined slightly from 1991 to 1992, possibly due to the fewer vehicle-miles and number of transit rail vehicles.

Table 6.7
Class I Railroad Freight Systems in the United States
Ranked by Revenue Ton-Miles, 1992

Railroad	Revenue ton-miles (millions)	Percent
Burlington Northern Railroad Company	232,789	21.8
Union Pacific Railroad	209,109	19.6
CSX Transportation, Incorporation	147,280	13.8
Norfolk Southern Corporation	107,173	10.1
Southern Pacific Transportation Company	94,237	8.8
Atchison, Topeka and Santa Fe Railway	85,640	8.0
Consolidated Rail Corporation (Conrail)	84,278	7.9
Chicago and North Western Transportation Company	30,140	2.8
Soo Line Railroad	22,905	2.2
Illinois Central Railroad	18,735	1.8
Denver and Rio Grande Western Railroad	16,038	1.5
Kansas City Southern Railway	13,196	1.2
Grand Trunk Corporation	5,261	0.5
Total	**1,066,781**	**100.0**

Source:
Association of American Railroads, Analysis of Class I Railroads 1992, July 1993 p. 163.

Table 6.8
Summary Statistics for Class I Freight Railroads, 1970-92

Year	Number of locomotives in service[a]	Number of freight cars (thousands)[b]	Train-miles (millions)	Car-miles (millions)	Revenue tons (millions)	Average length of haul (miles)	Revenue ton-miles (millions)	Energy intensity (Btu/ton-mile)	Energy use (trillion Btu)
1970	27,077[c]	1,424	427	29,890	2,616	515	764,809	655	500.6
1971	27,160[d]	1,422	430	29,181	2,458	507	739,723	697	515.6
1972	27,044	1,411	451	30,309	2,543	511	776,746	706	548.2
1973	27,438	1,395	469	31,248	2,701	531	851,809	662	563.9
1974	27,627	1,375	469	30,719	2,732	527	850,961	665	565.9
1975	27,855	1,359	403	27,656	2,437	541	754,252	682	514.5
1976	27,233	1,332	425	28,530	2,452	540	794,059	677	537.6
1977	27,298	1,287	428	28,749	2,439	549	826,292	667	551.4
1978	26,959	1,226	433	29,076	2,312	617	858,105	637	546.7
1979	27,660	1,217	438	29,436	2,463	611	913,669	616	562.6
1980	28,094	1,168	428	29,277	2,434	616	918,621	592	544.1
1981	27,421	1,111	408	27,968	2,386	626	910,169	571	519.7
1982	26,795	1,039	345	23,952	1,990	629	797,759	547	436.5
1983	25,448	1,007	346	24,358	1,936	641	828,275	521	431.6
1984	24,117	948	369	26,409	2,119	645	921,542	508	468.5
1985	22,548	867	347	24,920	1,985	664	876,984	487	426.9
1986	20,790	799	347	24,414	1,938	664	867,722	474	411.5
1987	19,647	749	361	25,627	1,926	688	943,747	443	417.9
1988	19,364	725	379	26,339	2,001	697	996,182	434	432.3
1989	19,015	682	383	26,196	1,988	723	1,013,841	427	432.9
1990	18,835	659	380	26,159	2,024	726	1,033,969	411	425.2
1991	18,344	633	375	25,628	1,987	751	1,038,875	384	399.3
1992	18,004	605	390	26,128	2,016	763	1,066,781	399	425.4
				Average annual percentage change					
1970-92	-1.8%	-3.8%	-0.4%	-0.6%	-1.2%	1.8%	1.5%	-2.2%	-0.7%
1982-92	-3.9%	-5.3%	1.2%	0.9%	0.1%	2.0%	2.9%	-3.1%	-0.3%

Sources:
Association of American Railroads, Railroad Facts, 1992 Edition, Washington, DC, September 1993, pp. 27, 33, 34, 36, 48, 50.
Revenue tons - Association of American Railroads, Analysis of Class I Railroads 1991, July 1992, p. 109, and annual.
Energy use - See Appendix A for Table 2.7.

[a]Does not include self-powered units. From 1972-79, the number of locomotives used in AMTRAK passenger operations (See Table 6.12) are subtracted from the total locomotives used in passenger and freight service to calculate the number of Class I locomotives in service.
[b]Does not include private or shipper-owned cars.
[c]Data represent total locomotives used in freight and passenger service. Separate estimates are not available.

Although revenue carloadings declined by 20% from 1974 to 1992, coal is still the commodity with the highest share of carloadings. Rail shipments of many commodities were drastically reduced from 1974 to 1992. The only commodities which had increased the number of carloadings were coal, chemicals, nonmetallic minerals, and "others."

Table 6.9
Railroad Revenue Carloadings by Commodity Group, 1974 and 1992

Commodity group	Carloadings (thousands) 1974	Carloadings (thousands) 1992	1992 Percent distribution	Percentage change 1974-92
Coal	4,544	5,572	26.3	22.6
Farm products	3,021	1,646	7.8	-45.5
Chemicals and allied products	1,464	1,592	7.5	8.7
Nonmetallic minerals	821	1,352	6.4	64.7
Food and kindred products	1,777	1,127	5.3	-36.6
Lumber and wood products	1,930	1,029	4.9	-46.7
Metallic ores	1,910	726	3.4	-62.0
Stone, clay and glass	2,428	618	2.9	-74.5
Pulp, paper, and allied products	1,180	559	2.6	-52.6
Petroleum products	877	489	2.3	-44.2
Primary metal products	1,366	487	2.3	-64.3
Waste and scrap material	889	483	2.3	-45.7
Transportation equipment	1,126	514	2.4	-54.4
Others	3,451	5,012	23.6	45.2
Total	26,784	21,206	100.0	-20.8

Sources:
1974 - Association of American Railroads, Railroad Facts, 1976 Edition, Washington, DC, 1975, p. 26.
1992 - Association of American Railroads, Railroad Facts, 1993 Edition, Washington, DC, August 1993, p. 25.

Table 6.10
Summary Statistics for the National Railroad Passenger Corporation (Amtrak), 1971-92

Year	Number of locomotives in service	Number of passenger cars	Train-miles (thousands)	Car-miles (thousands)	Revenue passenger-miles (millions)	Average trip length (miles)	Energy intensity (Btu per revenue passenger mile)	Energy use (trillion Btu)
1971	[a]	1,165	16,537	140,147	1,993	188	[a]	[a]
1972	285	1,571	26,302	213,261	3,039	183	[a]	[a]
1973	352	1,777	27,151	239,775	3,807	224	3,756	14.3
1974	457	1,848	29,538	260,060	4,259	233	3,240	13.8
1975	355	1,913	30,166	253,898	3,753	224	3,677	13.8
1976	379	2,062	30,885	263,589	4,268	229	3,397	14.5
1977	369	2,154	33,200	261,325	4,204	221	3,568	15.0
1978	441	2,084	32,451	255,214	4,154	217	3,683	15.3
1979	437	2,026	31,379	255,129	4,867	226	3,472	16.9
1980	448	2,128	29,487	235,235	4,503	217	3,176	14.3
1981	398	1,830	30,380	222,753	4,397	226	2,979	13.1
1982	396	1,929	28,833	217,385	3,993	220	3,156	12.6
1983	388	1,880	28,805	223,509	4,227	223	2,957	12.5
1984	387	1,844	29,133	234,557	4,427	227	3,027	13.4
1985	382	1,818	30,038	250,642	4,785	238	2,800	13.4
1986	369	1,793	28,604	249,665	5,011	249	2,574	12.9
1987	381	1,850	29,515	261,054	5,361	259	2,537	13.6
1988	391	1,845	30,221	277,774	5,686	265	2,462	14.0
1989	312	1,742	31,000	285,255	5,859	274	2,731	16.0
1990	318	1,863	33,000	300,996	6,057	273	2,609	15.8
1991	316	1,786	34,000	312,484	6,273	285	2,503	15.7
1992	336	1,796	34,000	307,282	6,091	286	2,610	15.9
				Average annual percentage change				
1971-92	0.8%[b]	2.1%	3.5%	3.8%	5.5%	2.0%	-1.9%[c]	0.6%[c]
1982-92	-1.6%	-0.7%	1.7%	3.5%	4.3%	2.7%	-1.9%	2.4%

Sources:
1971-83 - Association of American Railroads, Economics and Finance Department, Statistics of Class I Railroads, Washington, DC, and annual.
1984-88 - Association of American Railroads, Railroad Facts, 1988 Edition, Washington, DC, December 1989, p. 61, and annual.
1989-92 - Personal communication with the Corporate Accounting Office of Amtrak, Washington, D.C.
Energy use - 1971-84: Association of American Railroads, Railroad Facts, 1984 Edition, Washington, DC, 1984, and annual.
1985-92: Personal communication with the Corporate Accounting Office of Amtrak, Washington, DC.

[a]Data are not available.
[b]Average annual percentage change is for years 1972-92.
[c]Average annual percentage change is for years 1973-92.

Table 6.11
Summary Statistics for Rail Transit Operations, 1970-92[a]

Year	Number of passenger vehicles	Vehicle-miles (millions)	Passenger trips (millions)[b]	Estimated passenger-miles (millions)[c]	Average trip length (miles)[d]	Energy intensity (Btu/passenger-mile)[e]	Energy use (trillion Btu)
1970	10,548	440.8	2,116	12,273[c]	[f]	2,453	30.1
1971	10,550	440.4	2,000	11,600[c]	[f]	2,595	30.1
1972	10,599	417.8	1,942	11,264[c]	[f]	2,540	28.6
1973	10,510	438.5	1,921	11,142[c]	[f]	2,460	27.4
1974	10,471	458.8	1,876	10,881[c]	[f]	2,840	30.9
1975	10,617	446.9	1,797	10,423[c]	[f]	2,962	31.1
1976	10,625	428.1	1,744	10,115[c]	[f]	2,971	30.3
1977	10,579	381.7	1,713	10,071	5.8	2,691	27.1
1978	10,459	383.0	1,810	10,722	5.9	2,210	23.7
1979	10,429	399.6	1,884	11,167	5.9	2,794	31.2
1980	10,654	402.2	2,241	10,939	4.9	3,008	32.9
1981	10,824	436.6	2,217	10,590	4.8	2,946	31.2
1982	10,831	445.2	2,201	10,428	4.6	3,069	32.0
1983	10,904	423.5	2,304	10,741	4.7	3,212	34.5
1984	10,848	452.7	2,388	10,531	4.4	3,732	39.3
1985	11,109	467.8	2,422	10,777	4.4	3,461	37.3
1986	11,083	492.8	2,467	11,018	4.5	3,531	38.9
1987	10,934	508.6	2,535	11,603	4.6	3,534	41.0
1988	11,370	538.3	2,462	11,836	4.8	3,565	42.2
1989	11,261	553.4	2,704	12,539	4.6	3,397	42.6
1990	11,332	560.9	2,521	12,046	4.8	3,453	41.6
1991	11,426	554.8	2,356	11,190	4.7	3,727	41.7
1992	11,303	554.1	2,396	11,441	4.8	3,575	40.9
			Average annual percentage change				
1970-92	0.3%	1.0%	0.6%	-0.3%	-1.3%[g]	1.7%	1.4%
1982-92	0.4%	2.2%	0.9%	0.9%	0.4%	1.5%	2.5%

Sources:
American Public Transit Association, 1993 Transit Fact Book, Washington, DC, November 1993, pp. 26, 27.
Energy use - See Appendix A for Table 2.7.

[a]Series not continuous between 1983 and 1984 because of a change in data source by the American Public Transit Association (APTA). Beginning in 1984, data provided by APTA are taken from mandatory reports filed with the Urban Mass Transit Administration (UMTA). Data for prior years were provided on a voluntary basis by APTA members and expanded statistically.

[b]1970-79 data represents total passenger rides; after 1979, data represents unlinked passenger trips.

[c]Estimated by ORNL for years 1970-76 based on an average trip length of 5.8 miles.

[d]Calculated as the ratio of passenger miles to passenger trips.

[e]Large system-to-system variations exist within this category.

[f]Data are not available.

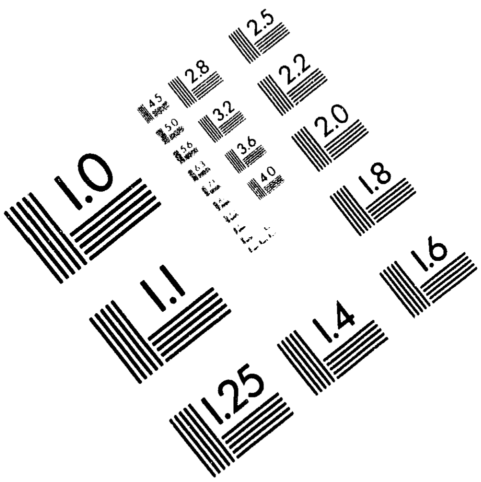
[g]Average annual percentage change is calculated for years 1977-92.

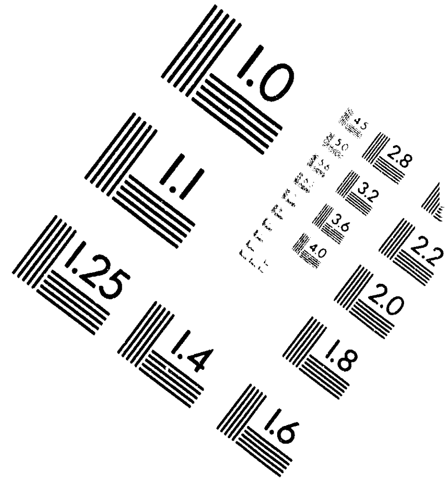
AIIM

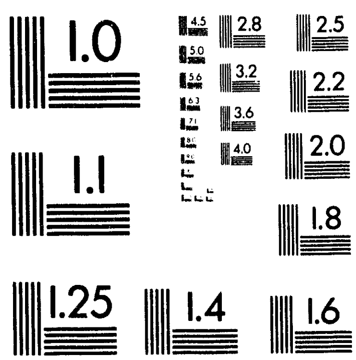
Association for Information and Image Management

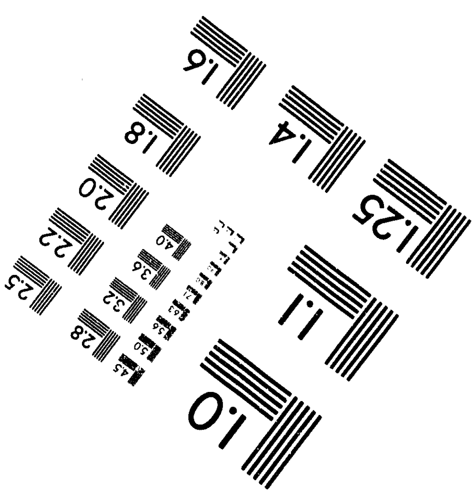
1100 Wayne Avenue, Suite 1100
Silver Spring, Maryland 20910

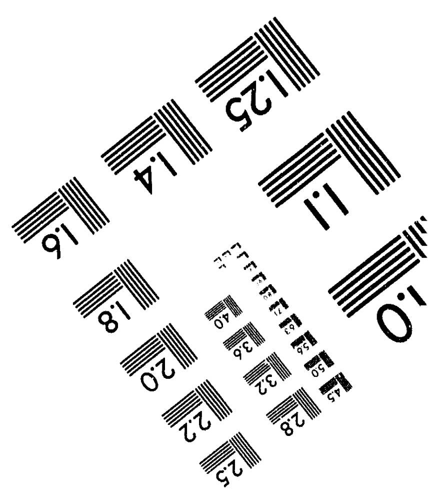
301/587-8202











MANUFACTURED TO AIIM STANDARDS

BY APPLIED IMAGE, INC.

CHAPTER 7
ENVIRONMENTAL ISSUES

Maintaining the earth's environment is of the utmost importance. Man-made pollution, however, is threatening that environment. Pollution comes from many sources and manifests itself in many ways. Some processes which are essential to our lives such as manufacturing and transportation, also contribute to pollution. The first part of this chapter deals with the effect that transportation has on national air quality.

The combustion of fossil fuel in transportation vehicles contributes significantly to air pollution. In 1992 the transportation sector was responsible for 79% of carbon monoxide (CO) emissions and over 30% of nitrogen oxide (NO_x), lead, and volatile organic compound (VOC) emissions (Table 7.1). Highway vehicles, which are responsible for the majority of transportation CO emissions, have reduced their emissions by 32% from 1970 to 1992 (Table 7.2), despite a 102% increase in vehicle travel in that time period. Some of the emission reduction can be attributed to the Federal Motor Vehicle Control Program. This program has resulted in the widespread use of catalytic converters on automobiles to reduce not only CO emissions but also NO_x and VOC emissions.

Transportation emissions of NO_x are second only to stationery fuel combustion (Table 7.4). Although passenger cars (gasoline powered) were responsible for more than triple the NO_x emissions compared to heavy-duty diesel vehicles in 1970, there is only a 27% difference in their emission levels in 1992. This was due to a 26% decline in passenger car emissions and 106% increase in heavy-duty diesel vehicle NO_x emissions from 1970 to 1992 (Table 7.5).

Emissions data on particulate matter (PM-10) and sulfur dioxide (SO_2) from 1940 to 1990 indicate large changes in emissions from rail and highway modes in the 50 year period. Railroads were responsible for 91% of PM-10 and 93% of SO_2 transportation emissions in 1940, but only 2% of PM-10 and 7% of SO_2 transportation emissions in 1992. Highway vehicles, on the other hand, accounted for 8% of PM-10 and 0% of SO_2 transportation emissions in 1940, and 85% of PM-10 and 75% of SO_2 transportation emissions in 1992 (Tables 7.6 and 7.8).

National lead emissions have declined by 98% from 1940 to 1992, mostly due to the 99% decline in transportation lead emissions. This is mainly due to the fact that almost all highway vehicles are now made to use unleaded gasoline (another result of the Federal Motor Vehicle Control Program). As the years pass, vehicles using leaded gasoline are scrapped and replaced with vehicles which use unleaded gasoline.

In addition to air pollution, global warming is also a topic of major concern. Greenhouse gases, which comprise no more than 1% of the atmosphere, block infrared radiation to outer space and reraditate the captured heat to the atmosphere. The capture of the reflected heat raises the Earth's average temperature and is referred to as the "greenhouse effect.[a]" The estimated emissions of greenhouse gases in 1990 are presented in Table 7.14. More than half of the carbon dioxide (CO_2) emitted from transportation sources comes from motor gasoline (Table 7.16).

In order to reduce the amount of emissions from mobile sources, the government has imposed standards for hydrocarbons, carbon monoxide, nitrogen oxide and particulate emissions. The Clean Air Act Amendments of 1990 set stricter standards nationwide beginning in 1994 (Tables 7.19-7.21). The California Air Resources Board developed a plan for their state to meet the tougher emission standards (Table 7.23).

Although the amount of CO emitted nationwide has declined, there were still 42 CO nonattainment areas and 22 serious ozone nonattainment areas in the U.S. in 1992 (Tables 7.25-7.26). A breakdown of the production of ozone-depleting substances for 1986 is found in Figure 7.6. Only one of these, CFC-12, concerns transportation. Almost 36% of all CFC-12 is used as the refrigerant in vehicle air conditioning systems.[b] Research is underway to develop alternative air conditioning technologies that are energy efficient, safe to use, environmentally "friendly," low cost, and high comfort and performance.[b]

---

[a]U.S. Department of Energy, Energy Information Administration, Emissions of Greenhouse Gases in the United States, 1985-1990, Washington, DC, September 1993.

[b]G. R. Hadder, "The Consumer and the Transition to Non-Chlorofluorocarbon Automobile Air Conditioners," Oak Ridge National Laboratory, Oak Ridge, TN, 1991.

Table 7.1
Total National Emissions by Sector, 1992
(millions of short tons)

Sector	CO	NO_x	PM-10	SO_2	VOC	Lead[a]
Transportation						
Highway vehicles	55.29	7.48	1.56	0.79	6.10	1.38
	62.2%	32.3%	3.0%	3.5%	26.8%	26.6%
Aircraft	1.00	0.14	0.08	0.00	0.20	[b]
	1.1%	0.6%	0.2%	0.0%	0.9%	[b]
Railroads	0.12	0.93	0.04	0.07	0.04	[b]
	0.1%	4.0%	0.1%	0.3%	0.2%	[b]
Vessels	0.06	0.18	0.04	0.20	0.04	[b]
	0.1%	0.8%	0.1%	0.9%	0.2%	[b]
Other off-highway	13.5	1.60	0.11	0.00	1.85	0.21[c]
	15.2%	6.9%	0.2%	0.0%	8.1%	4.1%
Transportation total	69.97	10.33	1.83	1.06	8.23	1.59
	78.7%	44.6%	3.6%	4.7%	36.2%	30.7%
Stationary source fuel combustion	6.18	11.73	1.10	19.52	0.71	0.50
	7.0%	50.7%	2.1%	85.9%	3.1%	9.7%
Industrial processes	5.08	0.88	1.94	2.12	10.90	2.35
	5.7%	3.8%	3.8%	9.3%	48.0%	45.4%
Waste disposal and recycling total	1.69	0.08	0.25	0.04	2.31	0.74
	1.9%	0.3%	0.5%	0.2%	10.2%	14.3%
Miscellaneous	5.96	0.13	46.31	0.00	0.58	0.00
	6.7%	0.6%	90.0%	0.0%	2.6%	0.0%
Total of all sources	**88.88**	**23.15**	**51.43**	**22.73**	**22.73**	**5.18**
	100.0%	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**

Source:
U. S. Environmental Protection Agency, National Air Pollutant Emission Estimates, 1900-1992, 1993, Appendix A.

Note: CO = Carbon monoxide. NO_x =Nitrogen oxides. PM-10 = Particulate matter. SO_2 = Sulfur dioxide. VOC = Volatile organic compounds.

[a]Thousands of short tons.
[b]Data are not available.
[c]Includes all off-highway and nonhighway vehicles.

