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Center for Transportation Analysis

Energy Division

TRANSPORTATION ENERGY DATA BOOK:

EDITION 12

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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.

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FORWARD

The ORNL team continues to make additions and refinements in each edition of the **Transportation Energy Data Book**. A few of the data items that caught my attention were:

- The average new car price (in constant dollars rose by $92 during the 1970's but increased by $4000 during the 1980's (Table 2.22).
- During the last twenty years, travel by autos rose 2.6% per year on average, whereas light truck travel grew 7.1% per year (Table 3.2).
- The average age of autos on the road was 7.8 years in 1990, 2.2 years higher than in 1970 (Table 3.5).
- In 1988, there were 513,682 vehicles in the Federal fleet. Over 63% of these vehicles were light-duty trucks (Table 3.36).
- The California auto emission requirements (which some other states may adopt) for the year 2003 require sales to be 10% zero emission vehicles (ZEV), 15% ultra low emission vehicles (ULEV), and 75% low emission vehicles (LEV) (Table 3.49).
- The average household spent 19.3% of its income on transportation in 1989 (Table 4.12).

I hope you find this resource document useful. Please let me know if you have suggestions for data that should be added.

Phil Patterson

ACKNOWLEDGEMENTS

We wish to express our gratitude to the many individuals who assisted in the preparation of this document. First, we 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, consultant, and Patricia Hu, David Greene, Bruce Peterson, Frank Southworth, Jerry Hadder, Scott Stevens, Shih-Miao Chin, and Shaw-Pin Miaou of Oak Ridge National Laboratory (ORNL). We would also like to thank the Federal Highway Administration (FHWA), for allowing the publication of the 1990 Nationwide Personal Transportation Study (NPTS) data. The tables, text, and figures from the NPTS were done for the FHWA by Patricia Hu, ORNL, and Jennifer Young, University of Tennessee.

In addition, we would like to acknowledge the contributions of Sherry Campbell of the Health, Safety, Environment, and Accountability Division for the preparation of the title index. Finally, we are indebted to Jonnie Sorensen for her skills in assisting with the preparation of the manuscript.

ABSTRACT

The Transportation Energy Data Book: Edition 12 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 - highway, air, water, rail, pipeline - is treated in separate chapters or sections. Chapter 1 compares U.S. transportation data with data from seven 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 automobiles, federal standards, fuel economies, and vehicle emission data. Household travel behavior characteristics are displayed in Chapter 4. Chapter 5 contains information on alternative fuels and alternatively-fueled vehicles. The last chapter, Chapter 6, covers each of the nonhighway modes: air, water, pipeline, and rail, respectively.

STATISTICAL SUMMARY

Vehicle stock (thousands)

	New sales	In use
Automobiles, 1989	9,772	123,276
Two seater	1.4%	2.3%
Minicompact	0.2%	3.3%
Subcompact	20.1%	23.0%
Compact	36.1%	24.5%
Midsize	28.2%	28.4%
Large	13.9%	18.5%
Trucks, 1989	4,846	53,202
Light	93.8%	91.9%
Medium	1.1%	2.3%
Light-heavy	0.8%	1.7%
Heavy-heavy	4.3%	4.1%
Motorcycles, 1989	505	4,434
Buses, 1989		588
Aircraft[e], 1989		220
Commercial water vessels, 1989		39
Recreational boats, 1989		9,829
Railroad cars, 1989		690

Transportation movement (billions)

Domestic passenger travel, 1989	
Vehicle-miles	1,801
Automobiles	82.4%
Motorcycles	0.6%
Personal trucks	16.1%
Buses[b]	0.3%
Air[c]	0.5%
Rail	0.1%
Passenger-miles	3,586
Automobiles	70.4%
Motorcycles	0.3%
Personal trucks	15.4%
Buses[d]	3.5%
Air[b]	9.7%
Rail	0.7%
Domestic intercity freight movement, 1989	
Ton-miles	3,138
Trucks	22.8%
Water	26.0%
Pipeline[f]	18.9%
Rail[g]	32.3%

Energy use (trillion Btu)

Total United States energy use, 1990	81,450
Total U.S. petroleum use, 1990	33,650
Percentage of U.S. energy use	41.3%
Percentage used in transportation	63.6%
Percentage of transportation energy	97.1%
Total transportation energy use, 1990	22,050
Percentage of U.S. energy use, 1990	27.1%
Highway, 1989	72.9%
Automobiles	39.2%
Motorcycles	0.1%
Trucks	32.9%
Buses	0.7%
Nonhighway, 1989	20.7%
Air	8.6%
Water	6.0%
Pipeline	3.9%
Rail	2.2%
Off-highway, 1985	2.9%
Military operations, 1989	3.5%

[b] Transit bus and school bus only.
[c] Certificated route air carriers and general aviation.
[d] Transit and intercity bus only.
[e] General aviation aircraft only.
[f] Coal slurry and crude oil and products pipeline only.
[g] Class I rail only.

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 Data 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 12.

The current role of the government in reducing transportation energy use is to supplement the efforts of private industry. To this end, the major thrust of the Office of Transportation Technologies is toward the research and development of generic, high-risk technologies with a large potential for energy savings. 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 12 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 seven selected countries in Asia, Europe, and North America. The U.S. data in this chapter are presented for comparison with other international data only and, therefore, should not match domestic data found in other chapters of the book. 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 federal standards and fuel economies of highway vehicles, and vehicle emission data. Household travel behavior characteristics are displayed in Chapter 4. Chapter 5 presents data on alternative fuels and alternatively-fueled vehicles. Chapter 6 consists of data for the nonhighway modes: air, water, pipeline, and rail. 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 can endorse the validity of these data.

Edition 12 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. An oil embargo was affecting the economy in 1982, and the base year was chosen as a year of economic recession.

Table identifiers, first used in edition 10, can be found on the upper outside corner of each table and in the Table of Contents. The table identifiers were created to assist in the specific location of information, since many of the same tables are updated in each edition of the data book, but are not given the same table number or page number as the previous edition. Throughout future editions of the data book, the table identifiers will remain the same for each table which is published, and new identifiers will be created for new tables.

CHAPTER 1
INTERNATIONAL TRANSPORTATION STATISTICS

This chapter includes statistics related to the transportation sector of eight selected countries around the world. Countries were selected 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 1960, 62.7% of the world's automobiles were registered in the United States; by 1989, that percentage had dropped to 33.7% (Table 1.1). The U.S. had a lower annual growth rate in automobile registrations from 1950 to 1989 than any of the other listed countries except Sweden, for which 1950 data are not available. The U.S. also accounts for 33.3% of the world's truck and bus registrations. Japan has experienced the most growth in truck and bus registrations since 1950, 13% annually (Table 1.2.).

The U.S. had the highest number of automobiles per capita in 1989 (0.575), with Canada following second (0.489). Japan has had the lowest number of automobiles per capita of any of the listed countries. However, Japan, whose truck and bus registration growth was noted earlier, closely follows the U.S. in the number of trucks and buses per capita, 0.178 and 0.173, respectively (Table 1.3).

The data on gasoline prices indicate that Italy has had the highest gasoline prices over the past eight years, while the U.S. has had the lowest of the listed countries (Table 1.4). Italy's high gasoline prices in 1989 were mainly due to the gasoline tax (Figure 1.4). The countries with the highest diesel taxes are West Germany and the United Kingdom (Figure 1.5).

The U.S. transported a greater share of goods by rail in 1985 than the other listed countries (Table 1.9). Water transport of goods was prevalent in Japan, but hardly used in Italy at that time. In all of the listed countries, more passenger-miles were traveled by automobile than any other mode (Table 1.10). Air transportation was the mode with the least passenger-miles for all countries except the U.S., where fewer passenger-miles were traveled by rail and bus. In 1987 France and Japan had the highest average number of people per vehicle, 1.85 and 1.84, respectively (Table 1.11). The automobile load factor for every listed country declined from 1970 to 1987.

Japan used 2.5 times more energy for automobiles and air travel in 1987 than in 1970 (Table 1.12). The only declines in energy use from 1970 to 1987 were in rail and air travel in West Germany and rail travel in the United Kingdom. The highway modes, automobiles and buses, consumed the majority of energy in all listed countries.