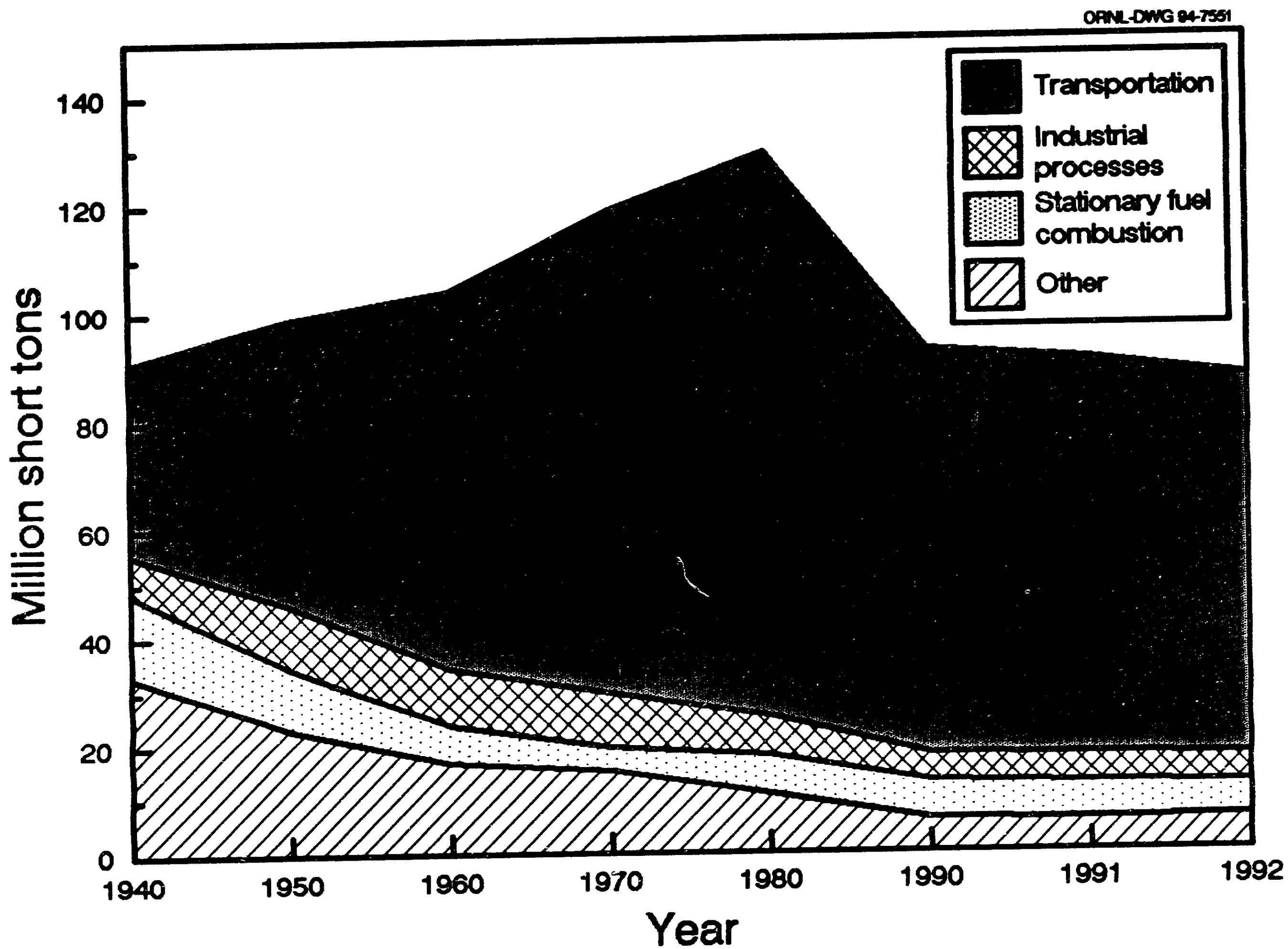
Table 7.2
Total National Emissions of Carbon Monoxide, 1940-92[a]
(million short tons)

Source category	1940	1950	1960	1970	1980	1990[b]	1991[b]	1992[b]
Transportation[c]								
Highway vehicles	27.37	41.37	58.30	79.26	88.00	59.80	58.83	55.29
Aircraft	0.00	0.93	1.76	1.00	1.02	0.97	0.97	1.00
Railroads	4.08	3.08	0.33	0.28	0.28	0.12	0.13	0.12
Vessels[d]	0.06	0.12	0.52	0.40	1.30	1.21	1.18	1.21
Other off-highway	3.90	7.48	8.96	8.33	13.52	12.35	11.97	12.35
Transportation total	35.41	52.98	69.87	89.27	104.12	74.45	73.08	69.97
Stationary fuel combustion total	15.33	11.32	7.02	4.63	7.30	6.76	6.62	6.18
Industrial processes total	7.28	11.64	10.28	9.84	6.95	5.23	5.15	5.08
Waste disposal and recycling total	3.63	4.72	5.60	7.06	2.30	1.69	1.64	1.69
Miscellaneous total	29.21	18.14	11.01	7.91	8.34	4.27	4.20	4.27
Total of all sources	**90.87**	**98.79**	**103.78**	**118.70**	**129.00**	**92.38**	**90.68**	**87.18**

Source:
U. S. Environmental Protection Agency, National Air Pollutant Emission Estimates, 1900-1992, 1993, p. 3-12.

[a]The sums of subcategories may not equal total due to rounding.
[b]Preliminary
[c]There was a change in methodology for estimates from 1970 to 1980.
[d]Recreational marine vessels.

Figure 7.1. National Emission Estimates of Carbon Monoxide, 1940-92



Source: See Table 7.2.

Table 7.3
Emissions of Carbon Monoxide from Highway Vehicles, 1970-92[a]
(million short tons)

Source category	1970	1980	1983	1984	1985[b]	1986	1987	1988	1989	1990	1991	1992
Gasoline powered												
Passenger cars & motorcycles	59.96	59.13	52.41	49.74	47.10	45.08	45.54	45.47	41.71	41.52	40.84	38.39
Light trucks[c]	9.55	17.66	17.38	17.44	18.52	18.67	15.18	14.85	13.81	13.71	13.54	12.68
Heavy duty vehicles	9.40	10.04	7.72	7.01	6.39	5.37	3.38	3.33	3.06	2.95	2.80	2.57
Total	78.91	86.83	77.51	74.19	72.01	69.12	64.10	63.65	58.58	58.18	57.18	53.64
Diesel powered												
Passenger cars	0.01	0.01	0.02	0.02	0.02	0.02	0.03	0.03	0.03	0.03	0.04	0.04
Light trucks	[d]	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.03	0.03
Heavy duty vehicles	0.35	1.15	1.13	1.19	1.47	1.32	1.46	1.53	1.50	1.57	1.59	1.58
Total	0.35	1.17	1.16	1.22	1.50	1.35	1.51	1.57	1.55	1.62	1.65	1.65
Total												
Highway vehicle total	**79.26**	**87.99**	**78.67**	**75.40**	**73.52**	**70.47**	**65.60**	**65.22**	**60.13**	**59.80**	**58.83**	**55.29**

Source:
U. S. Environmental Protection Agency, National Air Pollutant Emission Estimates, 1900-1992, 1993, p. A-5.

[a]The sums of subcategories may not equal total due to rounding.
[b]Methodologies to estimate 1984, 1985, and 1986 emission estimates differ. Becuase of these differences, the allocation of emissions among source categories could result in significant changes in the emission estimates between the years, particularly at the more detailed source category level.
[c]Less than 8,500 pounds.
[d]Data are not available.

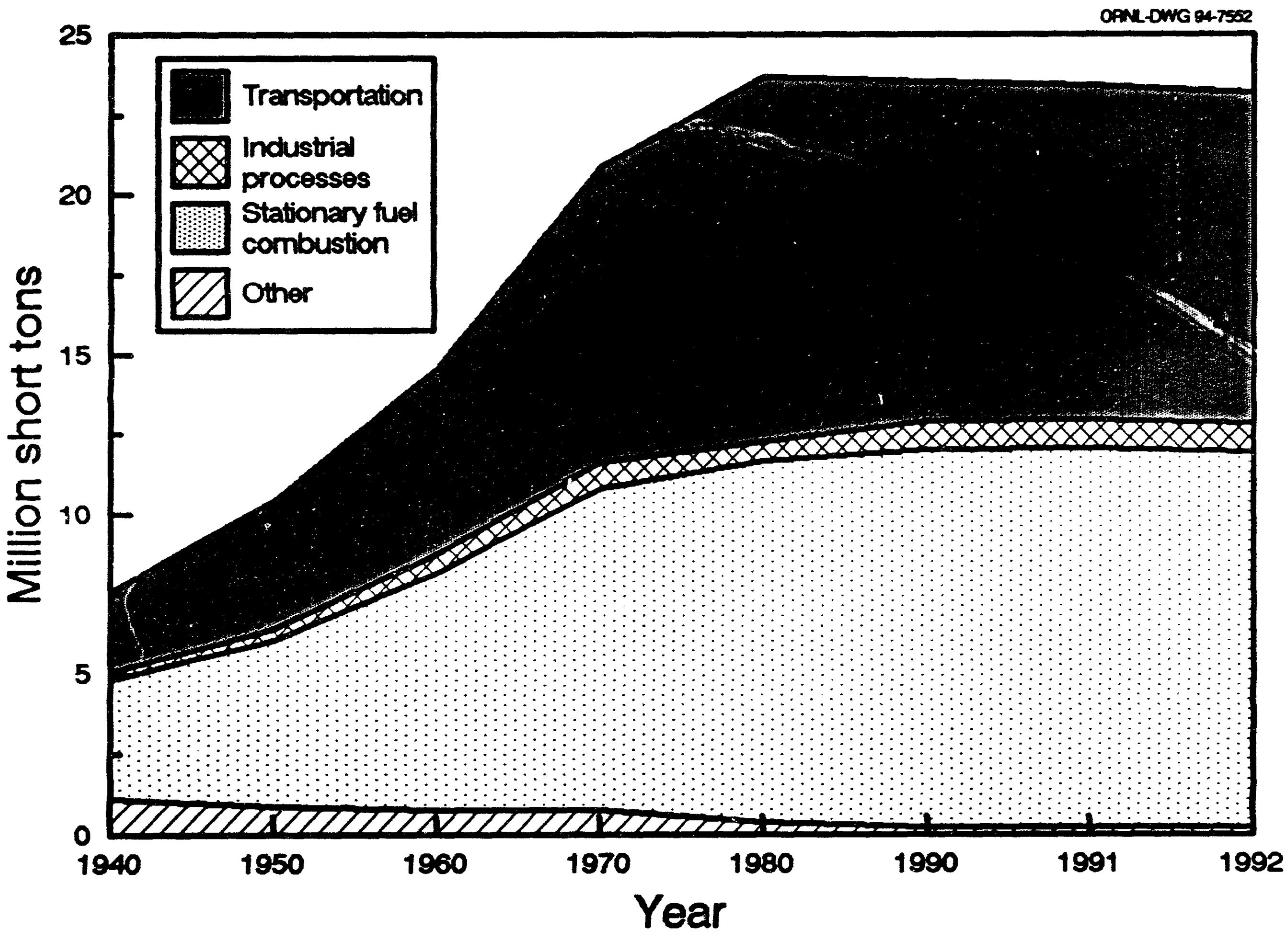
Table 7.4
Total National Emissions of Nitrogen Oxides, 1940-92[a]
(million short tons)

Source category	1940	1950	1960	1970	1980[b]	1990[c]	1991[c]	1992[c]
Transportation								
Highway vehicles	1.52	2.45	4.42	7.43	8.71	7.82	7.72	7.48
Railroads	0.66	0.99	0.77	0.71	0.83	0.93	0.98	0.93
Other off-highway	0.33	0.55	0.67	1.12	1.90	1.91	1.79	1.93
Transportation total	2.51	3.99	5.86	9.26	11.44	10.66	10.49	10.34
Stationary fuel combustion total	3.73	5.16	7.37	10.06	11.32	11.79	11.83	11.73
Industrial processes total	0.22	0.38	0.57	0.78	0.56	0.89	0.89	0.88
Waste disposal and recycling total	0.11	0.22	0.33	0.44	0.11	0.08	0.08	0.08
Miscellaneous total	0.99	0.67	0.44	0.33	0.25	0.13	0.13	0.13
Total of all sources	**7.57**	**10.40**	**14.58**	**20.86**	**23.66**	**23.56**	**23.41**	**23.15**

Source:
U. S. Environmental Protection Agency, National Air Pollutant Emission Estimates, 1900-1992, 1993, p. 3-13.

[a]The sums of subcategories may not equal total due to rounding.
[b]There is a change in methodology for highway vehicles and off-highway emission estimates from 1970 to 1980.
[c]Preliminary.

Figure 7.2. National Emission Estimates of Nitrogen Oxides, 1940-92



Source: See Table 7.4.

Table 7.5
Emissions of Nitrogen Oxides from Highway Vehicles, 1970-92[a]
(million short tons)

Source category	1970	1980	1983	1984	1985[b]	1986	1987	1988	1989	1990	1991	1992
Gasoline powered												
Passenger cars & motorcycles	4.73	4.65	4.22	4.01	3.70	3.53	3.54	3.56	3.46	3.54	3.55	3.52
Light trucks[c]	0.87	1.38	1.43	1.45	1.50	1.52	1.23	1.22	1.17	1.17	1.16	1.13
Heavy duty vehicles	0.55	0.37	0.32	0.30	0.27	0.23	0.19	0.20	0.19	0.20	0.20	0.20
Total	6.15	6.40	5.97	5.76	5.47	5.28	4.96	4.98	4.82	4.91	4.91	4.85
Diesel powered												
Passenger cars	[d]	0.02	0.03	0.03	0.03	0.03	0.04	0.04	0.04	0.04	0.05	0.05
Light trucks	[d]	0.01	0.01	0.01	0.01	0.01	0.02	0.03	0.03	0.03	0.03	0.03
Heavy duty vehicles	1.28	2.29	2.10	2.15	2.61	2.31	2.85	2.93	2.81	2.84	2.73	2.56
Totai	1.28	2.31	2.14	2.19	2.65	2.35	2.91	3.00	2.88	2.91	2.81	2.64
Total												
Highway vehicle total	**7.43**	**8.71**	**8.10**	**7.95**	**8.11**	**7.63**	**7.87**	**7.98**	**7.70**	**7.82**	**7.72**	**7.48**

Source:
U. S. Environmental Protection Agency, National Air Pollutant Emission Estimates, 1900-1992, 1993, p. A-10.

[a]The sums of subcategories may not equal total due to rounding.
[b]Methodologies to estimate 1984, 1985, and 1986 emission estimates differ. Becuase of these differences, the allocation of emissions among source categories could result in significant changes in the emission estimates between the years, particularly at the more detailed source category level.
[c]Less than 8,500 pounds.
[d]Data are not available.

Table 7.6
Total National Emissions of Particulate Matter (PM-10), 1940-92[a]
(million short tons)

Source category	1940	1950	1960	1970	1980	1990[b]	1991[b]	1992[b]
Transportation								
Highway vehicles	0.21	0.31	0.55	0.96	1.11	1.48	1.53	1.56
Railroads	2.46	1.74	0.10	0.07	0.06	0.04	0.04	0.04
Other off-highway	0.02	0.05	0.09	0.21	0.22	0.24	0.23	0.24
Transportation total	2.69	2.10	0.74	1.24	1.39	1.76	1.80	1.84
Stationary fuel combustion total	3.48	2.78	1.90	1.34	1.76	1.16	1.14	1.09
Industrial processes total	5.90	8.85	9.24	7.67	2.75	1.98	1.87	1.94
Waste disposal and recycling total	0.39	0.51	0.76	1.00	0.27	0.22	0.22	0.25
Miscellaneous total	2.97	1.93	1.24	0.84	0.85	45.73[c]	50.32[c]	46.31[c]
Total of all sources	**15.43**	**16.16**	**13.90**	**12.08**	**7.02**	**50.84**	**55.34**	**51.43**

Source:
U. S. Environmental Protection Agency, National Air Pollutant Emission Estimates, 1900-1992, 1993, p. 3-17.

[a]The sums of subcategories may not equal total due to rounding.
[b]Preliminary.
[c]Includes fugitive dust estimates which were not available before 1990. For 1990-92, fugitive dust is approximately 98% of the Miscellaneous total.

Table 7.7
Emissions of Particulate Matter (PM-10) from Highway Vehicles, 1970-92[a]
(million short tons)

Source category	1970	1980	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
					Gasoline powered							
Passenger cars & motorcycles	0.64	0.60	0.54	0.56	0.56	0.58	0.62	0.65	0.66	0.70	0.72	0.74
Light trucks[b]	0.10	0.16	0.15	0.16	0.17	0.19	0.16	0.17	0.17	0.18	0.19	0.19
Heavy duty vehicles	0.07	0.06	0.06	0.05	0.05	0.04	0.04	0.04	0.04	0.05	0.04	0.04
Total	0.81	0.82	0.75	0.77	0.77	0.81	0.82	0.86	0.87	0.93	0.95	0.97
					Diesel powered							
Passenger cars	[c]	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.03	0.03
Light trucks	[c]	0.00	0.01	0.00	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02
Heavy duty vehicles	0.14	0.29	0.28	0.30	0.37	0.34	0.45	0.49	0.49	0.51	0.53	0.54
Total	0.14	0.29	0.30	0.32	0.40	0.37	0.49	0.52	0.53	0.55	0.58	0.59
					Total							
Highway vehicle total	**0.96**	**1.11**	**1.04**	**1.09**	**1.18**	**1.18**	**1.30**	**1.38**	**1.40**	**1.48**	**1.53**	**1.56**

Source:
U. S. Environmental Protection Agency, National Air Pollutant Emission Estimates, 1900-1992, 1993, p. A-32.

[a]The sums of subcategories may not equal total due to rounding.
[b]Less than 8,500 pounds.
[c]Data are not available.

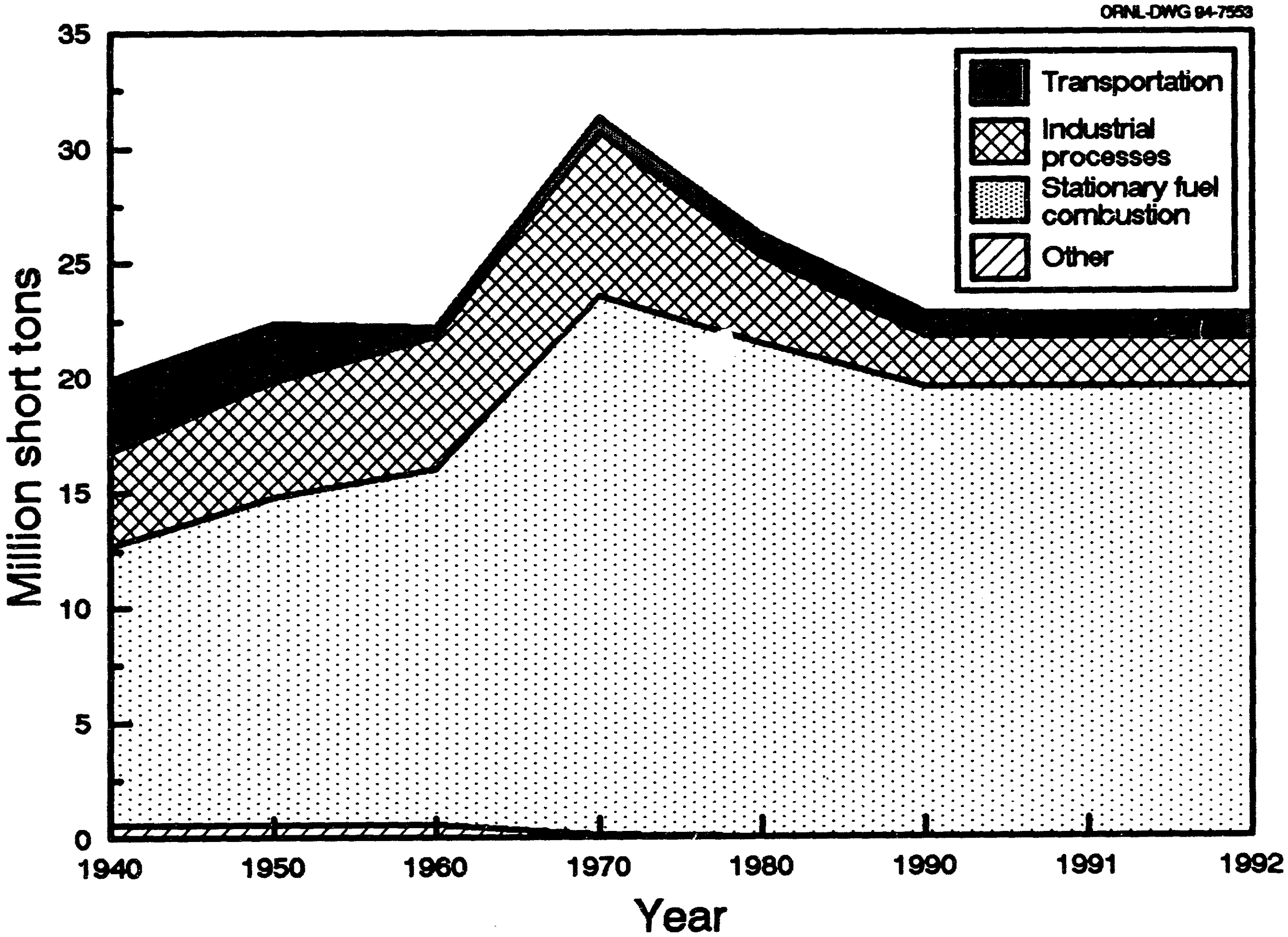
Table 7.8
Total National Emissions of Sulfur Dioxide, 1940-92[a]
(million short tons)

Source category	1940	1950	1960	1970	1980	1990[b]	1991[b]	1992[b]
Transportation								
Highway vehicles	0.00	0.10	0.11	0.28	0.46	0.74	0.77	0.79
Railroads	2.98	2.20	0.22	0.14	0.13	0.07	0.07	0.07
Other off-highway	0.22	0.24	0.12	0.24	0.40	0.20	0.20	0.20
Transportation total	3.20	2.54	0.45	0.66	0.99	1.01	1.04	1.06
Stationary fuel combustion total	12.13	14.20	15.45	23.46	21.41	19.57	19.53	19.52
Industrial processes total	4.08	5.11	5.78	7.09	3.77	2.20	2.16	2.12
Waste disposal and recycling total	0.00	0.00	0.01	0.01	0.03	0.04	0.04	0.04
Miscellaneous total	0.55	0.55	0.55	0.11	0.01	0.00	0.00	0.00
Total of all sources	**19.95**	**22.38**	**22.25**	**31.33**	**26.21**	**22.82**	**22.77**	**22.73**

Source:
U. S. Environmental Protection Agency, National Air Pollutant Emission Estimates, 1900-1992, 1993, p. 3-15.

[a]The sums of subcategories may not equal total due to rounding.
[b]Preliminary.

Figure 7.3. National Emission Estimates of Sulfur Dioxide, 1940-92



Source: See Table 7.8.

Table 7.9
Emissions of Sulfur Dioxide from Highway Vehicles, 1970-92[a]
(million short tons)

Source category	1970	1980	1983	1984	1985[b]	1986	1987	1988	1989	1990	1991	1992
Gasoline powered												
Passenger cars & motorcycles	0.13	0.16	0.17	0.18	0.18	0.19	0.20	0.21	0.21	0.22	0.23	0.24
Light trucks[c]	0.03	0.06	0.06	0.07	0.07	0.08	0.07	0.07	0.07	0.08	0.08	0.08
Heavy duty vehicles	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Total	0.17	0.24	0.24	0.26	0.26	0.28	0.28	0.29	0.29	0.31	0.32	0.33
Diesel powered												
Total	0.11	0.23	0.23	0.25	0.31	0.29	0.38	0.41	0.41	0.43	0.44	0.46
Total												
Highway vehicle total	**0.28**	**0.46**	**0.48**	**0.51**	**0.58**	**0.56**	**0.66**	**0.70**	**0.70**	**0.74**	**0.77**	**0.79**

Source:
U. S. Environmental Protection Agency, National Air Pollutant Emission Estimates, 1900-1992, 1993, p. A-27.

[a]The sums of subcategories may not equal total due to rounding.
[b]Methodologies to estimate 1984, 1985, and 1986 emission estimates differ. Becuase of these differences, the allocation of emissions among source categories could result in significant changes in the emission estimates between the years, particularly at the more detailed source category level.
[c]Less than 8,500 pounds.

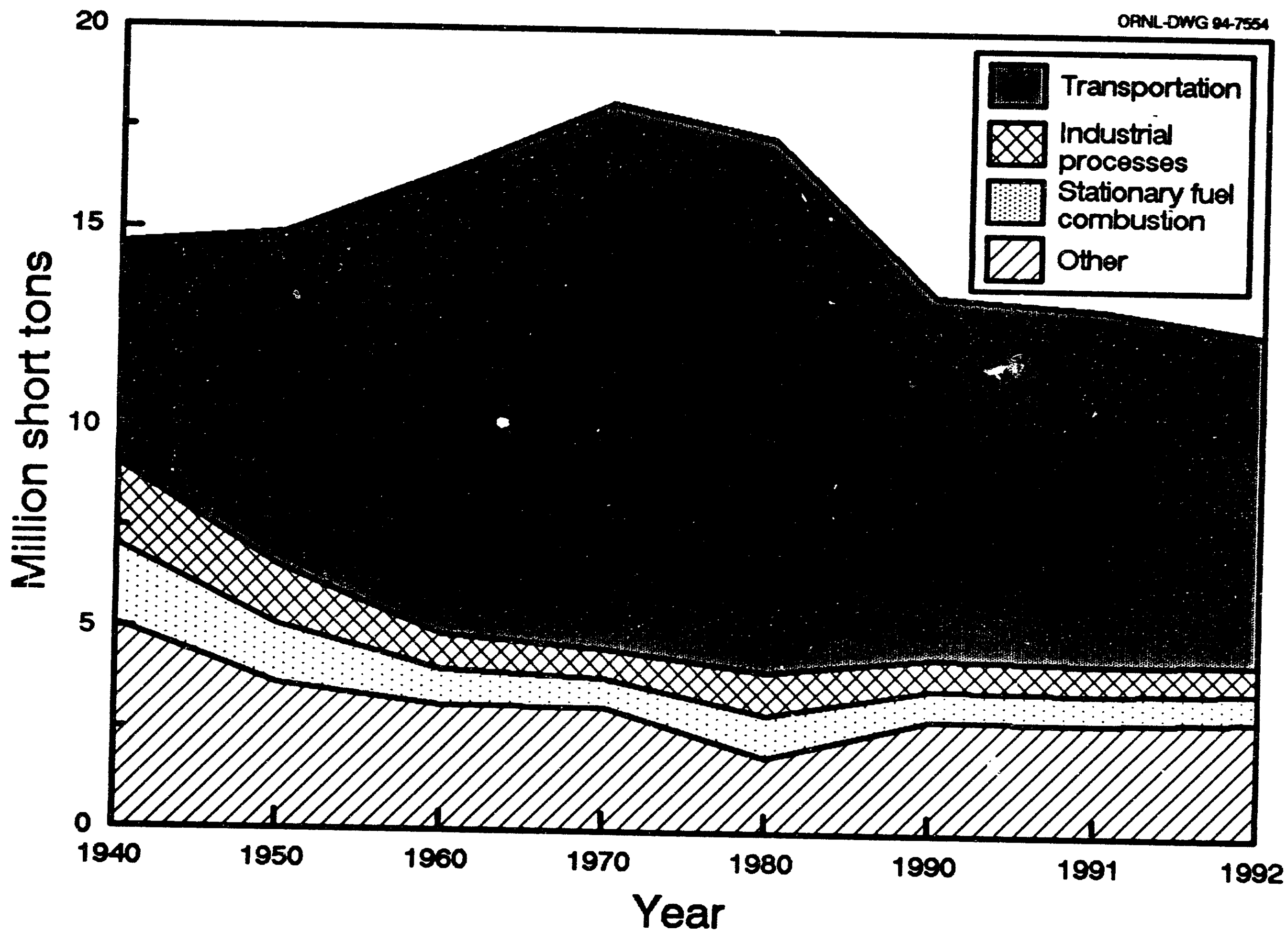
Table 7.10
Total National Emissions of Volatile Organic Compounds, 1940-92[a]
(million short tons)

Source category	1940	1950	1960	1970	1980[b]	1990[c]	1991[c]	1992[c]
Transportation								
Highway vehicles	4.77	7.17	10.37	12.22	10.99	6.98	6.81	6.10
Off-highway	0.78	1.21	1.22	1.39	2.32	2.12	2.06	2.13
Transportation total	5.55	8.38	11.59	13.61	13.31	9.10	8.87	8.23
Stationary fuel combustion total	1.98	1.44	0.88	0.72	1.05	0.76	0.75	0.71
Industrial processes total	4.52	7.40	8.73	12.33	12.10	10.98	11.00	10.90
Waste disposal and recycling total	0.99	1.10	1.55	1.98	0.76	2.26	2.22	2.31
Miscellaneous total	4.08	2.53	1.57	1.10	1.13	0.58	0.57	0.58
Total of all sources	**17.12**	**20.86**	**24.32**	**29.74**	**28.35**	**23.67**	**23.40**	**22.73**

Source:
U. S. Environmental Protection Agency, National Air Pollutant Emission Estimates, 1900-1992, 1993, p. 3-14.

[a]The sums of subcategories may not equal total due to rounding.
[b]There is a change in methodology for highway vehicles and off-highway emission estimates from 1970 to 1980.
[c]Preliminary.

Figure 7.4. National Emission Estimates of Volatile Organic Compounds, 1940-92



Source: See Table 7.10.

Table 7.11
Emissions of Volatile Organic Compounds from Highway Vehicles, 1970-92[a]
(million short tons)

Source category	1970	1980	1983	1984	1985[b]	1986	1987	1988	1989	1990	1991	1992
Gasoline powered												
Passenger cars & motorccles	9.55	7.13	6.50	6.15	5.86	5.55	5.47	5.39	4.74	4.63	4.53	4.05
Light trucks[c]	1.65	2.49	2.45	2.43	2.56	2.55	2.00	1.94	1.73	1.68	1.63	1.45
Heavy duty vehicles	0.90	0.96	0.75	0.68	0.62	0.51	0.31	0.30	0.25	0.24	0.23	0.19
Total	12.10	10.58	9.70	9.26	9.04	8.61	7.78	7.63	6.72	6.55	6.39	5.69
Diesel powered												
Passenger cars	[d]	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02
Light trucks	[d]	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01
Heavy duty vehicles	0.13	0.41	0.36	0.37	0.44	0.39	0.43	0.43	0.41	0.41	0.40	0.38
Total	0.13	0.42	0.38	0.38	0.46	0.40	0.45	0.46	0.43	0.43	0.43	0.41
Total												
Highway vehicle total	**12.22**	**10.99**	**10.08**	**9.63**	**9.49**	**9.00**	**8.23**	**8.08**	**7.15**	**6.98**	**6.81**	**6.10**

Source:
U. S. Environmental Protection Agency, National Air Pollutant Emission Estimates, 1900-1992, 1993, p. A-20.

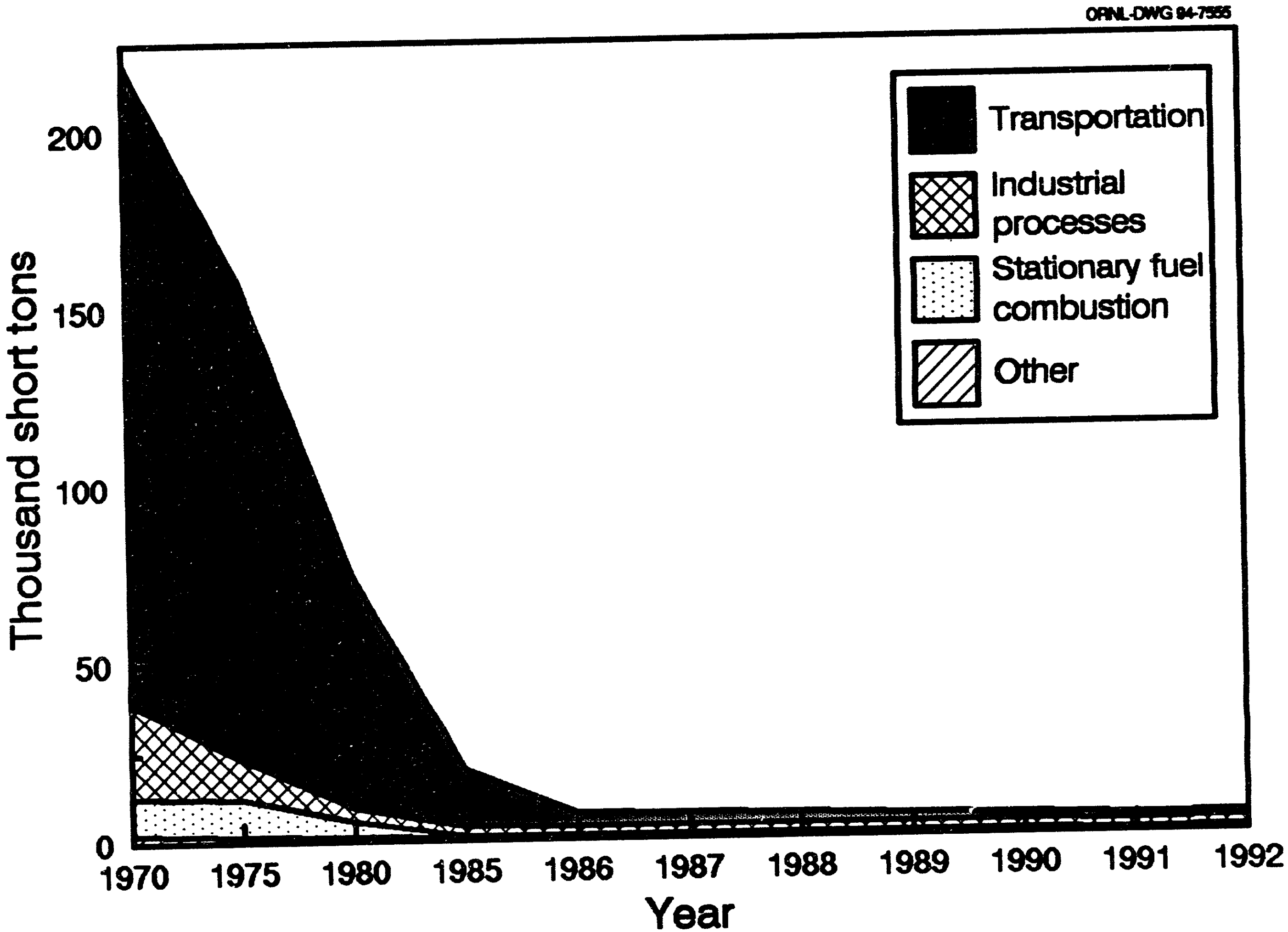
[a]The sums of subcategories may not equal total due to rounding.
[b]Methodologies to estimate 1984, 1985, and 1986 emission estimates differ. Becuase of these differences, the allocation of emissions among source categories could result in significant changes in the emission estimates between the years, particularly at the more detailed source category level.
[c]Less than 8,500 pounds.
[d]Data are not available.

Table 7.12
National Lead Emission Estimates, 1970-92
(thousand short tons per year)

Source category	1970	1975	1980	1985	1986	1987	1988	1989	1990	1991	1992
Transportation											
Highway vehicles	171.96	130.21	62.19	15.98	3.59	3.12	2.70	2.16	1.69	1.52	1.38
Off-highway	8.34	5.01	3.32	0.23	0.22	0.22	0.21	0.21	0.20	0.18	0.21
Transportation total	180.30	135.22	65.51	16.21	3.81	3.34	2.91	2.37	1.89	1.70	1.59
Stationary source fuel combustion	10.62	10.35	4.30	0.52	0.52	0.51	0.51	0.51	0.50	0.50	0.49
Industrial processes	26.35	11.38	3.94	2.53	2.13	2.14	2.22	2.46	2.44	2.24	2.35
Waste disposal and recycling total	2.20	1.60	1.21	0.87	0.84	0.84	0.82	0.77	0.80	0.58	0.74
Miscellaneous	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total of all sources	**219.47**	**158.54**	**74.96**	**20.12**	**7.30**	**6.84**	**6.46**	**6.11**	**5.64**	**5.01**	**5.18**

Source:
U. S. Environmental Protection Agency, National Air Pollutant Emission Estimates, 1900-1992, 1993, p. A-28, A-29, A-30.

Figure 7.5. National Emission Estimates of Lead, 1970-92



Source: See Table 7.12.

Table 7.13
Atmospheric Emissions of Selected Pollutants from the Transportation Sector
(million short tons)

	Total Emissions						Percent Total Emissions		
	CO_2[a]		CO		NO_x		CO_2[a]	CO	NO_x
	1971	1991	1970	1990	1971	1990	1991	1990	1990
Canada	97	130	8.707	[b]	0.901	1.235	27.1	[b]	58.3
United States	1,190	1,641	106.729	53.425	9.312	8.629	29.6	76.6	40.4
Japan	165	272	[b]	[b]	[b]	[b]	22.9	[b]	[b]
France	87	147	[b]	7.273	0.592	1.168	32.7	87.1	71.3
West Germany	112	175	9.830	6.732	1.167	2.103	[b]	74.7	73.2
Netherlands	53	74	1.639	0.788	0.233	0.371	34.7	68.8	61.1
Switzerland	12	20	0.553	0.299	0.098	0.138	40.5	62.9	67.9
United Kingdom	109	156	3.278	6.684	0.912	1.718	23.3	90.5	56.1

Source:
U.S. Department of Transportation, Bureau of Transportation Statiistics, Transportation Statistics Annual Report 1994, Washington, DC, January 1994, p. 167.

[a]Based on anthropogenic emissions from energy use.
[b]Data are not available.

Table 7.14
Estimated U.S. Emissions of Greenhouse Gases, 1990

Greenhouse gas	Unit of measure[a]	
Carbon dioxide	million metric tons of gas	5,012.4
	million metric tons of carbon	1,367.0
Methane	million metric tons of gas	29.1
	million metric tons of carbon	21.8
Nitrous oxide	million metric tons of gas	0.3
Carbon monoxide	million metric tons of gas	67.7
	million metric tons of carbon	29.0
Nitrogen oxide	million metric tons of gas	19.4
Nonmethane VOCs[b]	million metric tons of gas	17.6
CFC-11,12,113[c]	million metric tons of gas	0.2

Source:
U.S. Department of Energy, Energy Information Administration, Emissions of Greenhouse Gases in the United States, 1985-1990, Washington, DC, September 1993, p. x.

Table 7.15
U.S. Carbon Dioxide Emissions from Fossil Energy Consumption by End-Use Sector, 1985-91[d]
(million metric tons of carbon)

End use	1985	1986	1987	1988	1989	1990	1991
Energy consumption sectors							
Residential	177.2	176.9	181.5	192.4	194.9	182.9	187.3
Commercial	130.1	131.8	136.3	143.9	144.9	143.0	143.8
Industrial	548.2	530.5	547.9	575.3	579.1	579.6	561.1
Transportation	385.1	399.8	411.9	428.1	433.1	432.6	424.9
Total energy	**1240.6**	**1239.1**	**1,277.6**	**1,339.8**	**1,352.0**	**1,338.0**	**1,317.2**
Electric utility sector							
Electric utility	439.1	435.7	452.8	476.2	483.7	476.7	473.6

Source:
U.S. Department of Energy, Energy Information Administration, Emissions of Greenhouse Gases in the United States, 1985-1990, Washington, DC, September 1993, p. 13.

---

[a]Gases that contain carbon can be measured either in terms of the full molecular weight of the gas or just in terms of their carbon content.
[b]Volatile organic compounds.
[c]Chlorofluorocarbons.
[d]Includes energy from petroleum, coal, and natural gas. Electric utility emissions are distributed across consumption sectors.

Table 7.16
U.S. Carbon Dioxide Emissions from Energy Use in the Transportation Sector, 1980-91
(million metric tons of carbon)

Fuel	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
Petroleum												
Motor Gasoline	238.1	238.1	236.8	240.0	242.3	245.8	253.3	259.6	265.4	264.4	261.1	259.7
LPG[a]	0.3	0.6	0.5	0.7	0.7	0.5	0.4	0.4	0.4	0.4	0.4	0.3
Jet Fuel	42.0	39.7	39.9	41.3	46.5	48.1	51.7	54.8	57.5	59.0	60.3	58.3
Distillate Fuel	55.3	57.4	55.2	57.4	62.2	63.3	65.3	67.0	72.9	75.9	75.7	72.7
Residual Fuel	30.0	26.1	21.9	17.6	17.3	16.8	18.7	19.3	19.7	21.0	22.1	22.1
Lubricants	1.8	1.7	1.6	1.7	1.8	1.6	1.6	1.8	1.8	1.8	1.8	1.7
Aviation Gas	1.2	1.1	0.9	0.9	0.8	1.0	1.1	0.9	0.9	0.9	0.9	0.8
Total	**368.7**	**364.6**	**356.7**	**359.6**	**371.6**	**377.2**	**392.2**	**403.7**	**418.6**	**423.4**	**422.3**	**415.6**
Other energy												
Natural Gas	9.4	9.5	8.8	7.3	7.8	7.5	7.2	7.7	9.1	9.4	9.8	8.9
Electricity	0.3	0.3	0.3	0.3	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Total	**378.4**	**374.4**	**365.9**	**367.2**	**379.8**	**385.1**	**399.8**	**411.9**	**428.1**	**433.1**	**432.6**	**424.9**

Source:
U.S. Department of Energy, Energy Information Administration, Emissions of Greenhouse Gases in the United States, 1985-1990, Washington, DC, September 1993, p. 74.

[a]Liquid petroleum gas.

Table 7.17
CO^2-Equivalent Emissions of Light-Duty Combustion-Engine Vehicles (ICEVs)[a]
(grams/mile)

Source or Fuel-Cycle Stage	Reform. Gas	Std. Gas	Methanol from NG[b]	Methanol from Coal[c]	Methanol from Diesel[d]	LPG from NG and Oil[e]	Ethanol from wood
Vehicle end use	333.7	344.5	277.4	277.4	325.0	283.6	51.0
Compression/liquefaction	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fuel distribution	5.9	5.9	29.2	15.2	5.6	6.8	97.1
Fuel production	68.2[f]	51.2	84.0	401.5	23.7	12.4	-434.3
Feedstock transport	10.6	11.1	9.5	1.5	10.6	3.9	95.5
Feedstock recovery	11.8	12.4	17.6	9.2	11.8	8.1	417.5
CH_4 leaks/flares	5.1	5.4	11.3	37.3	5.1	5.7	0.0
First total	435.3	430.4	428.9	742.1	381.8	320.5	565.1
Change (%)[g]	n/a	-1.1	-1.5	66.8	-12.4	-26.4	-76.7
Car assembly	14.0	14.0	14.0	14.0	10.5[h]	14.3	51.5
Materials in cars	41.9	41.9	41.9	41.9	31.6[h]	42.8	154.5
Second total	491.2	486.3	484.8	798.0	423.9	377.6	771.1
Change (%)[g]	n/a	-1.0	-1.3	59.3	-13.7	-23.1	-70.6

Source:
DeLuchi, M. A., "Emissions of Greenhouse Gases from the Use of Transportation Fuels and Electricity: Volume 1," ANL/ESD/TM-22, Center for Transportation Research, Argonne National Laboratory, 1991.

Note: CH_4=methane. NG=natural gas. LPG=liquefied petroleum gas.

See footnotes on following page.

Footnotes for Table 7.17 - CO^2-Equivalent Emissions of Light-Duty Combustion-Engine Vehicles (ICEVs).

[a]Percentage changes for light-duty vehicles (LDVs) are relative to base-case reformulated-gasoline LDVs, and percentage changes for heavy-duty vehicles (HDVs) are relative to base-case diesel HDVs. The base-case LDV in combined city/highway driving gets 30 miles per gallon (mpg) on reformulated gasoline and 30.7 mpg on standard gasoline, because of the higher density (in Btu/gal) of standard gasoline. The base-case g/mi results for gasoline and diesel fuel for all the time horizons are:

Fuel	20-Year	100-Year (this table)	500-year
Reformulated gasoline (30 mpg, city/highway)	636.6	491.2	449.2
Diesel (6 mpg)	3,819.3	2,627.1	2,331.4

[b]100% methanol, all from remote natural gas (NG) in this base case.

[c]100% methanol, all from coal.

[d]Assumes that a diesel LDV gets 39 mph (27% better than a comparable vehicle on standard gasoline and 30% better than a comparable vehicle on reformulated gasoline), weighs 100 lb more than a comparable gasoline vehicle, lasts 150,000 (as opposed to 108,000 miles for the gasoline vehicle), and emits non-CO^2 greenhouse gases

[e]61.4% of the liquefied petroleum gas (LPG) comes from natural gas liquids (NGL) plants and 38.6% comes from petroleum refineries.

[f]Includes emissions from the production and delivery of methanol and ethanol used to make MTBE.

[g]To make an internally consistent scenario, methanol from coal is compared with reformulated gasoline that contains methyl tertiary butyl ether (MTBE) made from coal-derived methanol. The first total for this reformulated gasoline is 445.0 g/mi; the second total is 500.9 g/mi, and the LDV + HDV total is 628.4 g/mi. These totals are higher than the totals (shown above) for reformulated gasoline that contains NG-derived MTBE. The liquified natural gas (LNG) vehicle and the diesel LDV are compared with the baseline gasoline vehicle using NG-derived MTBE.

[h]Low values are due to the long life of the diesel vehicle.

Table 7.18
CO^2-Equivalent Emissions of Battery Powered Light-Duty Electric Vehicles by Source of Electricity[a]
(grams/mile)

Source or Fuel-Cycle Stage	U.S. National ("Marginal") Power Mix[b]	Coal-Fired Plants Only	Natural Gas-Fired Plants Only	Nuclear Power Plants Only	Solar Power Plants Only
Vehicle end use	0.0	0.0	0.0	0.0	0.0
Fuel Distribution	7.6[c]	0.0	21.1[d]	0.0	0.0
Fuel Production[e]	402.8	502.7	288.5	27.6	1.3[f]
Feedstock Transport	6.7	8.6	0.0	0.0	0.0
Feedstock Recovery	8.6	6.6	8.5	1.3	0.0
CH_4 leaks/flares	19.9	27.7	16.3	0.0	0.0
First total	445.6	545.6	334.4	29.0	1.3
Change (%)	-14.5	4.7	-35.8	-94.4	-99.7
Car assembly	14.4	14.4	14.4	14.4	14.4
Materials in cars[g]	46.6	46.6	46.6	46.6	46.6
Second total	506.6	606.6	395.4	90.0	67.3
Change (%)	-12.2	5.1	-31.5	-84.4	-89.2

Source:
Deluchi, M.A., "Emissions of Greenhouse Gases from the Use of Transportation Fuels and Electricity: Volume 1, "ANL/ESD/TM-22, Center for Transportation Research, Argonne National Laboratory, 1991.

Note: CH_4=methane.

---

[a]Because in the base case, battery-powered electric vehicles (EVs) are assumed to be used in city driving only, they are compared with reformulated-gasoline light-duty vehicles (LDV) in the city driving cycle. The reformulated-gasoline LDV that gets 30 mph in combined city/highway driving gets 24.5 mpg in city driving only. The base-case g/mi results (second total in the table) for the gasoline LDV in city driving, for all time horizons, are as follows:

Fuel	20-year	100-year	500-year
Reformulated gasoline (24.5 mpg, city driving)	727.7	577.1	533.1

The percentage changes in this table are given with respect to the value of 577.1 g/mi found in the reformulated gasoline LDV fuel cycle.

[b]The mix of power used nationally specifically to recharge EVs.

[c]Emissions from the distribution of fuel oil to power plants.

[d]Emissions from the transmission and distribution of NG by pipeline to power plants.

[e]Emissions from power plants plus emissions from the facilities that make the fuel used at power plants plus N_2O emissions from high-voltage power lines.

[f]Emissions of N_2O formed by the corona discharge from high-voltage transmission lines.

[g]This estimate of emissions from the manufacture of materials for an EV is only approximate, assuming that the breakdown of the materials in an EV, excluding the battery, is the same as the breakdown for an internal-combustion-engine vehicle (ICEV). However, this assumption is obviously not correct, since the powertrain in an EV is very different from that in an ICEV.

The Clean Air Act Amendment of 1990 established higher emission control standards. These standards will become effective in 1994.

Table 7.19
Federal Emission Control Requirements for Automobiles and Light Trucks, 1976-94[a]
(grams per mile)

	Automobiles				Light trucks[b]			
Model Year	Hydro-carbons (HC)	Carbon monoxide (CO)	Nitrogen oxides (NO_x)	Particulates[c]	Hydro-carbons (HC)	Carbon monoxide (CO)	Nitrogen oxides (NO_x)	Particulates[c]
1976	1.50	15.0	3.1	[d]	2.0	20.0	3.1	[d]
1977	1.50	15.0	2.0	[d]	2.0	20.0	3.1	[d]
1978	1.50	15.0	2.0	[d]	2.0	20.0	3.1	[d]
1979	1.50	15.0	2.0	[d]	1.7	18.0	2.3	[d]
1980	0.41	7.0	2.0	[d]	1.7	18.0	2.3	[d]
1981	0.41	3.4	1.0	[d]	1.7	18.0	2.3	[d]
1982	0.41	3.4	1.0	0.6	1.7	18.0	2.3	0.60
1983	0.41	3.4	1.0	0.6	1.7	18.0	2.3	0.60
1984	0.41	3.4	1.0	0.6	0.8	10.0	2.3	0.60
1985	0.41	3.4	1.0	0.6	0.8	10.0	2.3	0.60
1986	0.41	3.4	1.0	0.6	0.8	10.0	2.3	0.60
1987	0.41	3.4	1.0	0.2	0.8	10.0	2.3	0.26
1988	0.41	3.4	1.0	0.2	0.8	10.0	1.2[e]	0.26
1989	0.41	3.4	1.0	0.2	0.8	10.0	1.2[e]	0.26
1990	0.41	3.4	1.0	0.2	0.8	10.0	1.2[e]	0.26
1991	0.41	3.4	1.0	0.2	0.8	10.0	1.2[e]	0.26
1992	0.41	3.4	1.0	0.2	0.8	10.0	1.2[e]	0.26
1993	0.41	3.4	1.0	0.2	0.8	10.0	1.2[e]	0.26
1994	0.25	3.4	0.4	0.08	0.25[e]	3.4[e]	1.2[e]	0.26
1995-on	0.25	3.4	0.4	0.08	0.25[e]	3.4[e]	0.4[f]	0.08

Sources:

1976-93: Code of Federal Regulations 40CFR86, "Control of Air Pollution from New Motor Vehicles and New Motor Vehicle Engines: Certification and Testing Procedures," July 1, 1987 edition, p. 264.

1994-on: Clean Air Act Amendment of 1990.

[a]California standards not included.

[b]Applies to trucks under 6,000 pounds gross vehicle weight rating (GVWR) until model year 1978 and under 8,500 pounds GVWR beginning in model year 1979.