Table 1.1
Automobile Registrations for Selected Countries, 1950-89
(thousands)

	Asia	Europe					North America		Percentage		
Year	Japan	France	Italy	Sweden	United Kingdom	West Germany	Canada	United States	U.S. of world	All other countries[a]	World total
1950	43	[b]	342	[b]	2,307	[b]	1,913	40,339	[b]	[b]	[b]
1955	153	[b]	861	[b]	3,609	1,821	2,961	52,145	[b]	[b]	[b]
1960	457	4,873	1,976	[b]	5,650	4,559	4,104	61,671	62.7%	15,027	98,317
1965	2,181	8,718	5,473	[b]	9,131	9,043	5,279	75,258	53.8%	24,697	139,780
1970	8,779	12,280	10,191	[b]	11,802	13,299	6,602	89,244	46.1%	41,319	193,516
1975	17,236	15,555	15,060	2,760	14,061	16,764	8,870	106,706	41.0%	63,195	260,207
1980	23,660	19,150	17,686	2,553	15,438	21,455	10,256	121,601	37.9%	89,630	320,539
1981	24,612	19,725	18,603	2,893	15,633	21,812	10,199	123,098	38.4%	83,938	320,513
1982	25,539	20,420	19,616	2,936	17,640	22,086	10,530	123,702	36.4%	97,793	340,262
1983	26,385	20,950	20,389	3,007	18,101	22,624	10,732	126,444	35.9%	103,684	352,316
1984	27,144	21,175	20,888	3,081	18,521	23,193	10,781	128,158	35.1%	131,873	364,814
1985	27,845	21,325	21,500	3,151	18,936	23,777	11,118	131,864	35.2%	115,211	374,727
1986	28,654	21,575	22,100	3,253	19,390	24,700	11,586	135,431	35.1%	119,828	386,308
1987	29,478	21,950	22,800	3,367	20,069	25,558	11,686	137,324	34.8%	121,907	394,210
1988	30,776	22,370	23,500	3,483	20,923	26,228	12,086	141,252	34.2%	132,309	412,907
1989	32,621	23,010	26,300	3,578	21,849	26,914	12,811	143,081	33.7%	134,202	424,366
					Average annual percentage change						
1950-89	18.5%	5.5%[c]	11.8%	[b]	5.9%	8.2%[d]	5.0%	3.3%		7.8%[c]	5.2%[c]
1970-89	7.2%	3.4%	5.1%	1.9%[e]	3.3%	3.8%	3.6%	2.5%		6.4%	4.2%
1982-89	3.6%	1.7%	4.3%	2.9%	3.1%	2.9%	2.8%	2.1%		4.6%	3.2%

Source:
Motor Vehicle Manufacturers Association, World Motor Vehicle Data, 1991 Edition, Detroit, Michigan, 1991, pp. 33, 82, 138, 162, 183, 226, 252, 309, 336, 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 1960-89
[d]Average annual percentage change is for 1955-89.
[e]Average annual percentage change is for 1975-89.

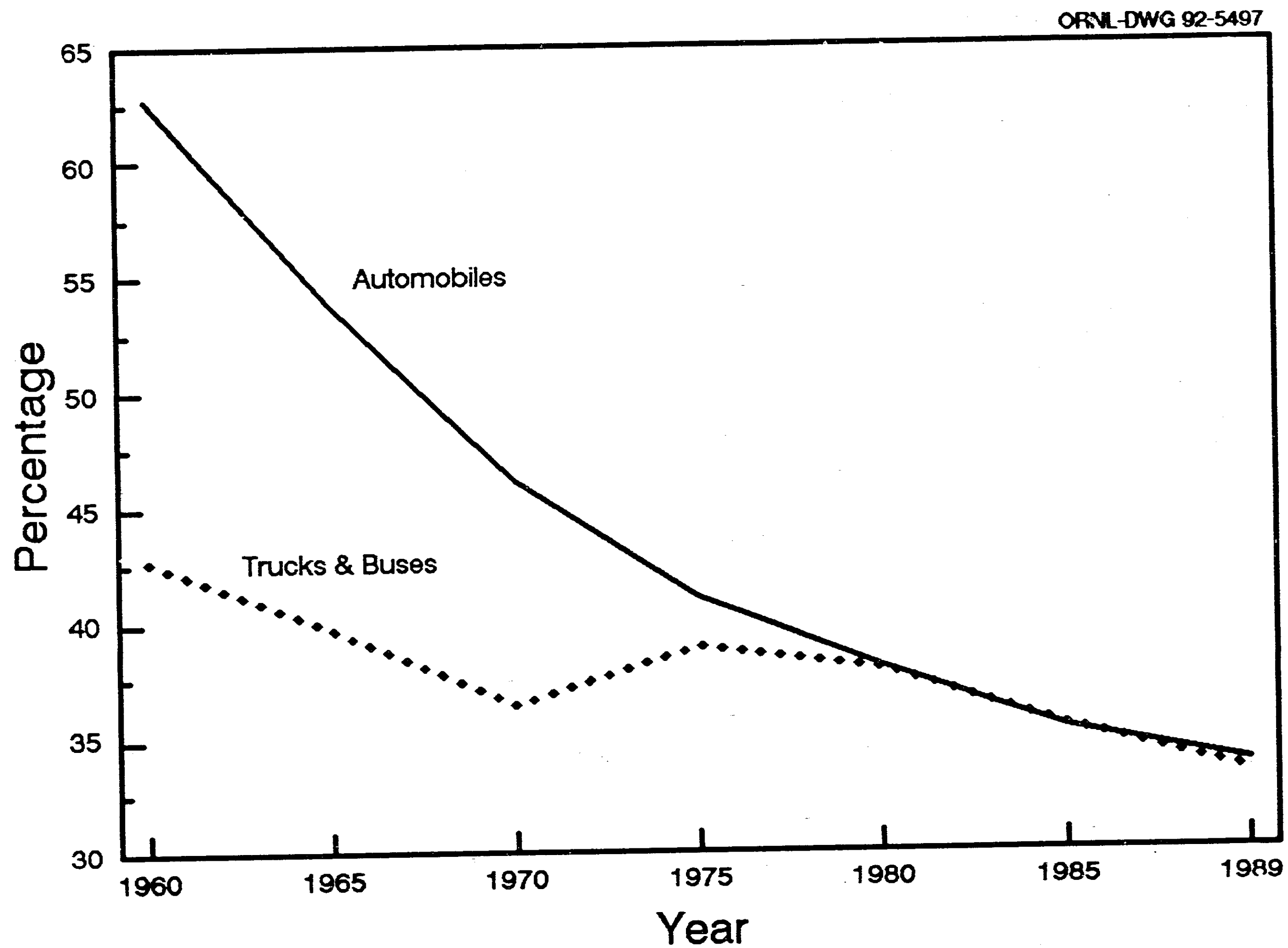
Table 1.2
Truck and Bus Registrations for Selected Countries, 1950-89
(thousands)

	Asia	Europe					North America		Percentage		
Year	Japan	France	Italy	Sweden	United Kingdom	West Germany	Canada	United States	U.S. of world	All other countries[a]	World total
1950	183	[b]	235	[b]	1,060	[b]	643	8,823	[b]	[b]	[b]
1955	318	[b]	335	[b]	1,244	764	952	10,544	[b]	[b]	[b]
1960	896	1,467	455	[b]	1,534	1,083	1,056	12,186	42.6%	9,960	28,637
1965	4,119	1,910	664	[b]	1,748	1,696	1,232	15,100	39.6%	11,658	38,127
1970	8,793	2,115	929	[b]	1,769	2,306	1,481	19,175	36.3%	16,285	52,852
1975	10,854	2,377	1,193	171	1,934	2,735	2,158	26,243	38.8%	20,030	67,693
1980	14,197	2,571	1,429	194	1,920	3,398	2,955	34,196	37.8%	29,712	90,573
1981	15,009	2,625	1,547	199	1,889	3,515	3,192	35,188	38.9%	27,399	90,563
1982	15,797	2,690	1,642	207	2,511	3,598	3,293	35,941	36.4%	32,978	98,657
1983	16,546	2,734	1,764	215	2,567	3,738	3,363	37,306	36.0%	35,483	103,716
1984	17,380	2,746	1,792	224	2,690	3,878	3,099	38,091	35.1%	38,564	108,464
1985	18,313	2,765	1,824	232	2,746	4,045	3,148	39,789	35.3%	39,954	112,816
1986	18,342	2,828	1,856	244	2,818	4,276	3,213	40,760	35.9%	38,087	113,423
1987	19,397	2,904	1,916	260	2,948	4,534	3,576	41,714	34.4%	44,224	121,176
1988	20,588	2,972	1,980	281	3,674	4,795	3,766	43,145	34.0%	45,681	126,882
1989	21,326	4,748[c]	2,082	309	3,824	5,140	3,458	44,179	33.3%	47,500	132,566
					Average annual percentage change						
1950-89	13.0%	4.1%[d]	5.8%	[b]	3.3%	5.8%[e]	4.4%	4.2%		5.5%[d]	5.4%[d]
1970-89	4.8%	4.3%	4.3%	4.3%[f]	4.1%	4.3%	4.6%	4.5%		5.8%	5.0%
1982-89	4.4%	8.5%	3.4%	5.9%	6.2%	5.2%	0.7%	3.0%		5.4%	4.3%

Source:
Individual countries - Motor Vehicle Manufacturers Association, World Motor Vehicle Data, 1991 Edition, Detroit, Michigan, 1991, pp 38, 82, 138, 162, 183, 226, 256, 309, 336, 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]Different data source.
[d]Average annual percentage change is for 1960-89.
[e]Average annual percentage change is for 1955-89
[f]Average annual percentage change is for 1975-89.

Figure 1.1. United States Automobile, and Truck and Bus Registrations as a Percent of World Registrations, 1960-89



Source: See Tables 1.1 and 1.2.

Table 1.3
Vehicles per Capita for Selected Countries, 1950-89

	Asia	Europe					North America	
Year	Japan	France	Italy	Sweden	United Kingdom	West Germany	Canada	United States
				Automobiles per capita				
1950	0.001	[a]	0.007	[a]	0.046	[a]	0.140	0.265
1955	0.002	[a]	0.018	[a]	0.071	0.036	0.188	0.314
1960	0.005	0.107	0.040	[a]	0.108	0.086	0.229	0.341
1965	0.022	0.179	0.106	[a]	0.168	0.159	0.268	0.387
1970	0.085	0.242	0.190	[a]	0.213	0.219	0.310	0.438
1975	0.154	0.295	0.270	0.337	0.252	0.271	0.390	0.500
1980	0.203	0.355	0.313	0.320	0.274	0.349	0.427	0.534
1985	0.230	0.387	0.376	0.377	0.334	0.390	0.442	0.551
1989	0.265	0.410	0.457	0.421	0.382	0.434	0.489	0.575
				Trucks and buses per capita				
1950	0.002	[a]	0.005	[a]	0.021	[a]	0.047	0.058
1955	0.004	[a]	0.007	[a]	0.024	0.016	0.060	0.064
1960	0.010	0.032	0.009	[a]	0.029	0.020	0.059	0.067
1965	0.042	0.039	0.013	[a]	0.032	0.030	0.063	0.078
1970	0.085	0.042	0.017	[a]	0.032	0.038	0.069	0.094
1975	0.097	0.045	0.021	0.021	0.035	0.031	0.095	0.123
1980	0.122	0.048	0.025	0.023	0.034	0.031	0.123	0.150
1985	0.152	0.050	0.032	0.028	0.048	0.045	0.125	0.166
1989	0.173	0.085	0.036	0.036	0.067	0.062	0.132	0.178

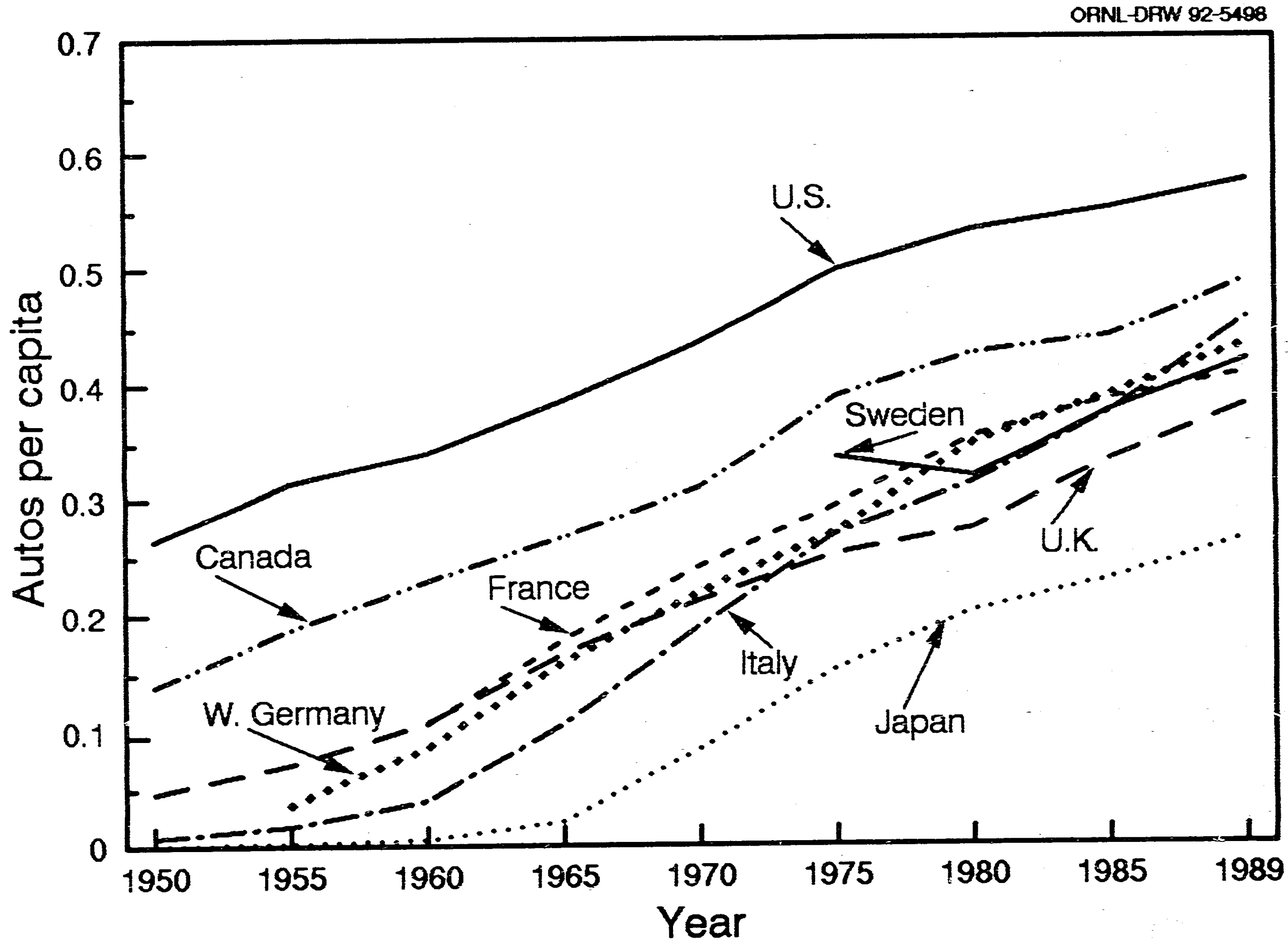
Sources:

Vehicle registrations - Motor Vehicle Manufacturers Association, World Motor Vehicle Data, 1991 Edition, Detroit, Michigan, 1991, pp. 38, 82, 138, 162, 183, 226, 252, 309, 336, and annual.

Population - United Nations, Department of International Economic and Social Affairs, Statistical Office, 1989 Demographic Yearbook, New York, 1991, pp. 142-145, and annual.

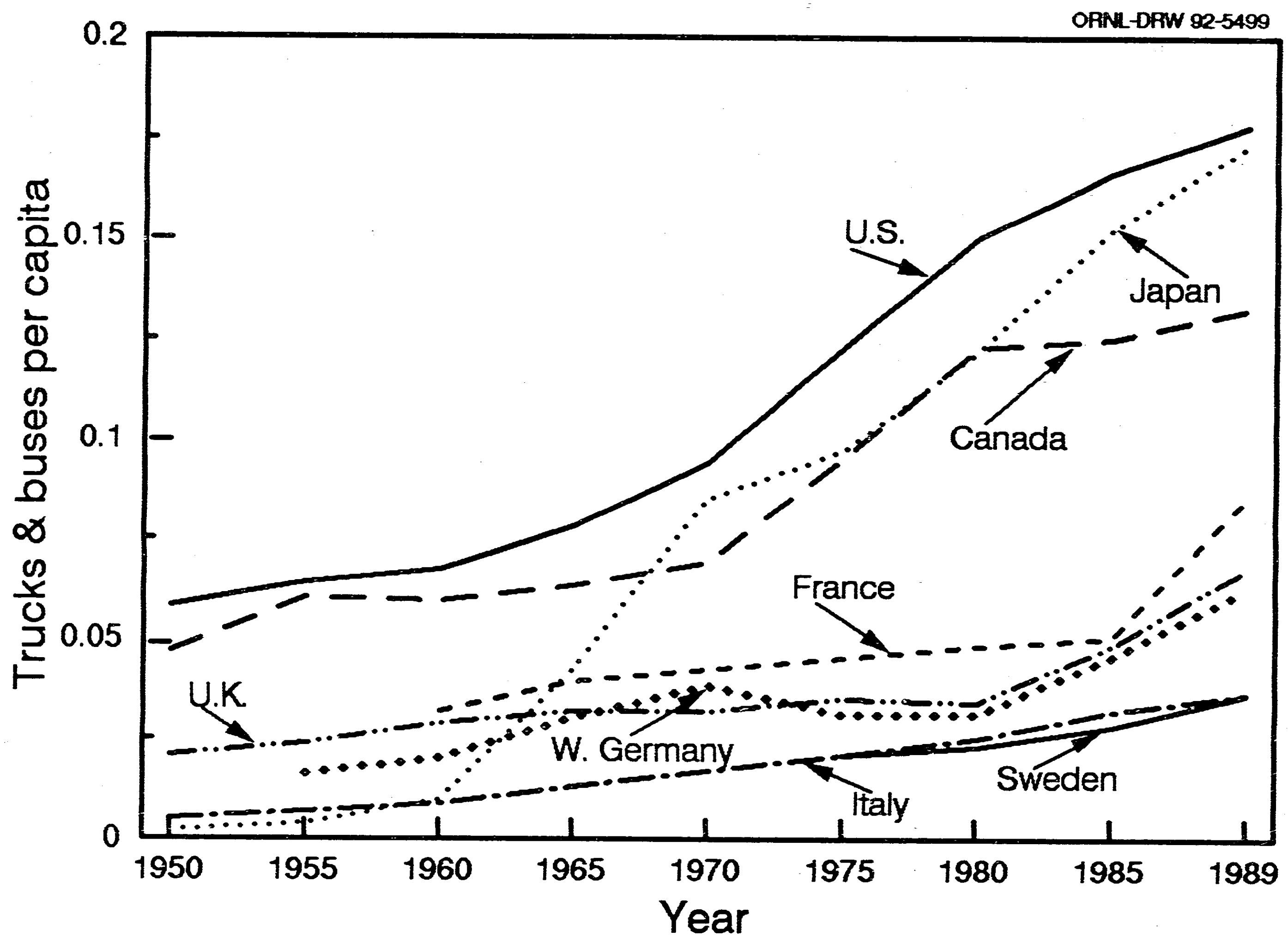
[a]Data are not available.