[c]Applies to diesel engines only.

[d]No standard was set for this year.

[e]Applies to light trucks up to and including 3,750 pounds loaded vehicle weight (LVW).

[f]Applies to light trucks up to and including 3,750 pounds loaded vehicle weight (LVW). Does not apply to diesel-fueled light trucks.

The Clean Air Act Amendment of 1990 established higher emission control standards. These standards will become effective in 1994.

Table 7.20
Federal Emission Control Requirements for Heavy-Duty Gasoline Trucks, 1976-94[a]
(grams per brake horsepower hour)

Model Year	Hydrocarbons (HC)	Carbon monoxide (CO)	Nitrogen oxides (NO_x)	Hydrocarbons + nitrogen oxides (HC + NO_x)
1976	[b]	40.0	[b]	16.0
1977	[b]	40.0	[b]	16.0
1978	[b]	40.0	[b]	16.0
1979	1.5	25.0	[b]	10.0
1980	1.5	25.0	[b]	10.0
1981	1.5	25.0	[b]	10.0
1982	1.5	25.0	[b]	10.0
1983	1.5	25.0	[b]	10.0
1984	1.3	15.5	10.7	[b]
1985	2.5	40.0	10.7	[b]
1986	2.5	40.0	10.7	[b]
1987	1.9	37.1	10.6	[b]
1988	1.9	37.1	10.6	[b]
1989	1.9	37.1	10.6	[b]
1990	1.9	37.1	6.0	[b]
1991	1.9	37.1	5.0	[b]
1992	1.9	37.1	5.0	[b]
1993	1.9	37.1	5.0	[b]
1994	1.9[c]	37.1	5.0[c]	[b]
1995	1.9[c]	37.1[c]	5.0[c]	[b]
1996	1.9[c]	37.1[c]	5.0[c]	[b]
1997	1.9[c]	37.1[c]	5.0[c]	[b]
1998	1.9[c]	37.1[c]	4.0[c]	[b]

Sources:
1976-93: Code of Federal Regulations, 40CFR86, "Control of Air Pollution from New Motor Vehicles and New Motor Vehicles Engines: Certification and Testing Procedures," July 1, 1987 edition, p. 264.
1994-on: Clean Air Act Amendment of 1990.

[a]Applies to trucks greater than 6,000 pounds gross vehicle weight until model year 1978; greater than 8,500 pounds gross vehicle weight from model year 1979-1986; and greater than 14,000 pounds gross vehicle weight starting in 1987.

[b]No standard was set for this year.

[c]Heavy-duty trucks must meet these standards or standards which reflect the greatest degree of emission reduction achievable through the application of the technology available.

The Clean Air Act Amendment of 1990 established higher emission control standards. These standards will become effective in 1994.

Table 7.21
Federal Emission Control Requirements for Heavy-Duty Diesel Trucks, 1976-94[a]
(grams per brake horsepower hour)

Model Year	Hydro-carbons (HC)	Carbon monoxide (CO)	Nitrogen oxides (NO_x)	Hydrocarbons + nitrogen oxides (HC + NO_x)	Particulates
1976	[b]	40.0	[b]	16.0	[b]
1977	[b]	40.0	[b]	16.0	[b]
1978	[b]	40.0	[b]	16.0	[b]
1979	1.5	25.0	[b]	10.0	[b]
1980	1.5	25.0	[b]	10.0	[b]
1981	1.5	25.0	[b]	10.0	[b]
1982	1.5	25.0	[b]	10.0	[b]
1983	1.5	25.0	[b]	10.0	[b]
1984	1.3	15.5	10.7	5.0	[b]
1985	1.3	15.5	10.7	[b]	[b]
1986	1.3	15.5	10.7	[b]	[b]
1987	1.3	15.5	10.7	[b]	[b]
1988	1.3	15.5	10.7	[b]	0.60
1989	1.3	15.5	10.7	[b]	0.60
1990	1.3	15.5	6.0	[b]	0.60
1991	1.3	15.5	5.0	[b]	0.25
1992	1.3	15.5	5.0	[b]	0.25
1993	1.3	15.5	5.0	[b]	0.25
1994	1.3[c]	15.5	5.0	[b]	0.10
1995	1.3[c]	15.5[c]	5.0[c]	[b]	0.10[c]
1996	1.3[c]	15.5[c]	5.0[c]	[b]	0.10[c]
1997	1.3[c]	15.5[c]	5.0[c]	[b]	0.10[c]
1998	1.3[c]	15.5[c]	4.0[c]	[b]	0.10[c]

Sources:
1976-93: Code of Federal Regulations, 40CFR86, "Control of Air Pollution from New Motor Vehicles and New Motor Vehicle Engines: Certification and Testing Procedures," July 1, 1987 edition, p. 264.
1994-on: Clean Air Act Amendment of 1990.

[a]Applies to trucks greater than 6,000 pounds gross vehicle weight until model year 1978; greater than 8,500 pounds gross vehicle weight beginning in model year 1979.
[b]No standard was set for this year.
[c]Heavy-duty trucks must meet these standards or standards which reflect the greatest degree of emission reduction achievable through the application of the technology available.

Table 7.22
Exhaust Emission Standards for Clean-Fuel Vehicles in the California Pilot Test Program
(50,000 mile standards in grams per mile)

	LDV & LDT ≤6,000 GVWR ≤3,750 LVW	LDT ≤6,000 GVWR >3,750 LVW ≤5,750 LVW	LDT [a] >6,000 GVWR ≤3,750 TW	LDT [a] >6,000 GVWR >3,750 TW ≤5,750 TW	LDT [a] >6,000 GVWR >5,750 TW
		Conventional vehicles			
Non-methane hydrocarbons	0.250	0.320	0.250	0.320	0.390
Carbon monoxide	3.400	4.400	3.400	4.400	5.000
Nitrogen oxides	0.400	0.700	0.400	0.700	1.100
Formaldehyde	[b]	[b]	[b]	[b]	[b]
		Transition low-emission vehicles (TLEVs)			
Non-methane organic gases	0.125	0.160	[c]	[c]	[c]
Carbon monoxide	3.400	4.400	[c]	[c]	[c]
Nitrogen oxides	0.400	0.700	[c]	[c]	[c]
Formaldehyde	0.015	0.018	[c]	[c]	[c]
		Low-emission vehicles (LEVs)			
Non-methane organic gases	0.075	0.100	0.125	0.160	0.195
Carbon monoxide	3.400	4.400	3.400	4.400	5.000
Nitrogen oxides	0.200	0.400	0.400	0.700	1.100
Formaldehyde	0.015	0.018	0.015	0.018	0.022
		Ultra-low emission vehicles (ULEVs)			
Non-methane organic gases	0.040	0.050	0.075	0.100	0.117
Carbon monoxide	1.700	2.200	1.700	2.200	2.500
Nitrogen oxides	0.200	0.400	0.200	0.400	0.600
Formaldehyde	0.008	0.009	0.008	0.009	0.011
		Zero-emission vehicles (ZEVs)			
Non-methane organic gases	0.0	0.0	0.0	0.0	0.0
Carbon monoxide	0.0	0.0	0.0	0.0	0.0
Nitrogen oxides	0.0	0.0	0.0	0.0	0.0
Formaldehyde	0.0	0.0	0.0	0.0	0.0

Source:
U.S. Environmental Protection Agency, Office of Mobile Sources, "California Pilot Test Program," Public Outreach Meeting, Ann Arbor, MI, May 17, 1991.

Note:
LDV = light-duty vehicle
LDT = light-duty truck
GVWR = gross vehicle weight rating
LVW = loaded vehicle weight
TW = tare weight

[a] The clean-fuel vehicle standards are not effective until the 1998 model year.
[b] Not applicable.
[c] There is no TLEV category for this vehicle class.

The California Air Resources Board has proposed these figures for fleet mixture in order to meet the emission standards. By the year 2001 it is proposed that 90% of the manufacturer's fleet be low-emission vehicles.

Table 7.23
California Air Resources Board Proposal for Meeting Emission Standards

Year	Percent of manufacturer's fleet	Vehicle type[a]
1989	100	CV
1993	100	CV
1994	90	CV
	10	TLEV
1995	85	CV
	15	TLEV
1996	80	CV
	20	TLEV
1997	73	CV
	25	LEV
	2	ULEV
1998-2000	48	CV
	48	LEV
	2	ULEV
	2	ZEV
2001-2002	90	LEV
	5	ULEV
	5	ZEV
2003[b]	75	LEV
	15	ULEV
	10	ZEV

Source:
California Air Resources Board, Mobile Sources Division, El Monte, CA, 1990.

[a] CV - Conventional vehicles
TLEV - Transition low emission vehicles
LEV - Low emission vehicles
ULEV - Ultra low emission vehicles
ZEV - Zero emission vehicles

[b]Fleet average of non-methane organic gases = 0.062 in 2003.

Four fuels are projected as capable of meeting the requirements for the transitional low-emission vehicles, low-emission vehicles, ultra-low emission vehicles, and zero-emission vehicles. Gasoline, alcohol, compressed natural gas, and liquified petroleum gas, with fuel and vehicle improvements, are projected as capable of meeting the first three levels. Electric vehicles are phased in as ultra-low emission vehicles and are the only vehicle type expected to be zero-emission vehicles.

Table 7.24
Possible Fuel/Vehicles for Clean-Fuel Vehicles

TRANSITIONAL LOW-EMISSION VEHICLES (TLEVs)

- ***Gasoline*** - small/medium displacement engines, heated fuel preparation system, close-coupled catalyst
- ***Alcohol*** - improved close-coupled catalyst
- ***Compressed natural gas*** - underfloor catalyst
- ***Liquified petroleum gas*** - close-coupled catalyst

LOW-EMISSION VEHICLES (LEVs)

- ***Gasoline*** - electrically heated catalyst, phase 2 gasoline
- ***Alcohol*** - heated fuel preparation system, close-coupled catalyst
- ***Compressed natural gas*** - electronic fuel injection, close-coupled catalyst
- ***Liquified petroleum gas*** - electronic fuel injection, close-coupled catalyst

ULTRA-LOW EMISSION VEHICLES (ULEVs)

- ***Gasoline*** - heated fuel preparation system, electrically heated catalyst, phase 2 gasoline
- ***Alcohol*** - heated fuel preparation system, electrically heated catalyst
- ***Compressed natural gas*** - electronic fuel injection, electrically heated catalyst
- ***Electricity*** - range-extended hybrid vehicles, battery powered vehicles with auxiliary combustion heaters

ZERO-EMISSION VEHICLES (ZEVs)

- ***Electricity*** - battery-powered vehicles

Source:
U.S. Department of Energy, Office of Transportation Technologies, "Electric Vehicle Progress," Washington, DC, January 1991, p.3.

Table 7.25
Carbon Monoxide Nonattainment Areas, 1992[a]

State	Nonattainment (NA) area name	Clean Air Act classification
Alaska	Anchorage Area	Moderate >= 12.7
Alaska	Fairbanks North Star Borough	Moderate < 12.7
Arizona	Phoenix NA Area	Moderate < 12.7
California	Chico NA Area	Moderate < 12.7
California	Fresno NA Area	Moderate >= 12.7
California	Lake Tahoe S. Shore	Moderate < 12.7
California	Los Angeles South Coast Air Basin	Serious
California	Modesto NA Area	Moderate < 12.7
California	Sacramento NA Area	Moderate < 12.7
California	San Diego NA ARea	Moderate < 12.7
California	San Francisco-Oakland-San Jose	Moderate < 12.7
California	Stockton NA Area	Moderate < 12.7
Colorado	Colorado Springs NA Area	Moderate < 12.7
Colorado	Denver-Boulder NA Area	Moderate >= 12.7
Colorado	Fort Collins Area	Moderate < 12.7
Colorado	Longmont NA Area	Moderate < 12.7
Connecticut	Hartford-New Britian-Middletown	Moderate < 12.7
DC-Maryland-Virginia	Washington NA Area	Moderate < 12.7
Massachutesetts	Boston NA Area	Moderate < 12.7
Maryland	Baltimore NA Area	Moderate < 12.7
Minnesota	Duluth NA Area	Moderate < 12.7
Minnesota	Minneapolis-St. Paul NA Area	Moderate < 12.7
Montana	Missoula	Moderate < 12.7
North Carolina	Raleigh-Durham NA Area	Moderate < 12.7
North Carolina	Winston-Salem NA Area	Moderate < 12.7
New Mexico	Albuquerque NA Area	Moderate < 12.7
Nevada	Las Vegas NA Area	Moderate >= 12.7
Nevada	Reno NA Area	Moderate < 12.7
New York - New Jersey	New York-N. New Jersey-Long Island	Moderate >= 12.7
Ohio	Cleveland NA Area	Moderate < 12.7
Oregon	Grants Pass	Moderate < 12.7
Oregon	Klamath Falls	Moderate < 12.7
Oregon	Medford	Moderate < 12.7
Pennsylvania - New Jersey	Philadelphia-Camden Co. NA Area	Moderate < 12.7
Tennessee	Memphis NA Area	Moderate < 12.7
Texas	El Paso	Moderate < 12.7
Utah	Ogden NA Area	Moderate < 12.7
Utah	Provo-Orem NA Area	Moderate >= 12.7
Washington - Oregon	Portland-Vancouver NA Area	Moderate < 12.7
Washington	Seattle-Tacoma NA Area	Moderate >= 12.7
Washington	Spokane NA Area	Moderate >= 12.7

Source: Personal communication with the U.S. Environmental Protection Agency, 1993.

[a]Unclassified nonattainment areas are not included in this listing.

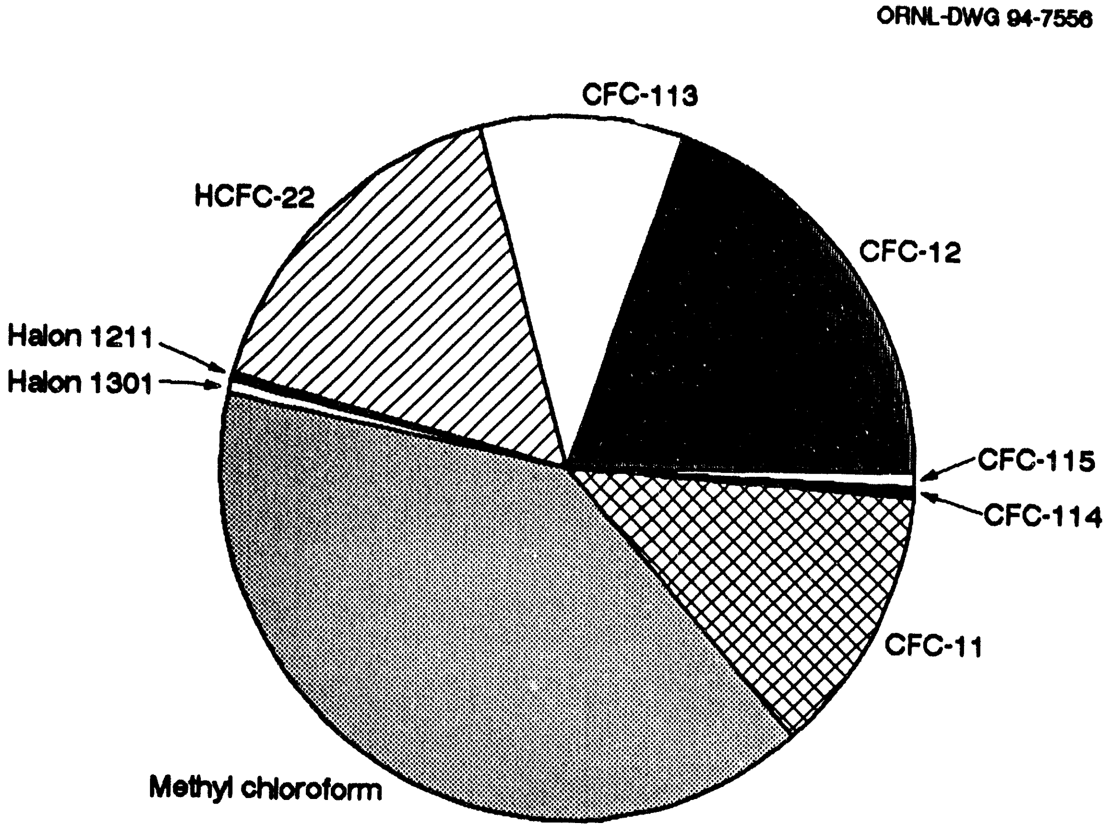
Table 7.26
Extreme, Severe, and Serious Ozone Nonattainment Areas, 1992[a]

State	Nonattainment (NA) area name	Clean Air Act classification
California	Los Angeles South Coast Air Basin	Extreme
California	Sacramento Metro NA Area	Serious
California	San Diego NA Area	Severe 15[b]
California	San Joaquin Valley NA Area	Serious
California	Southeast Desert Modified AQMD	Severe 17[b]
California	Ventura Co. NA Area	Severe 15[b]
Connecticut	Greater Connecticut NA Area	Serious
DC - Maryland - Virginia	Washington NA Area	Serious
Illinois - Indiana	Chicago - Gary - Lake County NA Area	Severe 17[b]
Georgia	Atlanta NA Area	Serious
Louisiana	Baton Rouge NA Area	Serious
Massachusetts - New Hampshire	Boston - Lawrence - Worcester NA Area	Serious
Massachusetts	Springfield (W. Mass.) NA Area	Serious
Maryland	Baltimore NA Area	Severe 15[b]
New Hampshire	Portsmouth - Dover - Rochester NH	Serious
New York - New Jersey - Connecticut	New York - N. New Jersey - Long Island	Severe 17[b]
Pennsylvania - New Jersey	Philadelphia - Wilmington - Trenton	Severe 15[b]
Rhode Island	Providence (all of RI) NA Area	Serious
Texas	Beaumont - Port Arthur NA Area	Serious
Texas	El Paso NA Area	Serious
Texas	Houston - Galveston - Brazoria NA Area	Sereve 17[b]
Wisconsin	Milkaukee - Racine NA Area	Severe 17[b]

Source: Personal communication with the U.S. Environmental Protection Agency, 1993.

[a]Unclassified nonattainment areas are not included in this listing.
[b]Severe 15 and Severe 17 areas face the same requirements but differ in their attainment dates (15 years or 17 years).

Figure 7.6. U.S. Production of Ozone-Depleting Substances, 1986 (1633 million lb)



Source:
G. R. Hadder, "The Consumer and the Transition to Non-Chlorofluorocarbon Automobile Air Conditioners", Oak Ridge National Laboratory, Oak Ridge, TN, 1991.

Note: CFC = Chlorofluorocarbon
HCFC = Hydrochlorofluorocarbons

APPENDIX A

SOURCES

This appendix, first included in Edition 10 of the Transportation Energy Data Book, contains documentation of the estimation procedures used by ORNL. The reader can examine the methodology behind the estimates and form an opinion as to their utility.

The appendix is arranged by table number and subject heading. Only tables which contain ORNL estimations are documented in Appendix A; all other tables have sources listed at the bottom of the table. Abbreviations are used throughout the appendix; so a list of abbreviations is also included.

List of Abbreviations Used in Appendix A

AAMA	American Automobile Manufacturers Association
AAR	Association of American Railroads
APTA	American Public Transit Association
Amtrak	National Railroad Passenger Corporation
Btu	British thermal unit
DOC	Department of Commerce
DOE	Department of Energy
DOT	Department of Transportation
EIA	Energy Information Administration
EPA	Environmental Protection Agency
FAA	Federal Aviation Administration
FHWA	Federal Highway Administration
gvw	gross vehicle weight
lpg	liquefied petroleum gas
MIC	Motorcycle Industry Council
mpg	miles per gallon
NHTSA	National Highway Traffic Safety Administration
NPTS	Nationwide Personal Transportation Study
ORNL	Oak Ridge National Laboratory
pmt	passenger-miles traveled
RECS	Residential Energy Consumption Survey
RTECS	Residential Transportation Energy Consumption Survey
TIUS	Truck Inventory and Use Survey
TSC	Transportation Systems Center
vmt	vehicle-miles traveled

Table 2.6
Domestic Consumption of Transportation Energy by Mode and Fuel Type, 1991

Most of the source data were given in gallons. It was converted to Btu by using the conversion factors in Appendix B.

Highway

Automobiles

Total gallons of fuel taken from DOT, FHWA, Highway Statistics 1992, Table VM-1. These were distributed as follows: 97.8% gasoline, 1.0% gasohol, and 1.2% diesel. Percentages were derived from the DOE, EIA, Office of Markets and End Use, Energy End Use Division, Household Vehicles Energy Consumption 1991, December 1993, p. 46.

Motorcycles

DOT, FHWA, Highway Statistics 1992, Table VM-1. For conversion purposes, fuel for all motorcycles was assumed to be gasoline.

Buses

Transit:

Diesel - APTA, 1993 Transit Fact Book, November 1993, Washington, DC, p. 100.
Gasoline - Total gallons of "other" fuel used by transit vehicles taken from APTA, 1993 Transit Fact Book, October 1993, Washington, DC, p. 100. According to APTA's Research and Statistics Department, motor bus gasoline use accounts for approximately 5% of this category.
Electricity - APTA, 1993 Transit Fact Book, October 1993, Washington, DC, p. 101.

Intercity:

Estimate provided by Frank Smith, Eno Foundation for Transportation, Washington, DC.

School:

Estimate provided by Frank Smith, Eno Foundation for Transportation, Washington, DC.

Trucks

Total:
Sum of light trucks and other trucks.

Light Trucks:
DOT, FHWA, Highway Statistics 1992, Table VM-1, for single-unit, 2-axle, 4-tire trucks. 96.6% of fuel assumed to be gasoline, 3.3% diesel, and 0.1% lpg; percentages were generated from the 1987 TIUS Public Use Tape.

Other Trucks:
DOT, FHWA, Highway Statistics 1992, Table VM-1. Total gallons for other trucks was the difference between total and 2-axle, 4-tire trucks. These gallons were distributed as follows based on data from the 1987 TIUS Public Use Tape: 19.4% of fuel assumed to be gasoline, 80.4% diesel, and 0.2% lpg.

Off Highway

Data supplied by Marianne Mintz, Argonne National Laboratory, from the Public Use Data Base, National Energy Accounts, DOC, OBA-NEA-10, August 1988.

Non-Highway

Air

General Aviation:
DOT, FAA, General Aviation Activity and Avionics Survey: Annual Summary Report Calendar Year 1991, Table 5.1. Jet fuel was converted from gallons to Btu using 135,000 Btu/gallon (kerosene-type jet fuel).

Domestic and International Air Carrier:
DOT, Research and Special Programs Administration, Data Administration Division, "Fuel Cost and Consumption Tables;" annual figures were obtained by summing monthly totals. Because the data for international included fuel purchased abroad, the international total was divided in half to estimate domestic fuel purchases for international flights.

Water

Freight:
Total - DOE, EIA, Fuel Oil and Kerosene Sales, 1991, Table 23. Adjusted sales of distillate and residual fuel oil for vessel bunkering.

Domestic and Foreign - Total freight energy use was distributed as follows:
Distillate fuel - 77.5% domestic, 22.5% foreign
Residual fuel - 9.3% domestic, 90.7% foreign
Percentages were derived from the DOC, U.S. Foreign Trade, Bunker Fuels, "Oil and Coal Laden in the U.S. on Vessels Engaged in Foreign Trade," 1988. This report was discontinued in 1989.

Recreational Boating:

Fuel use by recreational boating was calculated using the methodology developed by D. L. Greene in the report, Off-Highway Use of Gasoline in the United States (DOT, FHWA, July 1986, p. 3-22). Results from Model 1 in the report indicated an average annual consumption of 205 gallons per boat. Total consumption in gallons was then calculated using the following equation: Total = 0.95 (Gal/boat) (number of boats). An estimate of number of recreational boats in operation was found in Boating Industry Magazine, Annual Report, "The Boating Business 1991" (Communication Channels, Inc., Chicago, IL). The total was the sum of inboard, outboard and inboard/outdrive boats.