Figure 1.2. Automobiles per Capita for Selected Countries, 1950-89



Source: See Table 1.3.

Figure 1.3. Trucks and Buses per Capita for Selected Countries, 1950-89



Source: See Table 1.3.

The United Kingdom was the only European country which had a gasoline price decline (in constant 1990 dollars) from 1989 to 1990. The United States and Japan were the only other countries to experience this decline. However, the 1990 data represent prices only on January 1, 1990. The yearly average may be somewhat different. Over the past eight years, the United States has reported the lowest gasoline prices among all listed countries while Italy has the highest.

Table 1.4
Gasoline Prices for Selected Countries,[a] 1978-90

	Current dollars per gallon													Average annual percentage change	
	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990[b]	1978-90	1982-90
Asia:															
Japan[c]	2.00	2.10	2.58	2.64	2.60	2.42	2.31	2.25	2.79	3.17	3.43	3.18	3.05	3.6	2.0
Europe:															
France	2.15	2.56	3.03	2.70	2.56	2.37	2.24	2.37	2.58	3.05	3.06	3.07	3.40	3.9	3.6
Italy	2.23	2.47	3.10	2.97	2.88	2.93	2.79	2.63	3.26	3.79	3.95	3.80	4.27	5.6	5.0
Sweden	1.56	1.94	2.64	2.64	2.40	2.07	1.93	2.06	2.20	2.50	2.76	2.80	3.23	6.3	3.8
United Kingdom	1.22	1.79	2.50	2.57	2.42	2.25	2.05	2.12	2.07	2.39	2.51	2.51	2.55	6.3	0.7
West Germany	1.75	2.06	2.43	2.38	2.17	2.04	1.87	1.87	1.88	2.20	2.20	2.49	2.72	3.7	2.9
North America:															
Canada[c]	0.69	0.73	0.85	1.13	1.37	1.47	1.48	1.45	1.31	1.41	1.54	1.63	1.92	8.9	4.3
United States[d]	0.66	0.87	1.23	1.37	1.32	1.25	1.22	1.20	0.93	0.93	0.95	1.02	1.04	3.9	-2.9

	Constant 1990 dollars[e] per gallon													Average annual percentage change	
	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990[b]	1978-90	1982-90
Asia:															
Japan[c]	4.01	3.78	4.09	3.79	3.52	3.17	2.91	2.73	3.33	3.64	3.79	3.35	3.05	-2.3	-1.8
Europe:															
France	4.31	4.61	4.81	3.45	3.47	3.11	2.82	2.88	3.07	3.51	3.38	3.24	3.40	-2.0	-0.3
Italy	4.47	4.45	4.92	4.27	3.90	3.84	3.51	3.19	3.89	4.36	4.36	4.01	4.27	-0.4	1.1
Sweden	3.12	3.49	4.19	3.79	3.25	2.72	2.43	2.50	2.62	2.87	3.05	2.95	3.23	0.3	-0.1
United Kingdom	2.44	3.22	3.96	3.69	3.28	2.95	2.58	2.58	2.47	2.75	2.77	2.65	2.55	0.4	-3.1
West Germany	3.51	3.71	3.85	3.42	2.94	2.68	2.35	2.27	2.24	2.53	2.43	2.62	2.72	-1.0	-2.1
North America:															
Canada[c]	1.38	1.31	1.35	1.62	1.85	1.93	1.86	1.76	1.56	1.62	1.70	1.72	1.92	2.8	0.5
United States[d]	1.32	1.57	1.95	1.97	1.79	1.64	1.53	1.46	1.11	1.07	1.05	1.08	1.04	-2.0	-6.6

Source:
U.S. Department of Energy, Energy Information Administration, International Energy Annual 1989, Washington, DC, February 1991, pp. 91-94, 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.

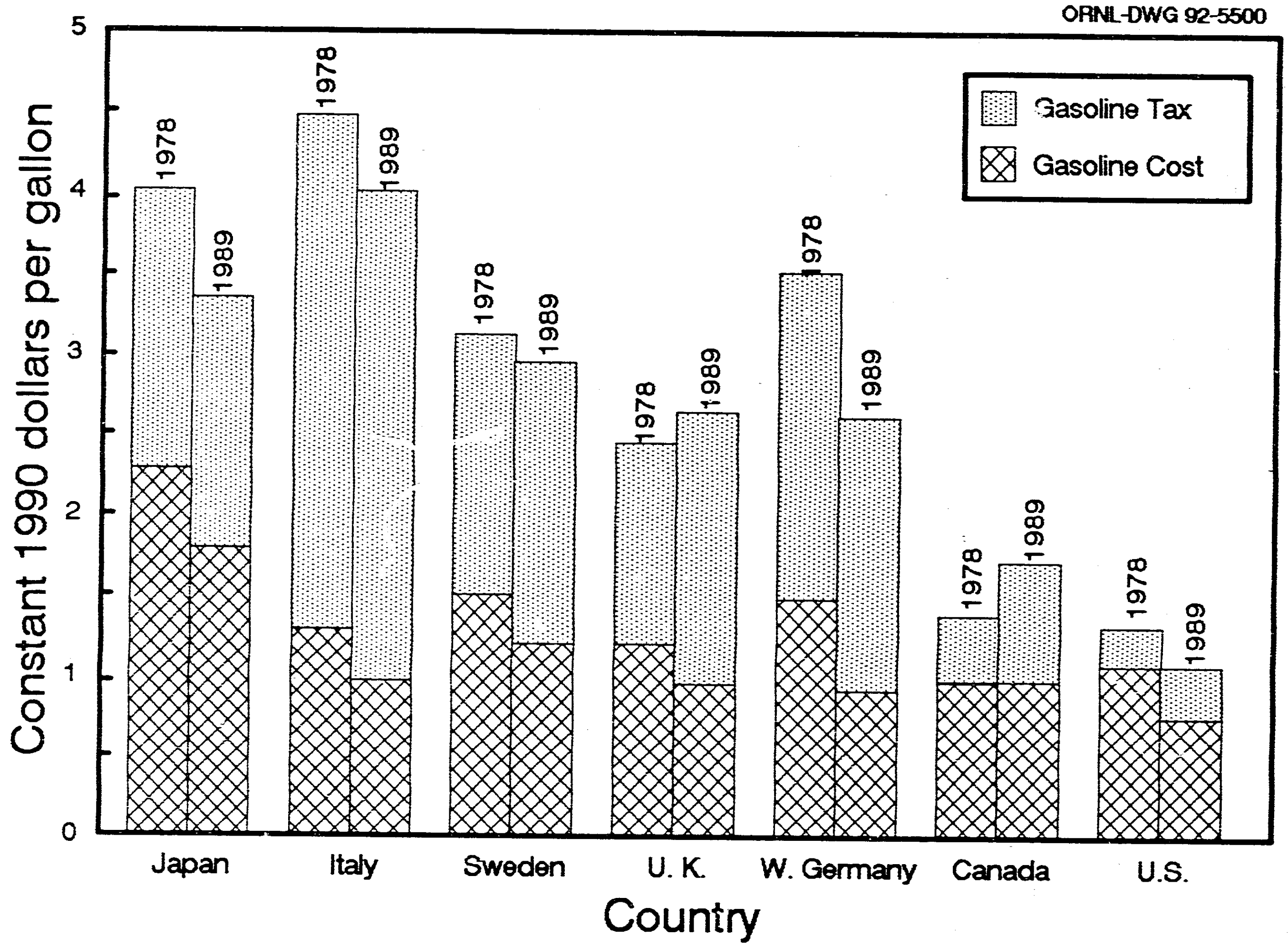
[b]1990 prices represent the retail prices (including taxes) for premium leaded gasoline on January 1, 1990.