Pipeline

Natural Gas:

The amount of natural gas used to transport natural gas was defined as "pipeline fuel" as reported in DOE, EIA, Natural Gas Annual 1991, Table 1. Cubic feet were converted to Btu using 1,031 Btu/ft^3. Electricity use was estimated using the following procedure as reported on p. 5-110 of J. N. Hooker et al., End Use Energy Consumption DataBase: Transportation Sector. The energy consumption of a natural gas pipeline was taken to be the energy content of the fuel used to drive the pumps. Some 94% of the installed pumping horsepower was supplied by natural gas. The remaining 6% of the horse power was generated more efficiently, mostly by electric motors. The energy consumed by natural gas pipeline pumps that were electrically powered was not known. In order to estimate the electricity consumed, the Btu of natural gas pipeline fuel consumed was multiplied by a factor of 0.015. From this computed value, electricity efficiency and generation loss must be taken into account. The electricity energy use in Btu must be converted to kWhr, using the conversion factor 29.305 x 10^{-5} kWhr/Btu. Electricity generation and distribution efficiency was 29%. When generation and distribution efficiency are taken into account, 1 kWhr equals 11,765 Btu.

Crude petroleum and petroleum product:

J. N. Hooker, Oil Pipeline Energy Consumption and Efficiency, ORNL-5697, ORNL, Oak Ridge, TN, 1981. (Latest available data.)

Coal slurry and water:

W. F. Banks, Systems, Science and Software, Energy Consumption in the Pipeline Industry, LaJolla, CA, October 1977. (Latest available data.)

Rail

Total:

DOE, EIA, Fuel Oil and Kerosene Sales, 1991, Table 23. Adjusted sales of deliveries of distillate fuel oil for railroad.

Freight:

Distillate fuel oil was obtained by subtracting total passenger fuel use from total distillate as reported by EIA.

Passenger:

Transit and Commuter - APTA, 1993 Transit Fact Book, November 1993, Washington, DC, p. 100-101. Transit was defined as the sum of "heavy rail," "light rail," and "other."

Intercity - Sum of fuel used by Amtrak and Class I passenger trains. Source for Amtrak was personal communication with the Corporate Accounting Office of Amtrak, Washington, DC. Source for fuel use by Class I passenger trains was the AAR, Statistics of Class I Railroads 1991, July 1992, p. 157. Fuel use for Class I passenger was derived as follows: fuel use for passenger locomotive, including weighted percent of fuel for yard switching. Diesel fuel consumed by work train was not included as it was considered to be indirect energy.

Military Operations

Defense Logistics Agency, Defense Fuel Supply Center, Fact Book Fiscal Year 1991, "Barrels and Dollars per Barrel," p. 33. For conversion purposes, estimates of jet fuel purchases were 50% JP4, 25% JP5, and 19% JP8 and 6% other, based on the breakdown from "Petroleum Procurement," p. 31. The purchases were the best estimates available for fuel consumption, both domestic and abroad. An estimate of 88.9% was purchased in the United States.

Table 2.7
Domestic Consumption of Transportation Energy by Mode and Fuel Type, 1992

Most of the source data were given in gallons. It was converted to Btu by using the conversion factors in Appendix B.

Highway

Automobiles

Total gallons of fuel taken from DOT, FHWA, Highway Statistics 1992, Table VM-1. These were distributed as follows: 97.8% gasoline, 1.0% gasohol, and 1.2% diesel. Percentages were derived from the DOE, EIA, Office of Markets and End Use, Energy End Use Division, Household Vehicles Energy Consumption 1991, December 1993, p. 46.

Motorcycles

DOT, FHWA, Highway Statistics 1992, Table VM-1. For conversion purposes, fuel for all motorcycles was assumed to be gasoline.

Buses

Transit:

Diesel: APTA, 1993 Transit Fact Book, November 1993, Washington, DC, p. 100.
Gasoline: Total gallons of "other" fuel used by transit vehicles taken from APTA, 1993 Transit Fact Book, November 1993, Washington, DC, p. 100. According to APTA's Research and Statistics Department, motor bus gasoline use accounts for approximately 5% of this category.
Electricity: APTA, 1993 Transit Fact Book, November 1993, Washington, DC, p.101.
Natural gas: APTA, 1993 Transit Fact Book, November 1993, Washington, DC, p.101. Pounds of compressed natural gas were converted to Btu.

Intercity:

1991 estimate provided by Frank Smith, Eno Transportation Foundation , Washington, DC. Data for 1992 are not yet available.

School:

1991 estimate provided by Frank Smith, Eno Foundation for Transportation, Washington, DC. Data for 1992 are not yet available.

Trucks

Total:

Sum of light trucks and other trucks.

Light Trucks:

DOT, FHWA, Highway Statistics 1992, Table VM-1, for single-unit, 2-axle, 4-tire trucks. 96.6% of fuel assumed to be gasoline, 3.3% diesel, and 0.1% lpg; percentages were generated from the 1987 TIUS Public Use Tape.

Other Trucks:

DOT, FHWA, Highway Statistics 1992, Table VM-1. Total gallons for other trucks was the difference between total and 2-axle, 4-tire trucks. These gallons were distributed as follows based on data from the 1987 TIUS Public Use Tape: 19.4% of fuel assumed to be gasoline, 80.4% diesel, and 0.2% lpg.

Off Highway

Data supplied by Marianne Mintz, Argonne National Laboratory, from the Public Use Data Base, National Energy Accounts, DOC, OBA-NEA-10, August 1988.

Non-Highway

Air

General Aviation:

DOT, FAA, General Aviation Activity and Avionics Survey: Annual Summary Report Calendar Year 1992, Table 5.1. Jet fuel was converted from gallons to Btu using 135,000 Btu/gallon (kerosene-type jet fuel).

Domestic and International Air Carrier:

DOT, Research and Special Programs Administration, Data Administration Division, "Fuel Cost and Consumption Tables;" annual figures were obtained by summing monthly totals. Because the data for international included fuel purchased abroad, the international total was divided in half to estimate domestic fuel purchases for international flights.

Water

Freight:

Total - DOE, EIA, Fuel Oil and Kerosene Sales, 1992, Table 23. Adjusted sales of distillate and residual fuel oil for vessel bunkering.

Domestic and Foreign - Total freight energy use was distributed as follows:
Distillate fuel - 77.5% domestic, 22.5% foreign
Residual fuel - 9.3% domestic, 90.7% foreign
Percentages were derived from the DOC, U.S. Foreign Trade, Bunker Fuels, "Oil and Coal Laden in the U.S. on Vessels Engaged in Foreign Trade," 1988. This report was discontinued in 1989.

Recreational Boating:

Fuel use by recreational boating was calculated using the methodology developed by D. L. Greene in the report, Off-Highway Use of Gasoline in the United States (DOT, FHWA, July 1986, p. 3-22). Results from Model 1 in the report indicated an average annual consumption of 205 gallons per boat. Total consumption in gallons was then calculated using the following equation: Total = 0.95 (Gal/boat) (number of boats). An estimate of number of recreational boats in operation was found in Boating Industry Magazine, Annual Report, "The Boating Business 1992" (Communication Channels, Inc., Chicago, IL). The total was the sum of inboard, outboard and inboard/outdrive boats.

Pipeline

Natural Gas:

The amount of natural gas used to transport natural gas was defined as "pipeline fuel" as reported in DOE, EIA, Natural Gas Annual 1992, Table 1. Cubic feet were converted to Btu using 1,031 Btu/ft^3. Electricity use was estimated using the following procedure as reported on p. 5-110 of J. N. Hooker et al., End Use Energy Consumption DataBase: Transportation Sector. The energy consumption of a natural gas pipeline was taken to be the energy content of the fuel used to drive the pumps. Some 94% of the installed pumping horsepower was supplied by natural gas. The remaining 6% of the horse power was generated more efficiently, mostly by electric motors. The energy consumed by natural gas pipeline pumps that were electrically powered was not known. In order to estimate the electricity consumed, the Btu of natural gas pipeline fuel consumed was multiplied by a factor of 0.015. From this computed value, electricity efficiency and generation loss must be taken into account. The electricity energy use in Btu must be converted to kWhr, using the conversion factor 29.305 x 10^{-5} kWhr/Btu. Electricity generation and distribution efficiency was 29%. When generation and distribution efficiency are taken into account, 1 kWhr equals 11,765 Btu.

Crude petroleum and petroleum product:

J. N. Hooker, Oil Pipeline Energy Consumption and Efficiency, ORNL-5697, ORNL, Oak Ridge, TN, 1981. (Latest available data.)

Coal slurry and water:

W. F. Banks, Systems, Science and Software, Energy Consumption in the Pipeline Industry, LaJolla, CA, October 1977. (Latest available data.)

Rail

Total:

DOE, EIA, Fuel Oil and Kerosene Sales, 1992, Table 23. Adjusted sales of deliveries of distillate fuel oil for railroad.

Freight:

Distillate fuel oil was obtained by subtracting total passenger fuel use from total distillate as reported by EIA.

Passenger:

Transit and Commuter - APTA, 1993 Transit Fact Book, November 1993, Washington, DC, p. 100-101. Transit was defined as the sum of "heavy rail," "light rail," and "other."

Intercity - Sum of fuel used by Amtrak and Class I passenger trains. Source for Amtrak was personal communication with the Corporate Accounting Office of Amtrak, Washington, DC. Source for fuel use by Class I passenger trains was the AAR, Statistics of Class I Railroads 1992, July 1993, Items 747-750. Fuel use for Class I passenger was derived as follows: fuel use for passenger locomotive, including weighted percent of fuel for yard switching. Diesel fuel consumed by work train was not included as it was considered to be indirect energy.

Military Operations

Defense Logistics Agency, Defense Fuel Supply Center, Fact Book Fiscal Year 1992, "Barrels and Dollars per Barrel," p. 29. For conversion purposes, estimates of jet fuel purchases were 47% naphtha-based fuel and 53% kerosene-based fuel, according to the breakdown from "Petroleum Procurement," p. 27. The purchases were the best estimates available for fuel consumption, both domestic and abroad. An estimate of 68.9% was purchased in the United States.

Table 2.10
Transportation Energy Consumption by Mode, 1970-92

Highway

Automobiles

Total gallons of fuel for automobiles was taken from DOT, FHWA, Highway Statistics Summary to 1985, Table VM-201A; and Table VM-1 in the 1986-92 annual editions. Fuel for automobiles was distributed between fuel types for conversion into Btu's as follows:

1970-80 - 94.7% gasoline, 5.3% diesel as reported in the DOE, EIA, Office of Energy Markets and End Use, Residential Energy Consumption Survey: Consumption Patterns of Household Vehicles, June 1979 to December 1980, p. 10.

1981-82 - 94.1% gasoline, 5.9% diesel as reported in the DOE, EIA, Office of Energy Markets and End Use, Residential Energy Consumption Survey: Consumption Patterns of Household Vehicles, Supplement: January 1981 to September 1981, pp. 11, 13.

1983-84 - 97.5% gasoline, 2.5% diesel as reported in the DOE, EIA, Office of Markets and End Use, Energy End Use Division, Residential Transportation Energy Consumption Survey: Consumption Patterns of Household Vehicles, 1983, Jan., 1985, pp. 7, 9.

1985-87 - 98.5% gasoline, 1.5% diesel as reported in the DOE, EIA, Office of Energy Markets and End Use, Residential Transportation Energy Consumption Survey: Consumption Patterns of Household Vehicles 1985, April 1987, pp. 25, 27.

1988-90 - 98.8% gasoline and 1.2% diesel as reported in the DOE, EIA, Office of Markets and End Use, Energy End Use Division, Household Vehicles Energy Consumption 1988, March 1990, p. 65.

1991-92 - 97.8% gasoline, 1.0% gasohol, and 1.2% diesel as reported in the DOE, EIA, Office of Markets and End Use, Energy End Use Division, Household Vehicles Energy Consumption 1991, December 1993, p. 46.

Motorcycles

Department of Transportation, Federal Highway Administration, Highway Statistics Summary to 1985, Table VM-201A; and Table VM-1 in the 1986-92 annual editions. For conversion purposes, fuel for all motorcycles was assumed to be gasoline.

Buses

Sum of transit, intercity and school.

Transit:

Diesel - APTA, 1993 Transit Fact Book, November 1993, Washington, DC, p. 100, and annual.

Gasoline - Total gallons of gasoline used by transit vehicles taken from APTA, 1993 Transit Fact Book, November 1993, Washington, DC, p. 100. According to APTA's Research and Statistics Department, motor bus gasoline use accounts for approximately 5% of this category.

Electricity - APTA, 1993 Transit Fact Book, November 1993, Washington, DC, p.101.

Natural gas - APTA, 1993 Transit Fact Book, November 1993, Washington, DC, p.101. Pounds of compressed natural gas were converted to Btu.

Intercity:

1970-84 - American Bus Association, Annual Report, Washington, DC, annual.

1985-86 - Eno Transportation Foundation, Transportation in America, Seventh edition, Washington, DC, p. 9.

1987-91 - Personal communication with Frank Smith, Eno Transportation Foundation, Washington, DC. Data for 1992 are not yet available.

School:

1970-84 - DOT, FHWA, Highway Statistics 1984, Washington, DC, Table VM-1, and annual.

1985-86 - DOT, Research and Special Programs Administration, National Transportation Statistics, Figure 2, p. 5, and annual.

1987-91 - Personal communication with Frank Smith, Eno Transportation Foundation, Washington, DC. Data for 1992 are not yet available.

Trucks

Light Trucks:

Defined as 2-axle, 4-tire trucks. Total gallons of fuel was taken from DOT, FHWA, Highway Statistics Summary to 1985, Table VM-201A, and Table VM-1 of the 1986-92 annual editions. Based on data from the 1982 TIUS Public Use Tape, fuel use for 1970-1987 was distributed among fuel types as follows: 95.3% gasoline; 3.5% diesel; and 1.2% lpg. Fuel use for 1990 was distributed based on the 1987 TIUS: 96.6% gasoline; 3.3% diesel; and 0.1% lpg.

Other Trucks:

Defined as the difference between total trucks and 2-axle, 4-tire trucks. Total gallons of fuel was taken from DOT, FHWA, Highway Statistics Summary to 1985, Table VM-201A, and Table VM-1 of the 1986-92 annual editions. Based on data from the 1982 TIUS Public Use Tape, fuel use for 1970-1987 was distributed among fuel types as follows: 39.6% gasoline; 59.4% diesel; and 1.0% lpg. Fuel use for 1988-90 was distributed based on the 1987 TIUS: 19.4% gasoline; 80.4% diesel; and 0.2% lpg.

Total Highway

Sum of autos, motorcycles, buses, light trucks, and other trucks.

Non-Highway

Air

Sum of fuel use by General Aviation and Certificated Route Air Carrier.

General Aviation:

1970-74 - DOT, TSC, National Transportation Statistics, Cambridge, MA, 1981.
1975-85 - DOT, FAA, FAA Aviation Forecasts, Washington, DC, annual.
1985-92 - DOT, FAA, General Aviation Activity and Avionics Survey: Annual Summary Report, Calendar Year 1992, Table 5.1. Jet fuel was converted from gallons to Btu using 135,000 Btu/gallon (kerosene-type jet fuel).

Certificated Route Air Carrier:

1970-81 - DOT, Civil Aeronautics Board, Fuel Cost and Consumption, Washington, DC, annual.
1982-92 - DOT, Research and Special Programs Administration, Data Administration Division, "Fuel Cost and Consumption Tables;" annual figures were obtained by summing monthly totals. Because the data for international included fuel purchased abroad, the international total was divided in half to estimate domestic fuel purchases for international flights.

Water

Sum of vessel bunkering fuel (i.e., freight) and fuel used by recreational boats.

Freight:

Total - DOE, EIA, Fuel Oil and Kerosene Sales, 1992, Table 23. Adjusted sales of distillate and residual fuel oil for vessel bunkering.
Domestic and Foreign - 1970-88 - DOC, U.S. Foreign Trade, Bunker Fuels, "Oil and Coal Laden in the U.S. on Vessels Engaged in Foreign Trade," 1988, annual. In this were fuel oil (i.e., residual) and diesel oil laden in the U.S. on vessels engaged in foreign trade. The totals for residual and diesel used by foreign vessels and American vessels for foreign trade were subtracted from the EIA totals for residual and diesel deliveries to obtain the value for domestic trade.
1989-92 - Total freight energy use was distributed as follows:
Distillate fuel - 77.5% domestic, 22.5% foreign
Residual fuel - 9.3% domestic, 90.7% foreign

Percentages were derived from the DOC, U.S. Foreign Trade, Bunker Fuels, "Oil and Coal Laden in the U.S. on Vessels Engaged in Foreign Trade," 1988. This report was discontinued in 1989.

Recreational Boating:

1970-1984 - DOT, FHWA, Highway Statistics, Washington, DC, Table MF-24, annual.

1985-1992 - Fuel use by recreational boating was calculated using the methodology developed by D. L. Greene in the report, Off-Highway Use of Gasoline in the United States (DOT, FHWA, July 1986, p. 3-22). Results from Model 1 in the report indicated an average annual consumption of 205 gallons per boat. Total consumption in gallons was then calculated using the following equation: Total = 0.95 (Gal/boat) (number of boats). An estimate of number of recreational boats in operation was found in Boating Industry Magazine, Annual Report, "The Boating Business 1992" (Communication Channels, Inc., Chicago, IL) and annual. The total was the sum of inboard, outboard and inboard/outdrive boats.

Pipeline

Natural Gas:

The amount of natural gas used to transport natural gas was defined as "pipeline fuel" as reported in DOE, EIA, Natural Gas Annual 1990, Table 1. Cubic feet were converted to Btu using 1,031 Btu/ft^3. Electricity use was estimated using the following procedure as reported on p. 5-110 of J. N. Hooker et al., End Use Energy Consumption DataBase: Transportation Sector. The energy consumption of a natural gas pipeline was taken to be the energy content of the fuel used to drive the pumps. Some 94% of the installed pumping horsepower was supplied by natural gas. The remaining 6% of the horse power was generated more efficiently, mostly by electric motors. The energy consumed by natural gas pipeline pumps that were electrically powered was not known. In order to estimate the electricity consumed, the Btu of natural gas pipeline fuel consumed was multiplied by a factor of 0.015. From this computed value, electricity efficiency and generation loss must be taken into account. The electricity energy use in Btu must be converted to kWhr, using the conversion factor 29.305 x 10^{-5} kWhr/Btu. Electricity generation and distribution efficiency was 29%. When generation and distribution efficiency are taken into account, 1 kWhr equals 11,765 Btu.

Crude petroleum and petroleum product:

J. N. Hooker, Oil Pipeline Energy Consumption and Efficiency, ORNL-5697, ORNL, Oak Ridge, Tennessee, 1981. (Latest available data.)

Coal slurry and water:

W. F. Banks, Systems, Science and Software, Energy Consumption in the Pipeline Industry, LaJolla, California, October 1977. (Latest available data.)

Rail

Total:

DOE, EIA, Fuel Oil and Kerosene Sales, 1992, Table 23, and annual. Adjusted sales of distillate fuel oil for railroad.

Freight:

Distillate fuel oil was obtained by subtracting total passenger fuel use from total distillate as reported by EIA.

Passenger:

Transit and Commuter - APTA, 1993 Transit Fact Book, November 1993, Washington, DC, p. 100, annual. Transit was defined as the sum of "heavy rail," "light rail," and "other."

Intercity - Sum of fuel used by Amtrak and Class I passenger trains. Source for Amtrak was personal communication with the Corporate Accounting Office of Amtrak, Washington, DC. Source for fuel use by Class I passenger trains was the AAR, Statistics of Class I Railroads 1992, July 1993, Items 747-750, and annual. Fuel use for Class I passenger was derived as follows: fuel use for passenger locomotive, including weighted percent of fuel for yard switching. Diesel fuel consumed by work train was not included as it was considered to be indirect energy.

Table 2.12
Passenger Travel and Energy Use in the United States, 1991

Highway

Automobiles

Number of Vehicles - DOT, FHWA, Highway Statistics 1992, Table VM-1.
Vmt - DOT, FHWA, Highway Statistics 1992, Table VM-1.
Pmt - Calculated by ORNL (load factor times vmt).
Load Factor - DOT, FHWA, Office of Highway Information Management, 1990 NPTS, Public Use Tape, 1992.
Energy Use - Total gallons of fuel taken from DOT, FHWA, Highway Statistics 1992, Table VM-1. These were distributed as follows: 97.8% gasoline, 1.0% gasohol, and 1.2% diesel. Percentages were derived from the DOE, EIA, Office of Markets and End Use, Energy End Use Division, Household Vehicles Energy Consumption 1991, December 1993, p. 46.

Personal Trucks

Number of Vehicles - Based on the 1987 TIUS, 68.6% of total 2-axle, 4-tire trucks and 11.1% of total other trucks were for personal use. Therefore, 68.6% of total 2-axle, 4-tire trucks (as reported by DOT, FHWA in Highway Statistics 1992, Table VM-1) and 11.1% of total other trucks were estimated to be for personal use.
Vmt - 62.7% of total vehicle miles traveled by 2-axle, 4-tire trucks (as reported by DOT, FHWA in Highway Statistics 1992, Table VM-1) and 2.3% of total vehicle miles traveled by other trucks were for personal use. The percentages were derived by ORNL from the 1987 TIUS public use tape.
Pmt - Calculated by ORNL as vmt multiplied by load factor.
Load Factor - DOT, FHWA, Office of Highway Information Management, 1990 NPTS, Public Use Tape, 1992.
Energy Use - Assuming that there is no difference in fuel economy (measured in miles per gallon) between personal-use trucks and non-personal use trucks, 62.7% of total fuel consumption by 2-axle, 4-tire trucks (as reported by DOT, FHWA in Highway Statistics 1992, Table VM-1, p. 192) and 2.3% of total other truck fuel consumption was for personal use. These percentages were derived by ORNL from the 1987 TIUS Public Use tape. Total truck energy use was the sum of light truck and other truck energy use.

Light Trucks: DOT, FHWA, Highway Statistics 1992, Table VM-1, for single-unit, 2-axle, 4-tire trucks. 96.6% of fuel assumed to be gasoline, 3.3% diesel, and 0.1% lpg; percentages were generated from the 1987 TIUS Public Use Tape.

Other Trucks: DOT, FHWA, Highway Statistics 1992, Table VM-1.
Total gallons for other trucks was the difference between total and 2-axle, 4-tire trucks. These values were distributed based on data from the 1987 TIUS Public Use Tape: 19.4% of fuel assumed to be gasoline, 80.4% diesel, and 0.2% lpg.

Motorcycles

Number of Vehicles and Vmt - DOT, FHWA, Highway Statistics 1992, Table VM-1.
Pmt - Calculated by ORNL as vmt multiplied by load factor.
Load Factor - DOT, FHWA, Office of Highway Information Management, 1990 NPTS, Publlic Use Tape, 1992.
Energy Use - DOT, FHWA, Highway Statistics 1992, Table VM-1. For conversion purposes, fuel for all motorcycles was assumed to be gasoline.

Buses

Transit:

Number of Vehicles, Vmt, Pmt, and Energy Use - Motor bus only. APTA, 1992 Transit Fact Book, October 1992, Washington, DC, pp. 26-28.
Load Factor - Calculated by ORNL as pmt/vmt.

Intercity:

Number of Vehicles - Estimated by ORNL as 18% of commercial bus registrations, DOT, FHWA, Highway Statistics 1991, p. 20.
Pmt - Eno Transportation Foundation, Transportation in America, Eleventh Edition, Washington, DC, 1993, p. 47.
Vmt - Estimated using passenger travel and an average load factor of 23.2 persons/vehicle.
Load Factor -Estimated as 23.2 based on historical data.
Energy Use - Personal communication with Frank Smith, Eno Transportation Foundation, Washington, DC.

School:

Number of Vehicles - School and other nonrevenue as reported in DOT, FHWA, Highway Statistics 1991, p. 20.
Energy Use - Personal communication with Frank Smith, Eno Transportation Foundation, Washington, DC.
Load Factor - Calculated by ORNL as pmt/vmt.
Vmt, Pmt - National Safety Council, Accident Facts, 1992 Edition, Chicago, IL, pp. 70-71.

Non-Highway

Air

Large Certified Route Air Carriers:

Vmt - Revenue aircraft miles flown, DOT, FAA, FAA Statistical Handbook of Aviation Calendar Year 1991, p. 6-4.

Pmt - Revenue pmt of domestic operations, scheduled and unscheduled, DOT, FAA, FAA Statistical Handbook of Aviation Calendar Year 1990, p. 6-4.

Load Factor - Calculated by ORNL as pmt/vmt.

Energy Use - DOT, Research and Special Programs Administration, Data Administration Division, "Fuel Cost and Consumption Tables;" annual figures were obtained by summing monthly totals. Because the data for international included fuel purchased abroad, the international total was divided by two to estimate domestic fuel purchases for international flights.