[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 1.4. Gasoline Prices for Selected Countries, 1978 and 1989



Source: See Table 1.4.

Diesel fuel prices in the U.S. in 1990 were at least 75 cents lower than any other listed country. The U.S. has typically had the lowest diesel prices, while the European countries have the highest.

Table 1.5
Diesel Fuel Prices for Selected Countries,[a] 1978-90

	Current dollars per gallon													Average annual percentage change	
	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990[b]	1978-90	1982-90
Asia:															
Japan	[c]	1.23	1.70	1.81	1.78	1.72	1.66	1.60	1.90	1.91	2.02	2.02	1.75	3.3[d]	-0.2
Europe:															
France	1.30	1.65	2.11	1.98	1.88	1.76	1.63	1.68	1.69	1.92	1.84	1.86	1.78	2.7	-0.7
Italy	0.64	0.80	1.21	1.11	1.19	1.26	1.20	1.21	1.31	1.62	1.78	1.82	2.34	11.4	8.8
Sweden	0.62	0.83	1.31	1.35	1.41	1.26	1.32	1.36	1.24	1.54	1.64	1.84	2.30	11.5	6.3
United Kingdom	1.24	1.70	2.19	2.23	2.05	1.87	1.68	1.78	1.71	1.89	1.99	2.06	2.04	4.2	-0.1
West Germany	1.48	1.77	2.10	1.90	1.81	1.66	1.53	1.52	1.51	1.72	1.66	1.71	2.72	5.2	5.2
North America:															
Canada	[c]	[c]	[c]	1.27	1.27	1.33	1.30	1.31	1.27	1.33	1.45	1.47	1.55	[c]	2.5
United States[e]	0.54	0.73	1.01	1.18	1.16	1.20	1.22	1.22	0.94	0.96	0.95	0.89	0.99	5.2	-2.0

	Constant 1990 dollars[f] per gallon													Average annual percentage change	
	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990[b]	1978-90	1982-90
Asia:															
Japan	[c]	2.21	2.70	2.60	2.41	2.26	2.09	1.94	2.26	2.20	2.23	2.13	1.75	-2.1[d]	-3.9
Europe:															
France	2.60	2.97	3.35	2.84	2.55	2.31	2.05	2.04	2.01	2.21	2.03	1.96	1.78	-3.1	-4.4
Italy	1.28	1.44	1.92	1.59	1.61	1.65	1.51	1.47	1.56	1.86	1.97	1.92	2.34	5.2	4.8
Sweden	1.24	1.49	2.08	1.94	1.91	1.65	1.66	1.65	1.48	1.77	1.81	1.94	2.30	2.3	5.3
United Kingdom	2.48	3.06	3.47	3.20	2.78	2.45	2.11	2.16	2.04	2.17	2.20	2.17	2.04	-1.6	-3.8
West Germany	2.96	3.19	3.33	2.73	2.45	2.18	1.92	1.85	1.80	1.98	1.83	1.80	2.72	1.3	-0.7
North America:															
Canada	[c]	[c]	[c]	1.82	1.72	1.74	1.64	1.59	1.51	1.53	1.60	1.55	1.55	[c]	-2.2
United States[e]	1.08	1.31	1.60	1.70	1.57	1.57	1.53	1.48	1.12	1.10	1.05	0.94	0.99	-0.7	-5.6

Source:
U.S. Department of Energy, Energy Information Administration, International Energy Annual 1989, Washington, DC, February 1991, p. 91-94, 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]1990 prices represent the retail prices (including taxes) for diesel fuel on January 1, 1990.

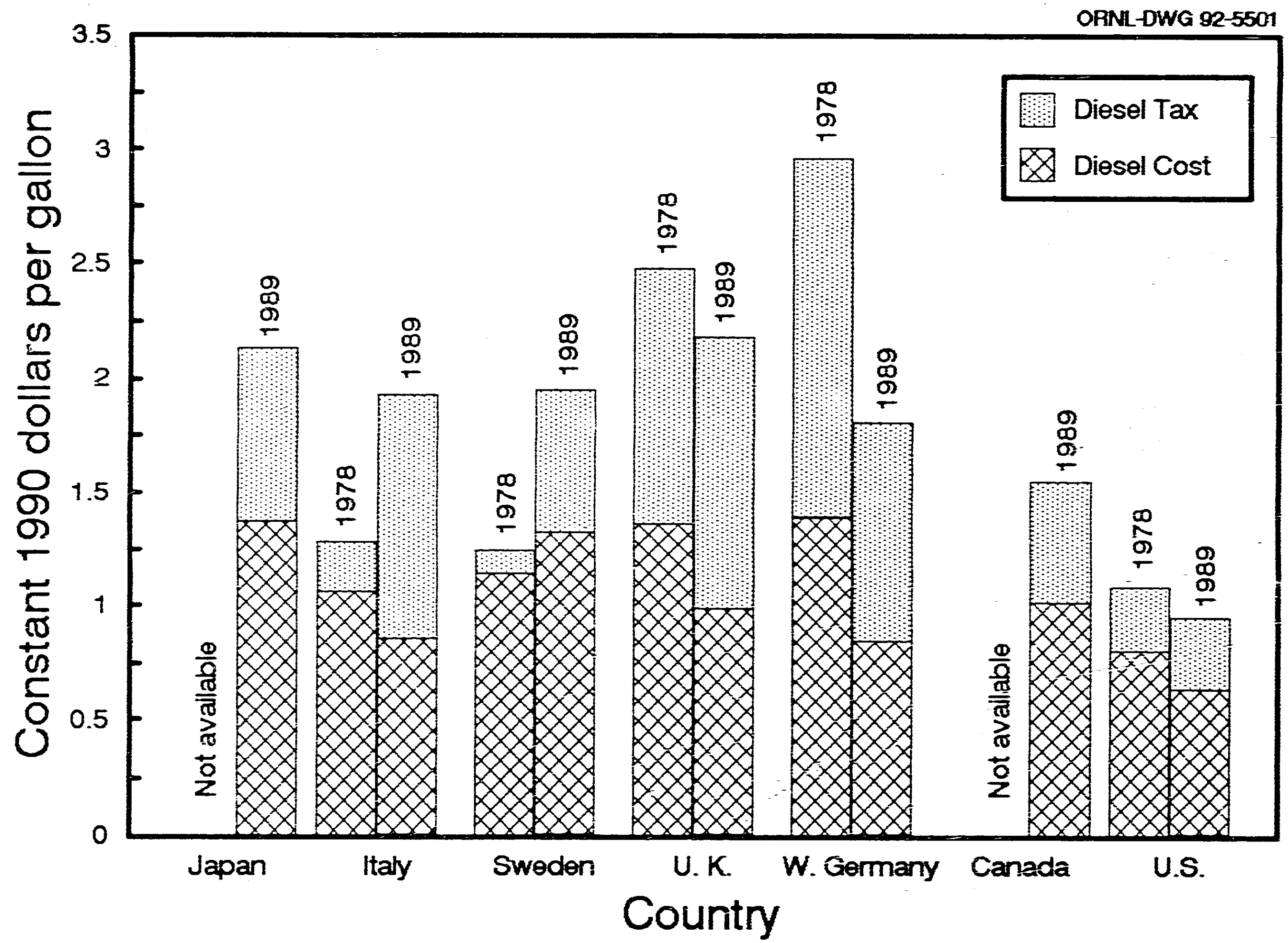
[c]Data are not available.

[d]Average annual percentage change is for years 1979-90.

[e]These estimates are for international comparisons only and do not necessarily correspond to diesel price estimates in other sections of the book.

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

Figure 1.5. Diesel Fuel Prices for Selected Countries, 1978 and 1989



Source: See Table 1.5.

*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.*

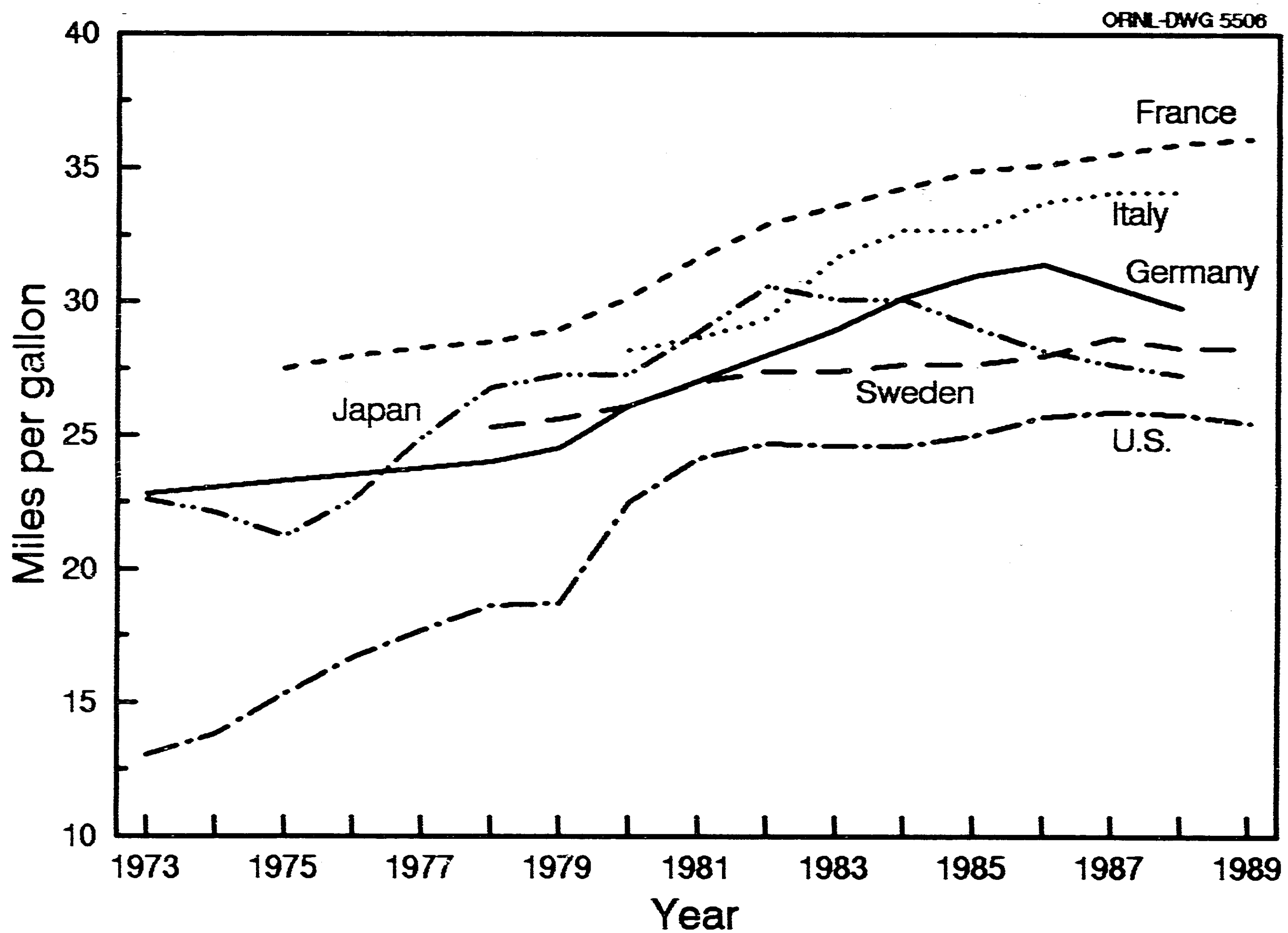
Table 1.6
New Gasoline Car Fuel Economy for Selected Countries, 1973-89
(miles per gallon)

Year	Japan	France	Italy	Sweden	Germany	United States
1973	22.6	[a]	[a]	[a]	22.8	13.0
1974	22.1	[a]	[a]	[a]	[a]	13.8
1975	21.2	27.5	[a]	[a]	[a]	15.3
1976	22.6	28.0	[a]	[a]	[a]	16.7
1977	24.9	28.3	[a]	[a]	[a]	17.7
1978	26.8	28.5	[a]	25.3	24.0	18.6
1979	27.3	29.0	[a]	25.6	24.5	18.7
1980	27.3	30.2	28.2	26.1	26.1	22.5
1981	28.9	31.7	28.7	27.0	[a]	24.1
1982	30.6	32.9	29.4	27.4	[a]	24.7
1983	30.1	33.6	31.7	27.4	29.0	24.6
1984	30.1	34.3	32.7	27.7	30.2	24.6
1985	29.1	34.9	32.7	27.7	31.0	25.0
1986	28.2	35.1	33.7	28.0	31.4	25.7
1987	27.7	35.5	34.1	28.7	30.6	25.9
1988	27.3	35.9	34.1	28.3	29.8	25.8
1989	[a]	36.1	[a]	28.3	[a]	25.5
			Average annual percentage change			
1973-89	1.3%[b]	1.9%[c]	2.4%[d]	1.0%[e]	1.8%[f]	4.3%
1982-89	-1.9%[b]	1.3%	2.5%[d]	0.5%	0.5%[f]	0.5%

Sources:
International Energy Studies, Energy Analysis Program, Lawrence Berkeley Laboratory, Berkeley, CA, 1991. Data were compiled from country sources, such as oil companies, energy economics institutes, and government ministries.

[a]Data are not available.
[b]Average annual percentage changes are for years 1973-88 and 1982-88.
[c]Average annual percentage change is for years 1975-89.
[d]Average annual percentage changes are for years 1980-88 and 1982-88.
[e]Average annual percentage change is for years 1978-89.
[f]Average annual percentage changes are for years 1973-88 and 1983-88.

Figure 1.6. New Gasoline Car Fuel Economy for Selected Countries, 1973-89



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 between 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 1.7
Fuel Economy of the Gasoline Automobile Population for Selected Countries, 1970-89
(miles per gallon)

Year	Japan	France	Italy	Sweden	United Kingdom	Germany	United States
1970	21.4	27.6	[a]	22.1	23.4	23.0	13.2
1971	19.6	27.6	[a]	[a]	23.4	22.0	13.2
1972	21.4	27.6	[a]	21.7	21.9	21.4	13.1
1973	21.4	27.9	27.8	21.5	21.7	21.9	13.0
1974	21.4	27.6	[a]	[a]	21.8	22.1	13.1
1975	21.4	27.2	[a]	[a]	22.5	21.9	13.2
1976	21.4	26.2	[a]	22.1	22.6	21.8	13.2
1977	21.4	26.3	[a]	[a]	22.4	21.6	13.5
1978	19.6	25.9	[a]	21.8	22.0	21.4	13.7
1979	19.6	26.3	27.8	[a]	21.5	21.7	14.0
1980	19.6	27.5	28.7	[a]	22.6	21.5	14.9
1981	19.6	28.0	28.0	21.6	23.5	21.6	15.3
1982	21.4	26.8	28.0	21.5	23.6	21.6	15.9
1983	21.4	26.6	28.2	21.8	23.7	21.6	16.3
1984	21.4	26.8	28.7	21.8	23.7	21.6	16.8
1985	21.4	26.9	28.9	22.0	24.1	21.6	17.1
1986	21.4	26.8	29.4	22.4	24.0	21.6	17.1
1987	21.4	26.9	29.9	22.8	24.4	21.8	17.5
1988	21.4	26.5	30.1	23.1	24.1	22.0	18.4
1989	[a]	26.9	30.6	23.1	25.3	22.4	18.9
			Average annual percentage change				
1970-89	0.0%[b]	-0.1%	0.6%[c]	0.2%	0.4%	-0.1%	1.9%
1982-89	0.0%[b]	0.1%	1.3%	1.0%	1.0%	-0.5%	2.5%

Sources:
International Energy Studies, Energy Analysis Program, Lawrence Berkeley Laboratory, Berkeley, CA, 1991. Data were compiled from country sources, such as oil companies, energy economics institutes, and government ministries.