General Aviation:

Number of Vehicles, Vmt, Energy Use - DOT, FAA, General Aviation Activity and Avionics, Survey: Calendar Year 1991, pp. 2-8, 3-11, 5-7.

Pmt - Eno Transportation Foundation, Transportation in America, Eleventh Edition, Washington, DC, 1993, p. 47.

Load Factor - Calculated by ORNL as pmt/vmt.

Recreational Boating

Number of Vehicles - Whitney Communications, Boating Industry Magazine, Annual Report, "The Boating Business 1991." The total was the sum of inboard, outboard, and inboard/outdrive boats.

Energy Use - Fuel use by recreational boating was calculated using the methodology developed by D. L. Greene in the report, Off-Highway Use of Gasoline in the United States (DOT, FHWA, July 1986, p. 3-22). Results from Model 1 in the report indicated an average annual consumption of 205 gallons per boat. Total consumption in gallons was then calculated using the following equation: Total = 0.95 (Gal/boat) (number of boats). An estimate of number of recreational boats in operation was found in Boating Industry Magazine, Annual Report, "The Boating Business 1991" (Communication Channels, Inc., Chicago, IL). The total was the sum of inboard, outboard and inboard/outdrive boats.

Rail

Intercity:

Number of Vehicles, Vmt and Pmt - Personal communication with the Corporate Accounting Office of Amtrak, Washington, DC.

Load Factor - Calculated by ORNL as pmt/vmt.

Energy Use - Personal communication with the Accounting Division of Amtrak, Washington, DC.

Transit and Commuter:

Number of Vehicles, Vmt and Pmt - APTA, 1993 Transit Fact Book, November 1993, Washington, DC, pp. 26-28.

Load Factor - Calculated by ORNL as pmt/vmt.

Energy Use - APTA, 1993 Transit Fact Book, November 1993, Washington, DC, p. 100-101. Transit was defined as the sum of "heavy rail," "light rail," and "other."

Table 2.13
Intercity Freight Movement and Energy Use in the United States, 1991

Highway

Trucks

Vehicles - 7.5% of total 2-axle, 4-tire trucks (as reported by DOT, FHWA in Highway Statistics 1992, Table VM-1) and 22.1% of total other trucks were engaged in intercity freight movement. These percentages were derived by ORNL from the 1987 TIUS public use tape.

Vmt - 13.7% of total vehicle miles traveled by 2-axle, 4-tire trucks (as reported by DOT, FHWA in Highway Statistics 1992, Table VM-1) and 50.2% of total vehicle miles traveled by other trucks were used in intercity freight movement. These percentages were derived by ORNL from the 1987 TIUS public use tape.

Ton Miles, Tons Shipped and Average Length of Haul - Eno Transportation Foundation, Transportation in America, Eleventh edition, Washington, DC, 1993, pp. 44, 46, 71.

Energy Intensity - Energy use divided by ton-miles.

Energy Use - 16% of total fuel consumption by 2-axle, 4-tire trucks (as reported by DOT, FHWA in Highway Statistics 1992, Table VM-1) and 53.2% of total other truck fuel consumption were used in intercity freight movement. These percentages were derived by ORNL from the 1987 TIUS public use tape.

Non-Highway

Waterborne Commerce

Vehicles - U.S. Department of the Army, Army Corps of Engineers, "Summary of U.S. Flag Passenger and Cargo Vessels, 1992," New Orleans, LA, 1993.

Ton Miles, Tons Shipped, and Average Length of Haul - U.S. Department of the Army, Corps of Engineers, Waterborne Commerce of the United States, Calendar Year 1990, Part 5: National Summaries, New Orleans, LA, 1993, pp. 1-6, 1-7.

Energy Intensity - Energy use divided by ton miles.

Energy Use - DOE, EIA, Fuel Oil and Kerosene Sales, 1991, Table 23. Adjusted sales of distillate and residual fuel oil for vessel bunkering.
Domestic freight energy use was calculated as:
Distillate fuel - 77.5% domestic, 22.5% foreign
Residual fuel - 9.3% domestic, 90.7% foreign

Percentages were derived from the DOC, U.S. Foreign Trade, Bunker Fuels, "Oil and Coal Laden in the U.S. on Vessels Engaged in Foreign Trade," 1988. This report was discontinued in 1989.

Pipeline

Natural Gas:

Tons shipped - DOE, EIA, Natural Gas Annual 1991, Washington, DC, 1992, Table 1. Total natural gas disposition divided by 44,870 ft^3/ton.

Energy use - The amount of natural gas used to transport natural gas was defined as "pipeline fuel" as reported in DOE, EIA, Natural Gas Annual 1991, Table 1. Cubic feet were converted to Btu using 1,031 Btu/ft^3. Electricity use was estimated using the following procedure as reported on p. 5-110 of J. N. Hooker et al., End Use Energy Consumption DataBase: Transportation Sector. The energy consumption of a natural gas pipeline was taken to be the energy content of the fuel used to drive the pumps. Some 94% of the installed pumping horsepower was supplied by natural gas. The remaining 6% of the horse power was generated more efficiently, mostly by electric motors. The energy consumed by natural gas pipeline pumps that were electrically powered was not known. In order to estimate the electricity consumed, the Btu of natural gas pipeline fuel consumed was multiplied by a factor of 0.015. From this computed value, electricity efficiency and generation loss must be taken into account. The electricity energy use in Btu must be converted to kWhr, using the conversion factor 29.305 x 10^{-5} kWhr/Btu. Electricity generation and distribution efficiency was 29%. When generation and distribution efficiency are taken into account, 1 kWhr equals 11,765 Btu.

Crude Oil and Petroleum Product:

Ton Miles and Tons Shipped - Eno Transportation Foundation, Transportation in America, Eleventh edition, Washington, DC, 1993, pp. 44, 46.

Coal Slurry - Ton Miles, Tons Shipped, and Average Length of Haul: DOT, Transport of Solid Commodities via Freight Pipelines, Freight Pipeline Technology, Vol. 11, Washington, DC, 1976, p. 6.

Energy Use - W. F. Banks, Systems, Science, and Software, Inc., Energy Consumption in the Pipeline Industry, LaJolla, CA, 1977.

Rail

Vehicles, Vmt, Ton Miles, Average Length of Haul - AAR, Railroad Facts, 1992 Edition, Washington, DC, September 1992, pp. 27, 34, 36, 50.
Tons shipped - AAR, Analysis of Class I Railroads 1991, July 1992, p. 109.
Energy Use - Distillate fuel oil was obtained by subtracting total passenger fuel use from total distillate as reported by EIA.

Total - DOE, EIA, Fuel Oil and Kerosene Sales, 1990, p. 42. Adjusted sales of distillate fuel oil for railroad.

Passenger - Transit and Commuter - APTA, 1993 Transit Fact Book, November 1993, Washington, DC, p. 100. Transit was defined as the sum of "heavy rail," "light rail," and "other."

Intercity - Sum of fuel used by Amtrak and Class I passenger trains. Source for Amtrak was personal communication with the Accounting Division of Amtrak, Washington, DC. Source for fuel use by Class I passenger trains was the AAR, Analysis of Class I Railroads 1991, July 1992, Items 747-750. Fuel use for Class I passenger was derived as follows: fuel use for passenger locomotive, including weighted percent of fuel for yard switching. Diesel fuel consumed by work train was not included as it was considered to be indirect energy.

Table 2.14
Energy Intensities of Passenger Modes, 1970-91

In reference to transportation, the energy intensity of a mode is the ratio of the energy inputs to a process to a measure of the useful outputs from that process; for example, Btu per pmt or Btu per ton-mile. The energy intensity ratios were calculated for each passenger mode using the following data sources:

Highway

Automobiles

Vmt - DOT, FHWA, Highway Statistics Summary to 1985, Table VM-201A, and Table VM-1 of the 1987-91 editions.
Pmt - vmt times load factor.
Energy Use - Total gallons of fuel for automobiles was taken from DOT, FHWA, Highway Statistics Summary to 1985, Table VM-201A; and Table VM-1 in the 1986-90 annual editions. Fuel for automobiles was distributed between fuel types for conversion into Btu's as follows:

1970-80 - 94.7% gasoline, 5.3% diesel as reported in the DOE, EIA, Office of Energy Markets and End Use, Residential Energy Consumption Survey: Consumption Patterns of Household Vehicles, June 1979 to December 1980, p. 10.
1981-82 - 94.1% gasoline, 5.9% diesel as reported in the DOE, EIA, Office of Energy Markets and End Use, Residential Energy Consumption Survey: Consumption Patterns of Household Vehicles, Supplement: January 1981 to September 1981, pp. 11, 13.
1983-84 - 97.5% gasoline, 2.5% diesel as reported in the DOE, EIA, Office of Markets and End Use, Energy End Use Division, Residential Transportation Energy Consumption Survey: Consumption Patterns of Household Vehicles, 1983, Jan., 1985, pp. 7, 9.
1985-87 - 98.5% gasoline, 1.5% diesel as reported in the DOE, EIA, Office of Energy Markets and End Use, Residential Transportation Energy Consumption Survey: Consumption Patterns of Household Vehicles 1985, April 1987, pp. 25, 27.
1988-90 - 98.8% gasoline and 1.2% diesel as reported in the DOE, EIA, Office of Markets and End Use, Energy End Use Division, Household Vehicles Energy Consumption 1988, March 1990, p. 65.
1991-92 - 97.8% gasoline, 1.0% gasohol, and 1.2% diesel as reported in the DOE, EIA, Office of Markets and End Use, Energy End Use Division, Household Vehicles Energy Consumption 1991, December 1993, p. 46.

Buses

Transit:

Vmt and Pmt - APTA, 1993 Transit Fact Book, November 1993, Washington, DC, pp. 26-28 and annual.

Energy Use - APTA, 1993 Transit Fact Book, November 1993, Washington, DC, pp. 100-101, and annual.

Intercity:

Pmt - 1970-84 - American Bus Association, Annual Report, Washington, DC, annual.

1985-91 - Eno Transportation Foundation, Transportation in America, Eleventh edition, Washington, DC, 1993, p. 47.

Energy Use - 1970-1984 - American Bus Association, Annual Report, Washington, DC, annual.

1985-86 - Eno Transportation Foundation, Transportation in America, Seventh edition, Washington, DC, p. 9.

1987-91 - Personal communication with Frank Smith, Eno Transportation Foundation, Washington, DC.

School:

Vmt - 1970-84 - DOT, FHWA, Highway Statistics 1984,Washington, DC, Table VM-1, p. 175, and annual.

1985-87 - DOT, TSC, National Transportation Statistics, 1989, Figure 2, p. 7, and annual.

1988-91 - National Safety Council, Accident Facts, 1992 Edition , Chicago, IL, p. 71, and annual.

Energy Use - 1970-1984 - DOT, FHWA, Highway Statistics 1984, Washington, DC, Table VM-1, and annual.

1985-86 - DOT, TSC, National Transportation Statistics, Figure 2, p. 5, and annual.

1987-91 - Personal communication with Frank Smith, Eno Transportation Foundation, Washington, DC.

Non-Highway

Air

Certificated Air Carriers:

Pmt - DOT, FAA, FAA Statistical Handbook of Aviation, Calendar Year 1991, Washington, DC, 1993, p. 6-4, and annual.

Energy Use - 1970-81 - DOT, Civil Aeronautics Board, Fuel Cost and Consumption, Washington, DC, annual.
1982-91 - DOT, Research and Special Programs Administration, Data Administration Division, "Fuel Cost and Consumption Tables;" annual figures were obtained by summing monthly totals. Because the data for international included fuel purchased abroad, the international total was divided in half to estimate domestic fuel purchases for international flights.

General Aviation:

Pmt - Eno Transportation Foundation, Transportation In America, Eleventh edition, Washington, DC, 1993, p.47.

Energy Use - 1970-74 - DOT, TSC, National Transportation Statistics, Cambridge, MA, 1981.
1975-85 - DOT, FAA, FAA Aviation Forecasts, Washington, DC, annual.
1985-91 - DOT, FAA, General Aviation Activity and Avionics Survey: Calendar Year 1991, Table 5.1. Jet fuel was converted from gallons to Btu using 135,000 Btu/gallon (kerosene-type jet fuel).

Rail

Passenger (Amtrak):

Pmt - 1971-83 - AAR, Statistics of Class I Railroads, Washington, DC, annual.
1984-88 - AAR, Railroad Facts, 1988 Edition, Washington, DC, December 1989, p. 61, and annual.
1989-91 - Personal communication with the Corporate Accounting Office of Amtrak.

Energy Use - Personal communication with the Corporate Accounting Office of Amtrak.

Transit:

Pmt - APTA, 1992 Transit Fact Book, October 1992, Washington, DC, p. 25.

Energy Use - *Transit and Commuter* - APTA, 1992 Transit Fact Book, October 1992, Washington, DC, pp. 100-101, annual. Transit was defined as the sum of "heavy rail," "light rail,"and "other."

Table 2.15
Energy Intensities of Freight Modes, 1970-91

In reference to transportation, the energy intensity of a mode is the ratio of the energy inputs to a process to a measure of the useful outputs from that process; for example, Btu per pmt or Btu per ton-mile. The energy intensity ratios were calculated for each freight mode using the following data sources:

Highway

Trucks

Vmt - DOT, FHWA, Highway Statistics Summary to 1985, Table VM-201A, and Table VM-1 of the 1987-92 editions. Light trucks were defined as 2-axle, 4-tire trucks. Other trucks were defined as the difference between total trucks and 2-axle, 4-tire trucks.

Energy Use - Light Trucks - Defined as 2-axle, 4-tire trucks. Total gallons of fuel was taken from DOT, FHWA, Highway Statistics Summary to 1985, Table VM-201A, and Table VM-1 of the 1986-92 annual editions. Based on data from the 1982 TIUS Public Use Tape, fuel use for 1970-1987 was distributed among fuel types as follows: 95.3% gasoline; 3.5% diesel; and 1.2% lpg. Fuel use for 1988-92 was distributed based on the 1987 TIUS: 96.6% gasoline; 3.3% diesel; and 0.1% lpg.

Other Trucks - Defined as the difference between total trucks and 2-axle, 4-tire trucks. Total gallons of fuel was taken from DOT, FHWA, Highway Statistics Summary to 1985, Table VM-201A, and Table VM-1 of the 1986-92 annual editions. Based on data from the 1982 TIUS Public Use Tape, fuel use for 1970-1987 was distributed among fuel types as follows: 39.6% gasoline; 59.4% diesel; and 1.0% lpg. Fuel use for 1988-92 was distributed based on the 1987 TIUS: 19.4% gasoline; 80.4% diesel; and 0.2% lpg.

Non-Highway

Water

Ton Miles - U.S. Department of the Army, Corps of Engineers, Waterborne Commerce of the United States, Calendar Year 1990, Part 5: National Summaries, New Orleans, LA, 1993, p. 1-6, and annual.

Energy Use - Calculated as the difference between total water freight energy use and foreign water freight energy use.

Total - DOE, EIA, Fuel Oil and Kerosene Sales, 1991, Table 23. Adjusted sales of distillate and residual fuel oil for vessel bunkering.

Domestic and Foreign - 1970-88 - DOC, U.S. Foreign Trade, Bunker Fuels,

"Oil and Coal Laden in the U.S. on Vessels Engaged in Foreign Trade," 1988, annual. In this were fuel oil (i.e., residual) and diesel oil laden in the U.S. on vessels engaged in foreign trade. The totals for residual and diesel used by foreign vessels and American vessels for foreign trade were subtracted from the EIA totals for residual and diesel deliveries to obtain the value for domestic trade.
1989-92 - Total freight energy use was distributed as follows:
Distillate fuel - 77.5% domestic, 22.5% foreign
Residual fuel - 9.3% domestic, 90.7% foreign
Percentages were derived from the DOC, U.S. Foreign Trade, Bunker Fuels, "Oil and Coal Laden in the U.S. on Vessels Engaged in Foreign Trade," 1988. This report was discontinued in 1989.

Rail

Freight Car Miles and Ton Miles - AAR, Railroad Facts, 1992 Edition, Washington, DC, September 1992, pp. 27, 36, and annual.

Energy Use - Distillate fuel oil was obtained by subtracting total passenger fuel use from total distillate as reported by EIA.

Total - DOE, EIA, Fuel Oil and Kerosene Sales, 1991, Table 23. Adjusted sales of distillate fuel oil for railroad.

Passenger - Transit and Commuter - APTA, 1993 Transit Fact Book, November 1993, Washington, DC, p. 100. Transit was defined as the sum of "heavy rail," "light rail," and "other."

Intercity - Sum of fuel used by Amtrak and Class I passenger trains. Source for Amtrak was personal communication with the Accounting Division of Amtrak, Washington, DC. Source for fuel use by Class I passenger trains was the AAR, Statistics of Class I Railroads 1991, July 1992, Items 747-750. Fuel use for Class I passenger was derived as follows: fuel use for passenger locomotive, including weighted percent of fuel for yard switching. Diesel fuel consumed by work train was not included as it was considered to be indirect energy.

Table 3.3
Vehicle Stock, New Sales and New Registrations in the United States, 1992 Calendar Year

Highway

Automobiles

Vehicle Stock:

The number of vehicles in use by EPA size class were derived as follows: Market Shares by EPA size class for new car sales from 1970-1975 were taken from the DOT, NHTSA, Automotive Characteristics Historical DataBase, Washington, DC. Market shares for the years 1976-1990 were found in Linda S. Williams and Patricia S. Hu, Highway Vehicle MPG and Market Shares Report: Model Year 1990, ORNL-6672, April 1991, Table 7 and draft report "Light-Duty Vehicle Summary: First Six Months of Sales Period 1992." These data were assumed to represent the number of cars registered in each size class for each year. These percentages were applied to the automobiles in operation for that year as reported by R. L. Polk and Company (FURTHER REPRODUCTION PROHIBITED) and summed to calculate the total mix for 1992. This method assumed that all vehicles, large and small, were scrapped at the same rate.

Sales:

Domestic, import, and total sales were from AAMA, Facts and Figures '93, p. 17. The domestic sales were distributed by size class according to the following percentages: Two seater, 0.3%; Minicompact, 0%; Subcompact, 20.4%; Compact 31.0%; Midsize, 29.3%; and Large, 18.9%. The import sales were distributed by size class according to the following percentages: Two-seater, 4.1%; Minicompact, 4.8%; Subcompact, 42.7%; Compact, 30.9%; Midsize, 17.2%; and Large, 0.3%. These percentages were derived from the ORNL Light-Duty Vehicle Market Shares Data System and were based on the first half of the 1992 sales period. Domestic-sponsored imports (captive imports) were included in the import figure only.

See Glossary for definition of Automobile Size Classifications.

Fleet

Fleets of ten or more:

Stock - E. J. Bobit (ed.), Bobit Publishing Company, 1993 Automotive Fleet Fact Book, Redondo Beach, CA, 1993, pp. 10, 16. Vehicle stock was equal to the sum of business fleets 25 or more, business fleets 10-24, individually leased, and "other" fleets. This number did not include all cars in Federal Government fleets. Federal Government fleet data were from Federal Motor Vehicle Fleet Report, General Services Administration, Table 1 (all agencies - domestic sedans and station wagons.)

Personal Autos:

Stock - Calculated by ORNL as the difference between total auto and fleets.

Motorcycles

Stock -MIC, 1993 Motorcycle Statisticsl Annual, p. 14, registrations.

Sales - MIC, 1993 Motorcycle Statistical Annual, pp. 10 and 16.
Sales included motorcycles, scooters, and all-terrain vehicles for on- and off-highway use. Domestic was the difference between total sales (p. 10) and imports (p. 16).

Recreational Vehicles

Sales - Recreation Vehicle Industry Association, 1992... The Year in Review, p. 4, "Total Shipments."

Trucks

Stock - Vehicles in use by weight class were determined by applying the percentage in use by weight class as reported in DOC, Bureau of the Census, 1987 TIUS, (0-10,000 lbs, 91.9%; 10,001-19,500 lbs, 2.3%; 19,501-26,000 lbs, 1.7%; 26,001 lbs and over, 4.1%) to the total number of trucks in use as reported by R. L. Polk and Company (FURTHER REPRODUCTION PROHIBITED).
Sales - AAMA, Facts and Figures '93, p. 19.

Table 3.27
Summary Statistics on Buses by Type, 1970-91

Number in Operation

Transit buses:
American Public Transit Association, 1992 Transit Fact Book, Washington, DC, October 1992, p. 82, and annual.

Intercity buses:
1970-80 - American Bus Association, 1984 Annual Report, Washington, DC, and annual.
1985 - U.S. Department of Transportation, Transportation Systems Center, National Transportation Statistics, Cambridge, MA, August 1990, Figure 5, p. 8, and annual.
1990-91 - Estimated as 38% of commercial buses (less transit motor buses). Commercial bus total found in Highway Statistics 1991, Table MV-10, and annual.

School buses:
U.S. Department of Transportation, Federal Highway Administration, Highway Statistics 1991, Washington, DC, 1992, Table MV-10, p. 20, and annual.

Vehicle-miles and Passenger-miles

Transit buses:
American Public Transit Association, 1992 Transit Fact Book, Washington, DC, October 1992, pp. 78, 79, and annual.

Intercity buses:
1970-80 - American Bus Association, Annual Report, Washington, DC, Annual.
1985-91 - Eno Transportation Foundation, Transportation in America, Eleventh edition, Washington, DC, 1993, p. 11.
1990-91 vehicle travel - Estimated using passenger travel and an average load factor of 23.2.

School buses:
1970-80 - U.S. Department of Transportation, Federal Highway Administration, Highway Statistics1984, Washington, DC, Table VM-1, p. 175, and annual.
1985 - U.S. Department of Transportation, Research and Special Programs Administration, National Transportation Statistics, 1989, Figure 2, p. 7, and annual.

1990-91 - National Safety Council, Accident Facts, 1992 Edition, Chicago, IL, p. 71, and annual.

Energy Use

Transit buses:

Diesel - APTA, 1992 Transit Fact Book, October 1992, Washington, DC, p. 100.

Gasoline - Total gallons of "other" fuel used by transit vehicles taken from APTA, 1992 Transit Fact Book, October 1992, Washington, DC, p. 100. According to APTA's Research and Statistics Department, motor bus gasoline use accounts for approximately 5% of this category.

Electricity - APTA, 1992 Transit Fact Book, October 1992, Washington, DC, p. 101.

Intercity buses:

1970-80 - American Bus Association, Annual Report, Washington, DC, annual.

1985 - Eno Transportation Foundation, Transportation in America, Seventh edition, Washington, DC, p. 9.

1990-91 - Personal communication with Frank Smith, Eno Transportation Foundation, Washington, DC.

School buses:

1970-80 - DOT, FHWA, Highway Statistics 1984, Washington, DC, Table VM-1, and annual.

1985 - DOT, Research and Special Programs Administration, National Transportation Statistics, Figure 2, p. 5, and annual.

1990-91 - Personal communication with Frank Smith, Eno Transportation Foundation, Washington, DC.

APPENDIX B

CONVERSIONS

A Note About Heating Values

The heat content of a fuel is the quantity of energy released by burning a unit amount of that fuel. However, this value is not absolute and can vary according to several factors. For example, empirical formulae for determining the heating value of liquid fuels depend on the fuels' American Petroleum Institute (API) gravity. The API gravity varies depending on the percent by weight of the chemical constituents and impurities in the fuel, both of which are affected by the combination of raw materials used to produce the fuel and by the type of manufacturing process. Temperature and climatic conditions are also factors.

Because of these variations, the heating values in Table B.1 may differ from values in other publications. The figures in this report are representative or average values, not absolute ones. The gross heating values used here agree with those used by the Energy Information Administration (EIA).

Heating values fall into two categories, gross and net. If the products of fuel combustion are cooled back to the initial fuel-air or fuel-oxidizer mixture temperature and the water formed during combustion is condensed, the energy released by the process is the higher (gross) heating value. If the products of combustion are cooled to the initial fuel-air temperature, but the water is considered to remain as a vapor, the energy released by the process is lower (net) heating value. Usually the difference between the gross and net heating values for fuels used in transportation is around 5 to 8 percent; however, it is important to be consistent in their use.

Table B.1
Approximate Heat Content for Various Fuels

Automotive gasoline	125,000 Btu/gal(gross)	= 115,400 Btu/gal(net)
Diesel motor fuel	138,700 Btu/gal (gross)	= 128,700 Btu/gal (net)
Methanol	64,600 Btu/gal (gross)	= 56,560 Btu/gal (net)
Ethanol	84,600 Btu/gal (gross)	= 75,670 Btu/gal (net)
Gasohol	120,900 Btu/gal (gross)	= 112,417 Btu/gal (net)
Aviation gasoline	120,200 Btu/gal (gross)	= 112,000 Btu/gal (net)
Propane	91,300 Btu/gal (gross)	= 83,500 Btu/gal (net)
Butane	103,000 Btu/gal (gross)	= 93,000 Btu/gal (net)
Jet fuel (naphtha)	127,500 Btu/gal (gross)	= 118,700 Btu/gal (net)
Jet fuel (kerosene)	135,000 Btu/gal (gross)	= 128,100 Btu/gal (net)
Lubricants	144,400 Btu/gal (gross)	= 130,900 Btu/gal (net)
Waxes	131,800 Btu/gal (gross)	= 120,200 Btu/gal (net)
Asphalt and road oil	158,000 Btu/gal (gross)	= 157,700 Btu/gal (net)
Petroleum coke	143,400 Btu/gal (gross)	= 168,300 Btu/gal (net)
Natural gas		
Wet	1,112 Btu/ft^3	
Dry	1,031 Btu/ft^3	
Compressed	20,551 Btu/pound	
Liquid	90,800 Btu/gal (gross)	= 87,600 Btu/gal (net)
Crude petroleum	138,100 Btu/gal (gross)	= 131,800 Btu/gal (net)
Fuel Oils		
Residual	149,700 Btu/gal (gross)	= 138,400 Btu/gal (net)
Distillate	138,700 Btu/gal (gross)	= 131,800 Btu/gal (net)
Coal		
Anthracite	23.268 x 10^6 Btu/short ton	
Bituminous and lignite		21.772 x 10^6 Btu/short ton
Production average		21.776 x 10^6 Btu/short ton
Consumption average		21.266 x 10^6 Btu/short ton

Table B.2
Fuel Equivalents

1 million bbl/day crude oil	= 0.3650 billion bbl/year crude oil = 5.800 trillion Btu/day = 2.117 quadrillion Btu/year = 90.09 million short tons coal/year = 2.074 trillion ft^3 natural gas/year = 22.33 x 10^{11} MJ/year
1 billion bbl/year crude oil	= 2.740 million bbl/day crude oil = 15.89 trillion Btu/day = 5.800 quadrillion Btu/year = 246.8 million short ton coal/year = 5.68 trillion ft^3/year natural gas/day = 61.19 x 10^{11} MJ/year
1 trillion Btu/day	= 172.4 thousand bbl/day crude oil = 62.93 million bbl/year crude oil = 0.3650 quadrillion Btu/year = 15.53 million short tons coal/year = 357.5 billion ft^3 natural gas/year = 38.51 x 10^{10} MJ/year
1 quadrillion Btu/year	= 0.4724 million bbl/day crude oil = 172.4 million bbl/year crude oil = 2.740 trillion Btu/day = 42.55 million short tons coal/year = 979.4 billion ft^3 natural gas/year = 10.55 x 10^{11} MJ/year
1 billion short tons coal/year	= 11.10 million bbl/day crude oil = 4.052 billion bbl/year crude oil = 64.38 trillion Btu/day = 23.50 quadrillion Btu/year = 23.02 trillion ft^3 natural gas/year = 24.79 x 10^{12} MJ/year
1 trillion ft^3 natural gas/year	= 0.4823 million bbl/day crude oil = 0.1760 billion bbl/year crude oil = 2.797 trillion Btu/day = 1.021 quadrillion Btu/year = 43.45 million short tons coal/year = 10.77 x 10^{11} MJ/year
1 mega joule/year	= 44.78 x 10^{-8} bbl/day crude oil = 16.34 x 10^{-5} bbl/year crude oil = 2.597 Btu/day = 947.9 Btu/year = 4.034 x 10^{-5} short tons coal/year = 0.9285 ft^3 natural gas/year

Table B.3
Energy Unit Conversions

1 Btu	= 778.2 ft-lb	1 kWhr	= 3412 Btu[a]
	= 107.6 kg-m		= 2.655×10^6 ft-lb
	= 1055 J		= 3.671×10^5 kg-m
	= 39.30×10^{-5} hp-h		= 3.600×10^6 J
	= 39.85×10^{-5} metric hp-h		= 1.341 hp-h
	= 29.31×10^{-5} kWhr		= 1.360 metric hp-h
1 kg-m	= 92.95×10^{-4} Btu	1 Joule	= 94.78×10^{-5} Btu
	= 7.233 ft-lb		= 0.7376 ft-lb
	= 9.806 J		= 0.1020 kg-m
	= 36.53×10^{-7} hp-h		= 37.25×10^{-8} hp-h
	= 37.04×10^{-7} metric hp-h		= 37.77×10^{-8} metric hp-h
	= 27.24×10^{-7} kWhr		= 27.78×10^{-8} kWhr
1 hp-h	= 2544 Btu	1 metric hp-h	= 2510 Btu
	= 1.98×10^6 ft-lb		= 1.953×10^6 ft-lb
	= 2.738×10^6 kgm		= 27.00×10^4 kg-m
	= 2.685×10^6 J		= 2.648×10^6 J
	= 1.014 metric hp-h		= 0.9863 hp-h
	= 0.7475 kWhr		= 0.7355 kWhr

[a]This figure does not take into account the fact that electricity generation and distribution efficiency is approximately 29%. If generation and distribution efficiency are taken into account, 1 kWhr = 11,765 Btu

Table B.4
Distance and Velocity Conversions

1 in.	= 83.33×10^{-3} ft	1 ft	= 12.0 in.
	= 27.78×10^{-3} yd		= 0.33 yd
	= 15.78×10^{-6} mile		= 189.4×10^{-3} mile
	= 25.40×10^{-3} m		= 0.3048 m
	= 0.2540×10^{-6} km		= 0.3048×10^{-3} km
1 mile	= 63360 in.	1 km	= 39370 in.
	= 5280 ft		= 3281 ft
	= 1760 yd		= 1093.6 yd
	= 1609 m		= 0.6214 mile
	= 1.609 km		= 1000 m

1 ft/sec = 0.3048 m/s = 0.6818 mph = 1.0972 km/h
1 m/sec = 3.281 ft/s = 2.237 mph = 3.600 km/h
1 km/h = 0.9114 ft/s = 0.2778 m/s = 0.6214 mph
1 mph = 1.467 ft/s = 0.4469 m/s = 1.609 km/h

Table B.5
Volume and Flow Rate Conversions[a]

1 U.S. gal	= 231 $in.^3$	1 liter	= 61.02 $in.^3$
	= 0.1337 ft^3		= 3.531×10^{-2} ft^3
	= 3.785 liters		= 0.2624 U.S. gal
	= 0.8321 imperial gal		= 0.2200 imperial gal
	= 0.0238 bbl		= 6.29×10^{-3} bbl
	= 0.003785 m^3		= 0.001 m^3
	A U.S. gallon of gasoline weighs 6.2 pounds		
1 imperial gal	= 277.4 $in.^3$	1 bbl	= 9702 $in.^3$
	= 0.1606 ft^3		= 5.615 ft^3
	= 4.545 liters		= 158.97 liters
	= 1.201 U.S. gal		= 42 U.S. gal
	= 0.0286 bbl		= 34.97 imperial gal
	= 0.004546 m^3		= 0.15897 m^3
1 U.S. gal/hr	= 3.209 ft^3/day		= 1171 ft^3/year
	= 90.84 liter/day		= 33157 liter/year
	= 19.97 imperial gal/day		= 7289 imperial gal/year
	= 0.5712 bbl/day		= 207.92 bbl/year
	For Imperial gallons, multiply above values by 1.201		
1 liter/hr	= 0.8474 ft^3/day		= 309.3 ft^3/year
	= 6.298 U.S. gal/day		= 2299 U.S. gal/year
	= 5.28 imperial gal/day		= 1927 imperial gal/year
	= 0.1510 bbl/day		= 55.10 bbl/year
1 bbl/hr	= 137.8 ft^3/year		= 49187 ft^3 year
	= 1008 U.S. gal/day		= 3.679×10^5 U.S. gal/year
	= 839.3 imperial gal/day		= 3.063×10^5 imperial gal/year
	= 3815 liter/day		= 1.393×10^6 liter/day

[a]The conversions for flow rates are identical to those for volume measures, if the time units are identical.

Table B.6

Power Conversions

FROM	TO					
	Horsepower	Kilowatts	Metric horsepower	Ft-lb per sec	Kilocalories per sec	Btu per sec
Horsepower	1	0.7457	1.014	550	0.1781	0.7068
Kilowatts	1.341	1	1.360	737.6	0.239	0.9478
Metric horsepower	0.9863	0.7355	1	542.5	0.1757	0.6971
Ft-lb per sec	1.36×10^{-3}	1.356×10^{-3}	1.84×10^{-3}	1	0.3238×10^{-3}	1.285×10^{-3}
Kilocalories per sec	5.615	4.184	5.692	3088	1	3.968
Btu per sec	1.415	1.055	1.434	778.2	0.2520	1

Table B.7
Mass Conversions

FROM	TO: Pound	Kilogram	Short ton	Long ton	Metric ton
Pound	1	0.4536	5.0×10^{-4}	4.4643×10^{-4}	4.5362×10^{-4}
Kilogram	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

Table B.8
Fuel Efficiency Conversions[a]

MPG	Miles/liter	Kilometers/L	L/100 kilometers
10	2.64	4.25	23.52
15	3.96	6.38	15.68
20	5.28	8.50	11.76
25	6.60	10.63	9.41
30	7.93	12.75	7.84
35	9.25	14.88	6.72
40	10.57	17.00	5.88
45	11.89	19.13	5.23
50	13.21	21.25	4.70
55	14.53	23.38	4.28

[a]To convert fuel efficiency from miles per gallon (mpg) to liters per hundred kilometers, divide mpg into 235.24.

Table B.9
SI Prefixes and Their Values

	Value	Prefix	Symbol
One million million millionth	10^{-18}	atto	a
One thousand million millionth	10^{-15}	femto	f
One million millionth	10^{-12}	pico	p
One thousand millionth	10^{-9}	nano	n
One millionth	10^{-6}	micro	μ
One thousandth	10^{-3}	milli	m
One hundredth	10^{-2}	centi	c
One tenth	10^{-1}	deci	
One	10^{0}		
Ten	10^{1}	deca	
One hundred	10^{2}	hecto	
One thousand	10^{3}	kilo	k
One million	10^{6}	mega	M
One billion[a]	10^{9}	giga	G
One trillion[a]	10^{12}	tera	T
One quadrillion[a]	10^{15}	peta	P
One quintillion[a]	10^{18}	exa	E

[a]Care should be exercised in the use of this nomenclature, especially in foreign correspondence, as it is either unknown or carries a different value in other countries. A "billion," for example, signifies a value of 10^{12} in most other countries.

Table B.10
Metric Units and Abbreviations

Quantity	Unit name	Symbol
Energy	joule	J
Specific energy	joule/kilogram	J/kg
Specific energy consumption	joule/kilogram•kilometer	J/(kg•km)
Energy consumption	joule/kilometer	J/km
Energy economy	kilometer/kilojoule	km/kJ
Power	kilowatt	Kw
Specific power	watt/kilogram	W/kg
Power density	watt/meter^3	W/m^3
Speed	kilometer/hour	km/h
Acceleration	meter/second^2	m/s^2
Range (distance)	kilometer	km
Weight	kilogram	kg
Torque	newton•meter	N•m
Volume	meter^3	m^3
Mass; payload	kilogram	kg
Length; width	meter	m
Brake specific fuel consumption	kilogram/joule	kg/J
Fuel economy (heat engine)	liters/100 km	L/100 km
Air pressure		

Conversion of Constant Dollar Values

Many types of information in this data book are expressed in dollars. Generally, constant dollars are used--that is, dollars of a fixed value for a specific year, such as 1990 dollars. Converting current dollars to constant dollars, or converting constant dollars for one year to constant dollars for another year, requires conversion factors (Table B.11 and B.12). Table B.11 shows conversion factors for the Consumer Price Index inflation factors. Table B.12 shows conversion factors using the Gross National Product inflation factors.

Table B.11
Consumer Price Inflation (CPI) Index

From	To: 1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1970	1.000	1.043	1.078	1.144	1.270	1.386	1.466	1.561	1.680	1.869	2.122	2.342	2.486	2.566	2.675	2.770	2.824	2.927	3.046	3.193	3.365	3.508	3.614
1971	0.958	1.000	1.033	1.097	1.217	1.328	1.405	1.496	1.609	1.791	2.035	2.245	2.382	2.458	2.563	2.654	2.708	2.806	2.921	3.061	3.227	3.364	3.465
1972	0.928	0.968	1.000	1.062	1.179	1.286	1.361	1.448	1.559	1.735	1.971	2.174	2.307	2.381	2.482	2.571	2.620	2.717	2.828	2.963	3.124	3.256	3.354
1973	0.874	0.911	0.941	1.000	1.110	1.211	1.281	1.364	1.467	1.633	1.856	2.047	2.173	2.243	2.338	2.421	2.469	2.558	2.662	2.790	2.941	3.065	3.158
1974	0.787	0.821	0.848	0.901	1.000	1.091	1.154	1.229	1.322	1.472	1.672	1.844	1.956	2.019	2.105	2.180	2.224	2.305	2.399	2.514	2.650	2.762	2.846
1975	0.721	0.752	0.777	0.826	0.916	1.000	1.058	1.126	1.212	1.349	1.532	1.690	1.792	1.850	1.929	1.997	2.038	2.112	2.198	2.303	2.428	2.531	2.607
1976	0.682	0.712	0.736	0.781	0.866	0.945	1.000	1.065	1.145	1.275	[illegible]	1.598	1.696	1.750	1.824	1.889	1.926	1.997	2.078	2.178	2.296	2.393	2.465
1977	0.641	0.668	0.690	0.733	0.814	0.888	0.939	1.000	1.076	1.198	1.361	1.501	1.594	1.645	1.715	1.776	1.809	1.876	1.952	2.046	2.156	2.248	2.316
1978	0.595	0.621	0.642	0.682	0.756	0.825	0.873	0.929	1.000	1.113	1.265	1.395	1.479	1.527	1.592	1.648	1.681	1.742	1.813	1.900	2.003	2.088	2.151
1979	0.535	0.558	0.576	0.612	0.679	0.741	0.784	0.835	0.898	1.000	1.135	1.253	1.330	1.373	1.431	1.482	1.511	1.566	1.630	1.708	1.800	1.877	1.933
1980	0.471	0.491	0.508	0.539	0.598	0.653	0.690	0.735	0.791	0.881	1.000	1.103	1.171	1.209	1.260	1.305	1.331	1.379	1.436	1.504	1.586	1.653	1.703
1981	0.427	0.445	0.460	0.489	0.542	0.592	0.626	0.666	0.717	0.798	0.907	1.000	1.062	1.096	1.142	1.183	1.206	1.250	1.301	1.363	1.437	1.498	1.543
1982	0.402	0.420	0.434	0.460	0.511	0.558	0.590	0.628	0.676	0.752	0.853	0.942	1.000	1.032	1.075	1.114	1.136	1.178	1.226	1.284	1.354	1.411	1.454
1983	0.390	0.406	0.420	0.446	0.495	0.540	0.571	0.608	0.655	0.728	0.827	0.913	0.970	1.000	1.043	1.080	1.100	1.141	1.187	1.244	1.312	1.367	1.409
1984	0.374	0.390	0.403	0.428	0.475	0.518	0.548	0.584	0.628	0.699	0.793	0.876	0.930	0.960	1.000	1.036	1.056	1.094	1.139	1.194	1.258	1.311	1.351
1985	0.361	0.376	0.389	0.413	0.458	0.500	0.529	0.564	0.606	0.675	0.766	0.846	0.898	0.926	0.966	1.000	1.019	1.057	1.100	1.152	1.215	1.266	1.304
1986	0.354	0.369	0.382	0.405	0.450	0.491	0.519	0.553	0.595	0.662	0.751	0.829	0.880	0.909	0.947	0.981	1.000	1.037	1.079	1.131	1.192	1.242	1.280
1987	0.342	0.356	0.368	0.391	0.434	0.474	0.501	0.533	0.574	0.639	0.725	0.800	0.849	0.876	0.914	0.946	0.964	1.000	1.041	1.091	1.150	1.199	1.235
1988	0.328	0.342	0.354	0.376	0.417	0.455	0.481	0.512	0.552	0.614	0.697	0.769	0.816	0.842	0.878	0.909	0.927	0.961	1.000	1.048	1.105	1.152	1.186
1989	0.313	0.327	0.337	0.358	0.398	0.434	0.459	0.489	0.526	0.586	0.665	0.734	0.779	0.804	0.838	0.868	0.884	0.917	0.954	1.000	1.054	1.099	1.132
1990	0.297	0.310	0.320	0.340	0.377	0.412	0.436	0.464	0.499	0.555	0.631	0.696	0.739	0.762	0.795	0.823	0.839	0.870	0.905	0.949	1.000	1.042	1.074
1991	0.285	0.297	0.307	0.326	0.362	0.395	0.418	0.445	0.479	0.533	0.605	0.668	0.709	0.731	0.762	0.790	0.805	0.834	0.868	0.910	0.959	1.000	1.030
1992	0.277	0.289	0.298	0.317	0.351	0.384	0.406	0.432	0.465	0.517	0.587	0.648	0.688	[illegible]	0.740	0.767	0.781	0.810	0.843	0.883	0.931	0.971	1.000

Source:
U.S. Department of Labor, Bureau of Labor Statistics, Monthly Labor Review, Washington, DC, monthly.

Table B.12
Gross National Product (GNP) Implicit Price Deflator

From	To 1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1970	1.000	1.051	1.095	1.159	1.260	1.377	1.448	1.534	1.646	1.789	1.953	2.141	2.270	2.356	2.454	2.531	2.600	2.667	2.763	2.867	2.985	3.120	3.230
1971	0.951	1.000	1.041	1.101	1.198	1.310	1.377	1.457	1.566	1.701	1.859	2.035	2.157	2.241	2.334	2.412	2.475	2.535	2.625	2.724	2.836	2.966	3.070
1972	0.913	0.960	1.000	1.058	1.150	1.257	1.323	1.400	1.504	1.634	1.786	1.955	2.072	2.151	2.240	2.315	2.375	2.435	2.522	2.617	2.725	2.849	2.949
1973	0.863	0.908	0.945	1.000	1.087	1.188	1.250	1.323	1.421	1.544	1.688	1.848	1.958	2.033	2.118	2.189	2.242	2.301	2.383	2.473	2.575	2.692	2.787
1974	0.794	0.834	0.869	0.920	1.000	1.094	1.150	1.218	1.307	1.421	1.551	1.700	1.802	1.871	1.948	2.014	2.062	2.117	2.193	2.276	2.370	2.477	2.564
1975	0.726	0.763	0.795	0.841	0.915	1.000	1.051	1.114	1.195	1.299	1.418	1.554	1.648	1.711	1.782	1.841	1.887	1.936	2.006	2.081	2.167	2.265	2.344
1976	0.691	0.726	0.756	0.800	0.871	0.952	1.000	1.058	1.137	1.235	1.350	1.478	1.566	1.628	1.696	1.752	1.795	1.840	1.906	1.978	2.059	2.153	2.228
1977	0.652	0.686	0.714	0.756	0.822	0.898	0.945	1.000	1.074	1.167	1.273	1.396	1.479	1.536	1.600	1.654	1.695	1.738	1.800	1.868	1.945	2.033	2.105
1978	0.608	0.639	0.665	0.704	0.766	0.837	0.880	0.931	1.000	1.087	1.187	1.300	1.378	1.432	1.492	1.542	1.580	1.619	1.677	1.740	1.812	1.894	1.961
1979	0.559	0.588	0.612	0.648	0.704	0.770	0.810	0.857	0.920	1.000	1.092	1.196	1.268	1.317	1.372	1.418	1.453	1.490	1.543	1.601	1.667	1.743	1.804
1980	0.512	0.539	0.560	0.592	0.645	0.705	0.741	0.784	0.842	0.915	1.000	1.095	1.160	1.206	1.256	1.298	1.332	1.363	1.412	1.465	1.525	1.595	1.651
1981	0.467	0.491	0.512	0.541	0.588	0.643	0.677	0.717	0.770	0.837	0.912	1.000	1.061	1.100	1.146	1.184	1.214	1.247	1.291	1.340	1.395	1.459	1.510
1982	0.441	0.464	0.483	0.511	0.556	0.607	0.639	0.676	0.726	0.789	0.861	0.944	1.000	1.040	1.082	1.118	1.145	1.175	1.217	1.263	1.315	1.375	1.423
1983	0.424	0.446	0.464	0.491	0.534	0.584	0.614	0.651	0.698	0.759	0.828	0.907	0.962	1.000	1.040	1.075	1.104	1.130	1.171	1.215	1.265	1.322	1.368
1984	0.408	0.428	0.445	0.471	0.514	0.562	0.589	0.624	0.670	0.728	0.797	0.870	0.922	0.961	1.000	1.035	1.059	1.083	1.122	1.164	1.212	1.267	1.312
1985	0.395	0.415	0.433	0.458	0.498	0.544	0.572	0.606	0.645	0.707	0.772	0.846	0.897	0.931	0.944	1.000	1.027	1.054	1.092	1.133	1.180	1.233	1.276
1986	0.385	0.404	0.421	0.446	0.485	0.530	0.557	0.590	0.633	0.688	0.751	0.824	0.873	0.906	0.944	0.974	1.000	1.026	1.062	1.103	1.148	1.200	1.242
1987	0.375	0.395	0.411	0.435	0.472	0.517	0.544	0.575	0.618	0.671	0.734	0.802	0.851	0.885	0.923	0.949	0.975	1.000	1.036	1.075	1.119	1.170	1.211
1988	0.362	0.381	0.397	0.420	0.456	0.499	0.525	0.556	0.596	0.648	0.708	0.774	0.822	0.854	0.891	0.916	0.941	0.966	1.000	1.038	1.081	1.130	1.170
1989	0.349	0.367	0.382	0.404	0.439	0.480	0.506	0.535	0.575	0.624	0.683	0.746	0.792	0.823	0.859	0.883	0.907	0.930	0.963	1.000	1.041	1.088	1.126
1990	0.335	0.353	0.367	0.388	0.422	0.461	0.486	0.514	0.552	0.600	0.656	0.717	0.760	0.790	0.825	0.848	0.871	0.894	0.925	0.960	1.000	1.046	1.083
1991	0.320	0.337	0.351	0.371	0.404	0.441	0.465	0.492	0.528	0.574	0.627	0.685	0.727	0.756	0.789	0.811	0.833	0.855	0.885	0.919	0.956	1.000	1.035
1992	0.310	0.326	0.339	0.359	0.390	0.427	0.449	0.475	0.510	0.554	0.606	0.662	0.703	0.731	0.762	0.783	0.805	0.826	0.855	0.888	0.924	0.966	1.000

Source:
U.S. Department of Commerce, Bureau of Economic Analysis, Survey of Current Business, Washington, DC, monthly.

GLOSSARY

Acceleration power - Measured in kilowatts. Pulse power obtainable from a battery used to accelerate a vehicle. This is based on a constant current pulse for 30 seconds at no less than 2/3 of the maximum open-circuit-voltage, at 80% depth-of-discharge relative to the battery's rated capacity and at 20° C ambient temperature.

Air Carrier - The commercial system of air transportation consisting of certificated air carriers, air taxis (including commuters), supplemental air carriers, commercial operators of large aircraft, and air travel clubs.

Certificated route air carrier: An air carrier holding a Certificate of Public Convenience and Necessity issued by the Department of Transportation to conduct scheduled interstate services. Nonscheduled or charter operations may also be conducted by these carriers. These carriers operate large aircraft (30 seats or more, or a maximum payload capacity of 7,500 pounds or more) in accordance with Federal Aviation Regulation part 121.

Domestic air operator: Commercial air transportation within and between the 50 States and the District of Columbia. Includes operations of certificated route air carriers, Pan American, local service, helicopter, intra-Alaska, intra-Hawaii, all-cargo carriers and other carriers. Also included are transborder operations conducted on the domestic route segments of U.S. air carriers. Domestic operators are classified based on their operating revenue as follows:

Majors - over $1 billion
Nationals - $100-1,000 million
Large Regionals - $10-99.9 million
Medium Regionals - $0-9.99 million

International air operator: Commercial air transportation outside the territory of the United States, including operations between the U.S. and foreign countries and between the U.S. and its territories and possessions.