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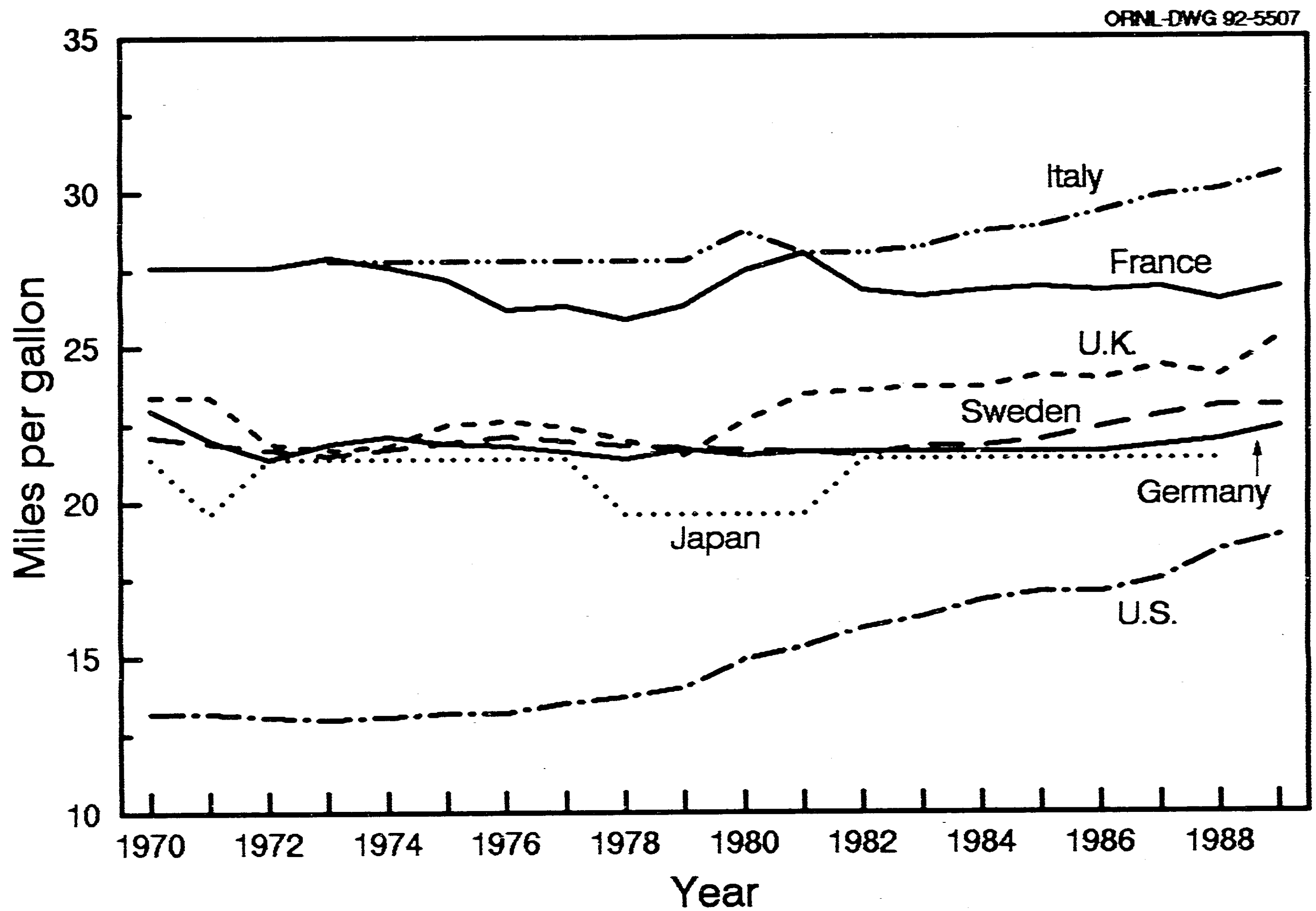
[a]Data are not available.
[b]Average annual percentage changes are for years 1970-88 and 1982-88.
[c]Average annual percentage change is for years 1973-89.

Figure 1.7. Fuel Economy of the Gasoline Automobile Population for Selected Countries, 1970-89



Source: See Table 1.7.

Table 1.8
Annual Miles per Vehicle for Selected Countries, 1984-89
(miles)

	1984	1985	1986	1987	1988	1989
Asia:						
Japan						
Cars	6,486	6,503	6,519	6,274	6,124	[a]
Trucks	7,485	7,438	7,483	6,786	6,913	[a]
Buses	17,052	17,070	17,250	17,299	17,310	[a]
Europe:						
France						
Cars	7,643	7,768	8,078	8,451	8,389	8,451
Trucks	12,428	12,428	12,428	12,428	13,049	13,671
Buses	29,827	29,827	29,827	29,827	29,827	31,070
Italy						
Cars	6,152	6,152	6,152	6,214	[a]	[a]
Trucks	19,596	13,453	13,566	13,648	[a]	[a]
Buses	31,960	32,822	34,616	35,636	[a]	[a]
Sweden						
Cars	7,457	7,457	7,457	7,768	7,768	7,457
Trucks	[a]	[a]	27,342	27,963	27,963	[a]
Buses	[a]	[a]	[a]	[a]	[a]	[a]
United Kingdom						
Cars	8,078	8,700	8,700	9,197	9,102	9,496
Trucks	30,449	30,449	31,691	35,544	29,963	13,752
Buses	28,584	26,720	27,963	22,992	16,947	19,529
West Germany						
Cars	8,700	8,451	8,700	8,886	9,072	9,010
Trucks	17,337	17,710	18,083	18,145	18,207	18,642
Buses	32,375	33,121	33,369	34,488	35,047	35,420
North America:						
Canada						
Cars	10,119	10,092	10,267	10,715	[a]	[a]
Trucks	[a]	[a]	[a]	[a]	[a]	[a]
Buses	[a]	[a]	[a]	[a]	[a]	[a]
United States						
Cars	9,785	9,558	9,606	9,882	10,117	10,382
Trucks	11,873	12,745	12,955	13,421	13,654	13,901
Buses	11,532	8,215	8,536	8,844	8,875	9,095

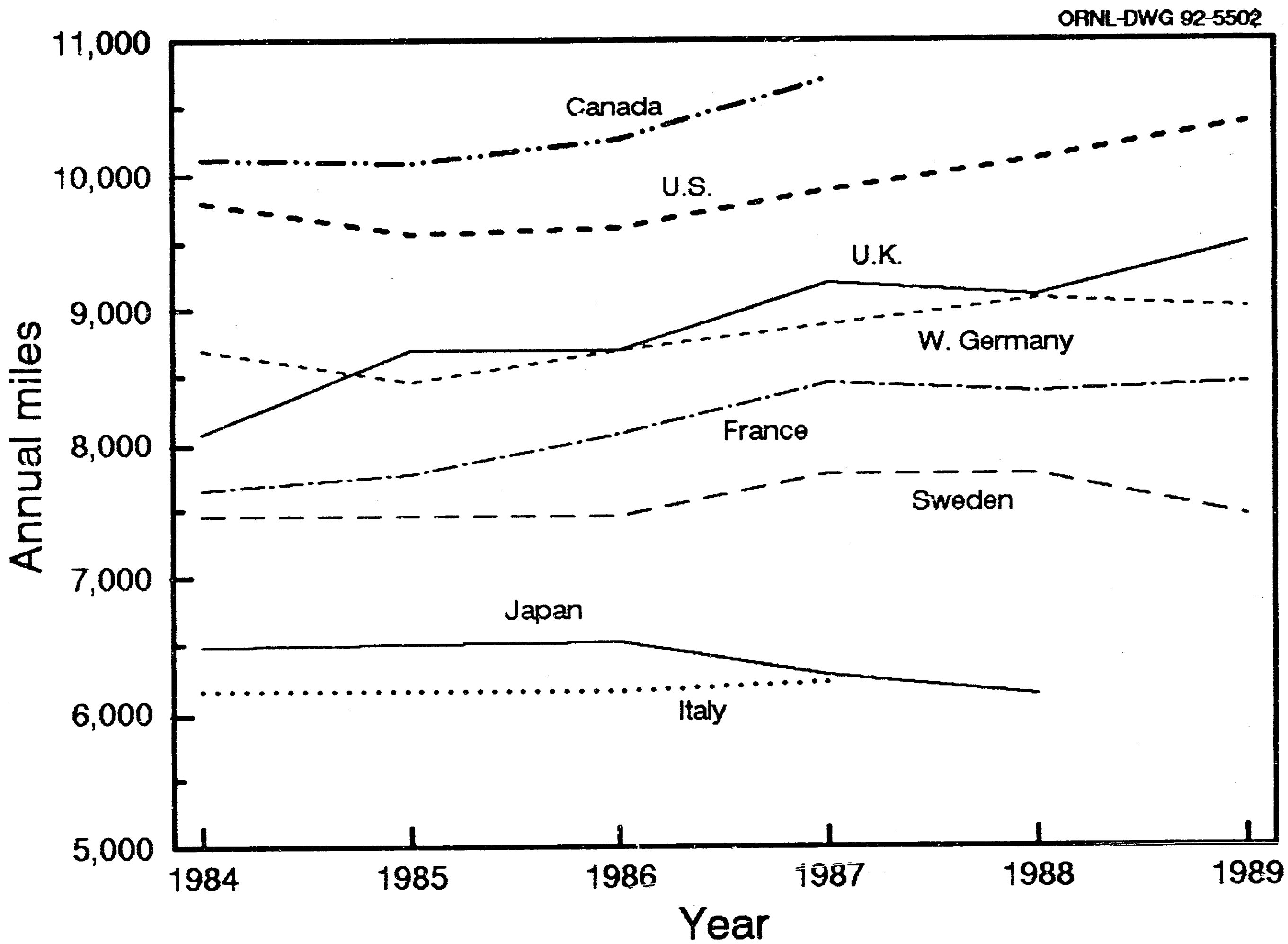
Sources:

International Road Foundation, World Road Statistics 1985-89, Washington, DC, 1990, pp. 78, 80, 82, 86, and 88.