Supplemental air carrier: A class of air carriers which hold certificates authorizing them to perform passenger and cargo charter services supplementing the scheduled service of the certificated route air carriers. Supplemental air carriers are often referred to as nonscheduled air carriers or "nonskeds".

Amtrak - See *Rail.*

Automobile size classifications - Size classifications of automobiles are established by the Environmental Protection Agency (EPA) as follows:

Minicompact - less than 85 cubic feet of passenger and luggage volume.
Subcompact - between 85 to 100 cubic feet of passenger and luggage volume.
Compact - between 100 to 110 cubic feet of passenger and luggage volume.
Midsize - between 110 to 120 cubic feet of passenger and luggage volume.
Large - more than 120 cubic feet of passenger and luggage volume.
Two seater - automobiles designed primarily to seat only two adults.

Station wagons are included with the size class for the sedan of the same name.

Aviation - See *General aviation.*

Aviation gasoline - All special grades of gasoline for use in aviation reciprocating engines, as given in the American Society for Testing and Materials (ASTM) Specification D 910. Includes all refinery products within the gasoline range that are to be marketed straight or in blends as aviation gasoline without further processing (any refinery operation except mechanical blending). Also included are finished components in the gasoline range which will be used for blending or compounding into aviation gasoline.

Barges - Shallow, nonself-propelled vessels used to carry bulk commodities on the rivers and the Great Lakes.

Battery efficiency - Measured in percentage. Net DC energy delivered on discharge, as a percentage of the total DC energy required to restore the initial state-of-charge. The efficiency value must include energy losses resulting from self-discharge, cell equalization, thermal loss compensation, and all battery-specific auxiliary equipment.

Btu - The amount of energy required to raise the temperature of 1 pound of water 1 degree Fahrenheit at or near 39.2 degrees Fahrenheit. An average Btu content of fuel is the heat value per quantity of fuel as determined from tests of fuel samples.

Bunker - A storage tank.

Bunkering fuels - Fuels stored in ship bunkers.

Bus -

Intercity bus: A standard size bus equipped with front doors only, high backed seats, luggage compartments separate from the passenger compartment and usually with restroom facilities, for high-speed long distance service.

Motor bus: Rubber-tired, self-propelled, manually-steered bus with fuel supply on board the vehicle. Motor bus types include intercity, school, and transit.
School and other nonrevenue bus: Bus services for which passengers are not directly charged for transportation, either on a per passenger or per vehicle basis.

Transit bus: A bus designed for frequent stop service with front and center doors, normally with a rear-mounted diesel engine, low-back seating, and without luggage storage compartments or restroom facilities. Includes motor bus and trolley coach.

Trolley coach: Rubber-tired electric transit vehicle, manually-steered, propelled by a motor drawing current, normally through overhead wires, from a central power source not on board the vehicle.

Calendar year - The period of time between January 1 and December 31 of any given year.

Captive imports - Products produced overseas specifically for domestic manufacturers.

Carbon dioxide (CO_2) - A colorless, odorless, non-poisonous gas that is a normal part of the ambient air. Carbon dioxide is a product of fossil fuel combustion.

Carbon monoxide (CO) - A colorless, odorless, highly toxic gas that is a normal by-product of incomplete fossil fuel combustion. Carbon monoxide, one of the major air pollutants, can be harmful in small amounts if breathed over a certain period of time.

Car-mile (railroad) - A single railroad car moved a distance of one mile.

Cargo ton-mile - See *Ton-mile*.

Certificated route air carriers - See *Air carriers*.

Class I freight railroad - See *Rail*.

Clean Fuel Vehicle - Vehicle meeting the clean fuel vheicle exhaust emissions standards with no restriction on fuel type.

Coal slurry - Finely crushed coal mixed with sufficient water to form a fluid.

Combination trucks - Consist of a power unit (a truck tractor) and one or more trailing units (a semi-trailer or trailer). The most frequently used combination is popularly referred to as a "tractor-semitrailer" or "tractor trailer".

Commercial sector - See *Residential and Commercial sector.*

Commuter railroad - See *Rail.*

Compact car - See *Automobile size classifications.*

Constant dollars - A series of figures is expressed in constant dollars when the effect of change in the purchasing power of the dollar has been removed. Usually the data are expressed in terms of dollars of a selected year or the average of a set of years.

Consumer Price Index (CPI) - An index issued by the U.S. Department of Labor, Bureau of Labor Statistics. The CPI is designed to measure changes in the prices of goods and services bought by wage earners and clerical workers in urban areas. It represents the cost of a typical consumption bundle at current prices as a ratio to its cost at a base year.

Continuous discharge capacity - Measured as percent of rated energy capacity. Energy delivered in a constant power discharge required by an electric vehicle for hill climbing and/or high-speed cruise, specified as the percent of its rated energy capacity delivered in a one hour constant-power discharge.

Corporate Average Fuel Economy (CAFE) standards - CAFE standards were originally established by Congress for new automobiles, and later for light trucks, in Title V of the Motor Vehicle Information and Cost Savings Act (15 U.S.C.1901, et seq.) with subsequent amendments. Under CAFE, automobile manufacturers are required by law to produce vehicle fleets with a composite sales-weighted fuel economy which cannot be lower than the CAFE standards in a given year, or for every vehicle which does not meet the standard, a fine of $5.00 is paid for every one-tenth of a mpg below the standard.

Crude oil - A mixture of hydrocarbons that exists in the liquid phase in natural underground reservoirs and remains liquid at atmospheric pressure after passing through surface separating facilities.

Crude oil imports - The volume of crude oil imported into the 50 States and the District of Columbia, including imports from U.S. territories, but excluding imports of crude oil into the Hawaiian Foreign Trade Zone.

Current dollars - Represents dollars current at the time designated or at the time of the transaction. In most contexts, the same meaning would be conveyed by the use of the term "dollars".

Disposable personal income - See *Income.*

Distillate fuel oil - The lighter fuel oils distilled off during the refining process. Included are products known as ASTM grades numbers 1 and 2 heating oils, diesel fuels, and number 4 fuel oil. The major uses of distillate fuel oils include heating, fuel for on-and off-highway diesel engines, and railroad diesel fuel.

Domestic air operator - See *Air carrier.*

Domestic water transportation - See *Internal water transportation.*

Electric utilities sector - Consists of privately and publicly owned establishments which generate electricity primarily for resale.

Emission standards - Standards for the levels of pollutants emitted from automobiles and trucks. Congress established the first standards in the Clean Air Act of 1963. Currently, standards are set for four vehicle classes - automobiles, light trucks, heavy-duty gasoline trucks, and heavy-duty diesel trucks.

Energy capacity - Measured in kilowatt hours. The energy delivered by the battery, when tested at C/3 discharge rate, up to termination of discharge specified by the battery manufacturer. The required acceleration power must be delivered by the battery at any point up to 80% of the battery's energy capacity rating.

Energy efficiency - In reference to transportation, the inverse of energy intensiveness: the ratio of outputs from a process to the energy inputs; for example, miles traveled per gallon of fuel (mpg).

Energy intensity - In reference to transportation, the ratio of energy inputs to a process to the useful outputs form that process; for example, gallons of fuel per passenger-mile or Btu per ton-mile.

Fixed operating cost - See *Operating cost.*

Fleet vehicles -

Private fleet vehicles: Ideally, a vehicle could be classified as a member of a fleet if it is:

a) operated in mass by a corporation or institution,
b) operated under unified control, or
c) used for non-personal activities.

However, the definition of a fleet is not consistent throughout the fleet industry. Some companies make a distinction between cars that were bought in bulk rather than singularly, or whether they are operated in bulk, as well as the minimum number of vehicles that constitute a fleet (i.e. 4 or 10).

Government fleet vehicles: Includes vehicles owned by all federal (GSA), state, county, city, and metro units of government, including toll road operations.

Foreign freight - Movements between the United States and foreign countries and between Puerto Rico, the Virgin Islands, and foreign countries. Trade between U.S. territories and possessions (e.g. Guam, Wake, American Samoa) and foreign countries is excluded. Traffic to or from the Panama Canal Zone is included.

Gas Guzzler Tax - Originates from the 1978 Energy Tax Act (Public Law 95-618). A new car purchaser is required to pay the tax if the car purchased has a combined city/highway fuel economy rating that is below the standard for that year. For model years 1986 and later, the standard is 22.5 mpg.

Gasohol - A mixture of 10% anhydrous ethanol and 90% gasoline by volume. There are other fuels that contain methanol and gasoline, but these fuels are not referred to as gasohol.

Gasoline - See *Motor gasoline.*

General aviation - That portion of civil aviation which encompasses all facets of aviation except air carriers. It includes any air taxis, commuter air carriers, and air travel clubs which do not hold Certificates of Public Convenience and Necessity.

Gross National Product - A measure of monetary value of the goods and services becoming available to the nation from economic activity. Total value at market prices of all goods and services produced by the nation's economy. Calculated quarterly by the Department of Commerce, the Gross National Product is the broadest available measure of the level of economic activity.

Gross vehicle weight (gvw) - The weight of the empty vehicle plus the maximum anticipated load weight.

Heavy-heavy truck - See *Truck size classifications*.

Household - Consists of all persons who occupy a housing unit, including the related family members and all unrelated persons, if any, who share the housing unit.

Housing unit - A house, 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 hallway 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.

Hydrocarbon (HC) - A compound that contains only hydrogen and carbon. The simplest and lightest forms of hydrocarbon are gaseous. With greater molecular weights they are liquid, while the heaviest are solids.

Income -

Disposable personal income: Personal income less personal tax and non-tax payments.

National income - The aggregate earnings of labor and property which arise in the current production of goods and services by the nation's economy.

Personal income: The current income received by persons from all sources, net of contributions for social insurance.

Industrial sector - Construction, manufacturing, agricultural and mining establishments.

Intercity bus - See *Bus*.

Internal water transportation - Includes all local (intraport) traffic and traffic between ports or landings wherein the entire movement takes place on inland waterways. Also termed internal are movements involving carriage on both inland waterways and the water of the Great Lakes, and inland movements that cross short stretches of open water that link inland systems.

International air operator - See *Air carrier.*

International freight - See *Foreign freight.*

Jet fuel - Includes both naphtha-type and kerosene-type fuels meeting standards for use in aircraft turbine engines. Although most jet fuel is used in aircraft, some is used for other purposes such as generating electricity in gas turbines.

Kerosene-type jet fuel: A quality kerosene product with an average gravity of 40.7 degrees API and 10% to 90% distillation temperatures of 217 and 261 degrees centigrade. Used primarily as fuel for commercial turbojet and turboprop aircraft engines. It is a relatively low freezing point distillate of the kerosene type.

Naphtha-type jet fuel: A fuel in the heavy naphtha boiling range with an average gravity of 52.8 degrees API and 10% to 90% distillation temperatures of 117 to 233 degrees centigrade used for turbojet and turboprop aircraft engines, primarily by the military. Excludes ramjet and petroleum.

Kerosene - A petroleum distillate in the 300 to 500 degrees Fahrenheit boiling range and generally having a flash point higher than 100 degrees Fahrenheit by the American Society of Testing and Material (ASTM) Method D56, a gravity range from 40 to 46 degrees API, and a burning point in the range of 150 to 175 degrees Fahrenheit. It is a clean-burning product suitable for use as an illuminant when burned in wick lamps. Includes grades of kerosene called range oil having properties similar to Number 1 fuel oil, but with a gravity of about 43 degrees API and an end point of 625 degrees Fahrenheit. Used in space heaters, cooking stoves, and water heaters.

Kerosene-type jet fuel - See *Jet fuel.*

Large car - See *Automobile size classifications.*

Light duty vehicles - Automobiles and light trucks combined.

Light truck - Unless otherwise noted, light trucks are defined in this publication as two-axle, four-tire trucks. The U.S. Bureau of Census classifies all trucks with a gross vehicle weight less than 10,000 pounds as light trucks (See *Truck size classifications*).

Light-heavy truck - See *Truck size classifications*.

Liquified petroleum gas (lpg) - Consists of propane and butane and is usually derived from natural gas. In locations where there is no natural gas and the gasoline consumption is low, naphtha is converted to lpg by catalytic reforming.

Load factor - A term relating the potential capacity of a system relative to its actual performance. Is often calculated as total passenger miles divided by total vehicle miles.

Low-emission vehicle - A clean fuel vehicle meeting the low-emission vehicle standards.

Medium truck - See *Truck size classifications*.

Midsize car - See *Automobile size classifications*.

Minicompact car - See *Automobile size classifications*.

Model year - In this publication, model year is referring to the "sales" model year, the period from October 1 to the next September 31.

Motor bus - See *Bus*.

Motor Gasoline - A mixture of volatile hydrocarbons suitable for operation of an internal combustion engine whose major components are hydrocarbons with boiling points ranging from 78 to 217 degrees centigrade and whose source is distillation of petroleum and cracking, polymerization, and other chemical reactions by which the naturally occurring petroleum hydrocarbons are converted into those that have superior fuel properties.

Naphtha-type jet fuel - See *Jet fuel*.

National income - See *Income*.

Nationwide Personal Transportation Study (NPTS) - A nationwide home interview survey of households that provides information on the characteristics and personal travel patterns of the U.S. population. Surveys were conducted in 1969, 1977, 1983 and 1990 by the U.S. Bureau of Census for the U.S. Department of Transportation.

Natural gas - A mixture of hydrocarbon compounds and small quantities of various non-hydrocarbons existing in the gaseous phase or in solution with crude oil in natural underground reservoirs at reservoir conditions.

Nitrogen Oxides (NO_x) - A product of combustion of fossil fuels whose production increases with the temperature of the process. It can become an air pollutant if concentrations are excessive.

Operating cost -

Fixed operating cost: In reference to passenger car operating cost, refers to those expenditures that are independent of the amount of use of the car, such as insurance costs, fees for license and registration, depreciation and finance charges.

Variable operating cost: In reference to passenger car operating cost, expenditures which are dependent on the amount of use of the car, such as the cost of gas and oil, tires, and other maintenance.

Organization for Petroleum Exporting Countries (OPEC) - Includes Saudi Arabia, Iran, Venezuela, Libya, Indonesia, United Arab Emirates, Algeria, Nigeria, Ecuador, Gabon, Iraq, Kuwait, and Qatar. Data for Saudi Arabia and Kuwait include their shares from the Partitioned Zone (formerly the Neutral Zone).

Other single-unit truck - See *Single-unit truck.*

Particulates - Carbon particles formed by partial oxidation and reduction of the hydrocarbon fuel. Also included are trace quantities of metal oxides and nitrides, originating from engine wear, component degradation, and inorganic fuel additives. In the transportation sector, particulates are emitted mainly from diesel engines.

Passenger-miles traveled (PMT) - One person traveling the distance of one mile. Total passenger-miles traveled, thus, give the total mileage traveled by all persons.

Passenger rail - See *Rail, "Amtrak" and "Transit Railroad".*

Personal Consumption Expenditures (PCE) - As used in the national accounts, the market value of purchases of goods and services by individuals and nonprofit institutions and the value of food, clothing, housing, and financial services received by them as income in kind. It includes the rental value of owner-occupied houses but excludes purchases of dwellings, which are classified as capital goods (investment).

Personal income - See *Income*.

Petroleum - A generic term applied to oil and oil products in all forms, such as crude oil, lease condensate, unfinished oil, refined petroleum products, natural gas plant liquids, and non-hydrocarbon compounds blended into finished petroleum products.

Petroleum consumption - A calculated demand for petroleum products obtained by summing domestic production, imports of crude petroleum and natural gas liquids, imports of petroleum products, and the primary stocks at the beginning of the period and then subtracting the exports and the primary stocks at the end of the period.

Petroleum exports - Shipments of petroleum products from the 50 States and the District of Columbia to foreign countries, Puerto Rico, the Virgin Islands, and other U.S. possessions and territories.
Petroleum imports - All imports of crude petroleum, natural gas liquids, and petroleum products from foreign countries and receipts from Guam, Puerto Rico, the Virgin Islands, and the Hawaiian Trade Zone. The commodities included are crude oil, unfinished oils, plant condensate, and refined petroleum products.

Petroleum inventories - The amounts of crude oil, unfinished oil, petroleum products, and natural gas liquids held at refineries, at natural gas processing plants, in pipelines, at bulk terminals operated by refining and pipeline companies, and at independent bulk terminals. Crude oil held in storage on leases is also included; these stocks are know as primary stocks. Secondary stocks - those held by jobbers dealers, service station operators, and consumers -are excluded. Prior to 1975, stock held at independent bulk terminals were classified as secondary stocks.

Petroleum products supplied - For each petroleum product, the amount supplied is calculated by summing production, crude oil burned directly, imports, and net withdrawals from primary stocks and subtracting exports.

Quad - Quadrillion, 10^{15}. In this publication, a Quad refers to Quadrillion Btu.

Rail -

Amtrak (American Railroad Tracks): Operated by the National Railroad Passenger Corporation of Washington, DC. This rail system was created by President Nixon in 1970, and was given the responsibility for the operation of intercity, as distinct from suburban, passenger trains between points designated by the Secretary of Transportation.

Class I freight railroad: Defined by the Interstate Commerce Commission each year based on annual operating revenue. A railroad is dropped from the Class I list if it fails to meet the annual earnings threshold for three consecutive years.

Commuter railroad: Those portions of mainline railroad (not electric railway) transportation operations which encompass urban passenger train service for local travel between a central city and adjacent suburbs. Commuter railroad service - using both locomotive-hauled and self-propelled railroad passenger cars - is characterized by multi-trip tickets, specific station-to-station fares, and usually only one or two stations in the central business district. Also known as suburban railroad.

Transit railroad: Includes "heavy" and "light" transit rail. **Heavy transit rail** is characterized by exclusive rights-of-way, multi-car trains, high speed rapid acceleration, sophisticated signaling, and high platform loading. Also known as subway, elevated railway, or metropolitan railway (metro). **Light transit rail** may be on exclusive or shared rights-of-way, high or low platform loading, multi-car trains or single cars, automated or manually operated. In generic usage, light rail includes streetcars, trolley cars, and tramways.

Residential and Commercial sector - Consists of housing units, non-manufacturing business establishments (e.g., wholesale and retail businesses), health and educational institutions, and government offices.

Residential Transportation Energy Consumption Survey (RTECS) - This survey was designed by the Energy Information Administration of the Department of Energy to provide information on how energy is used by households for personal vehicles. It has been conducted five times since 1979, the most recent being 1991.

Residual fuel oil - The heavier oils that remain after the distillate fuel oils and lighter hydrocarbons are boiled off in refinery operations. Included are products know as ASTM grade numbers 5 and 6 oil, heavy diesel oil, Navy Special Fuel 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.

Rural - Usually refers to areas with population less than 5,000.

Sales-weighted miles per gallon (mpg) - Calculation of a composite vehicle fuel economy based on the distribution of vehicle sales.

Scrappage rate - As applied to motor vehicles, it is usually expressed as the percentage of vehicles of a certain type in a given age class that are retired from use (lacking registration) in a given year.

School and other nonrevenue bus - See *Bus*.

Single unit truck - Includes two-axle, four-tire trucks and other single unit trucks.

Two-axle, four tire truck: A motor vehicle consisting primarily of a single motorized device with two axles and four tires.

Other single-unit truck: A motor vehicle consisting primarily of a single motorized device with more than two axles or more than four tires.

Special fuels - Consist primarily of diesel fuel with small amount of liquified petroleum gas, as defined by the Federal Highway Administration.

Specific acceleration power - Measured in watts per kilogram. Acceleration power divided by the battery system weight. Weight must include the total battery system.

Specific energy - Measured in watt hours per kilogram. The rated energy capacity of the battery divided by the total battery system weight.

Subcompact car - See *Automobile size classifications*.

Supplemental air carrier - See *Air carrier*.

Ton-mile - The movement of one ton of freight the distance of one mile. Ton-miles are computed by multiplying the weight in tons of each shipment transported by the distance hauled.

Transmission types -

A3 - Automatic three speed
A4 - Automatic four speed
A5 - Automatic five speed
L4 - Automatic lockup four speed
M5 - Manual five speed

Transit bus - See *Bus*.

Transit railroad - See *Rail*.

Transportation sector - Consists of both private and public passenger and freight transportation, as well as government transportation, including military operations.

Truck Inventory and Use Survey (TIUS) - Survey designed to collect data on the characteristics and operational use of the nation's truck population. It is conducted every five years by the U.S. Bureau of the Census. Surveys were conducted in 1963, 1967, 1972, 1977, 1982, 1987, and 1992. The 1992 data have not yet been released.

Trolley coach - See *Bus*.

Truck size classifications - U.S. Bureau of the Census has categorized trucks by gross vehicle weight (gvw) as follows:

Light - Less than 10,000 pounds gvw (Also see *Light Truck*.)
Medium - 10,001 to 20,000 pounds gvw
Light-heavy - 20,001 to 26,000 pounds gvw
Heavy-heavy - 26,001 pounds gvw or more.

Two-axle, four-tire truck - See *Single-unit truck*.

Two seater car - See *Automobile size classifications*.

Ultra-low emission vehicle - A clean fuel vehicle meeting the more stringent Ultra-low emission standards.

Urban - Usually refers to areas with population of 5,000 or greater.

Variable operating cost - See *Operating cost.*

Vehicle-miles traveled (vmt) - One vehicle traveling the distance of one mile. Total vehicle miles, thus, is the total mileage traveled by all vehicles.

Zero-emission vehicle - A clean fuel vehicle meeting even more stringent zero-emission vehicle standards.

AIIM

Association for Information and Image Management

1100 Wayne Avenue, Suite 1100
Silver Spring, Maryland 20910
301/587-8202

Centimeter

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 mm

1 2 3 4 5

Inches

1.0 1.1 1.25 1.4 1.6 1.8 2.0 2.2 2.5 2.8 3.2 3.6 4.0 4.5 5.0 5.6 6.3

MANUFACTURED TO AIIM STANDARDS
BY APPLIED IMAGE, INC.

TITLE INDEX

Notations:

*	indicates the end of the title
( )	indicates the page number

INTERNAL DISTRIBUTION

1. V. D. Baxter
2. D. J. Bjornstad
3. T. J. Blasing
4. R. B. Braid Jr
5. M. S. Bronzini
6. M. A. Brown
7. M. T. Bruer
8. J. B. Cannon
9. R. S. Carlsmith
10. M. D. Cheng
11. T. R. Curlee
12. A. H. Curtis III
13. S. Das
14. S. C. Davis
15. S. K. Fischer
16. D. L. Greene
17. E. L. Hillsman
18. P. S. Hu
19. B. J. Kirby
20. M. A. Kuliasha
21. S. P. Miaou
22. D. P. Middendorf
23. R. D. Perlack
24. B. E. Peterson
25. C. H. Petrich
26. R. M. Reed
27. R. B. Shelton
28. B. M.Sorensen
29. R. L. Wendt
30. T. J. Wilbanks
31. J. R. Young
32. ORNL Patent Office

33-34. Central Research Library

35. Document Reference Section

36-37. Laboratory Records

38. Laboratory Records--RC

EXTERNAL DISTRIBUTION

39. D. R. Bohi, Director, Energy and Natural Resources Division, Resources for the Future, 1616 P Street, N.W., Washington, DC 20036

40. T. E. Drabek, Department of Sociology, University of Denver, Denver, Colorado 80208-0209

41. C. D. MacCracken, President, Calmac Manufacturing Corporation, P.O. Box 710, Englewood, New Jersey 07631

42. J. B. Shrago, Director, Office of Technology Transfer, 405 Kirkland Hall, Vanderbilt University, Nashville, Tennessee 37240

43. G. F. Sowers, Senior Vice President, Law Companies Group, Inc., 114 Townpark Drive, Suite 250, Kennesaw, Georgia 30144-5599

44. C. M. Walton, Paul D. and Betty Roberston Meek Centennial Professor and Chairman, Department of Civil Engineering, College of Engineering, The University of Texas at Austin, Cockrell Hall, Suite 4.2, Austin, Texas 78712

45-997. Center for Transportation Analysis, Energy Division, 5500A, Room A217

998-999. OSTI, U.S. Department of Energy, P.O. Box 62, Oak Ridge, TN 37831

1000. Office of Assistant Manager of Energy Research and Development, DOE/ORO, P.O. Box 2001, Oak Ridge, TN 37831-8600

*U.S. GOVERNMENT PRINTING OFFICE:1994-550-165/60029

DATE

FILMED

9/ 8 / 94

END