1989 U.S. data - U.S. Department of Transportation, Federal Highway Administration, Highway Statistics 1989, Washington, DC, 1990, Table VM-1, p. 181.

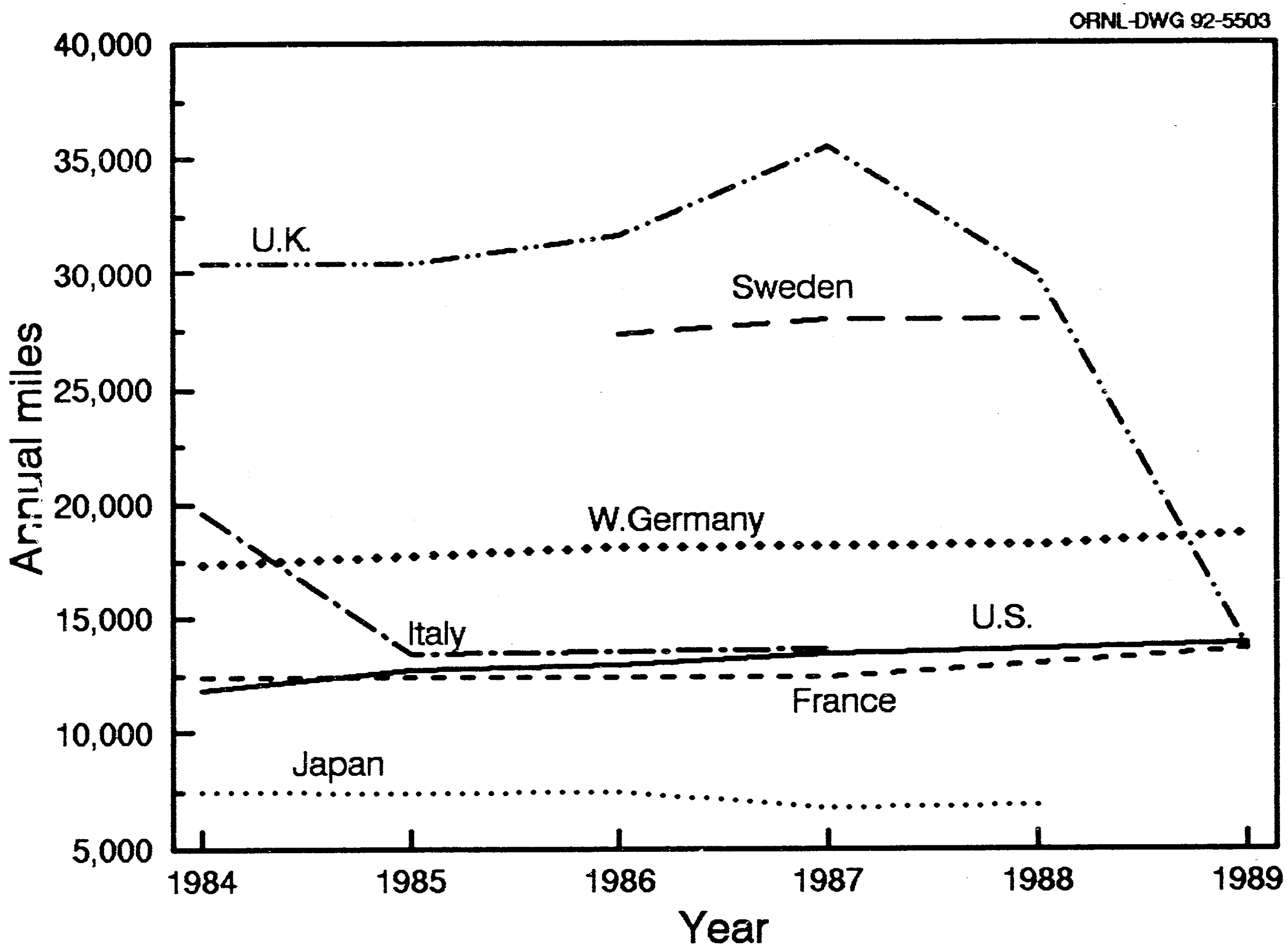
[a]Data are not available.

Figure 1.8. Annual Miles per Automobile for Selected Countries, 1984-89



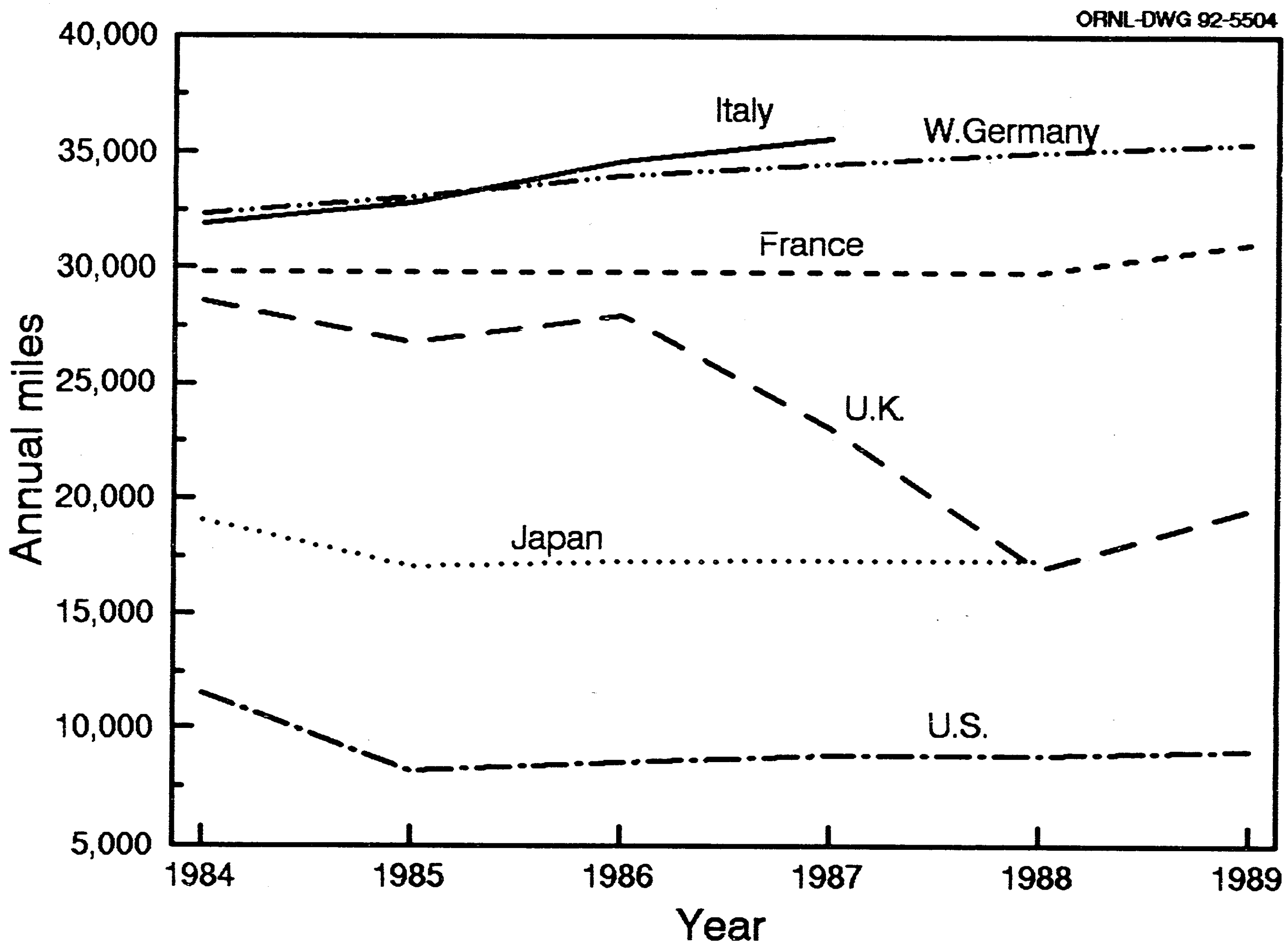
Source: See Table 1.8.

Figure 1.9. Annual Miles per Truck for Selected Countries, 1984-89



Source: See Table 1.8.

Figure 1.10. Annual Miles per Bus for Selected Countries, 1984-89



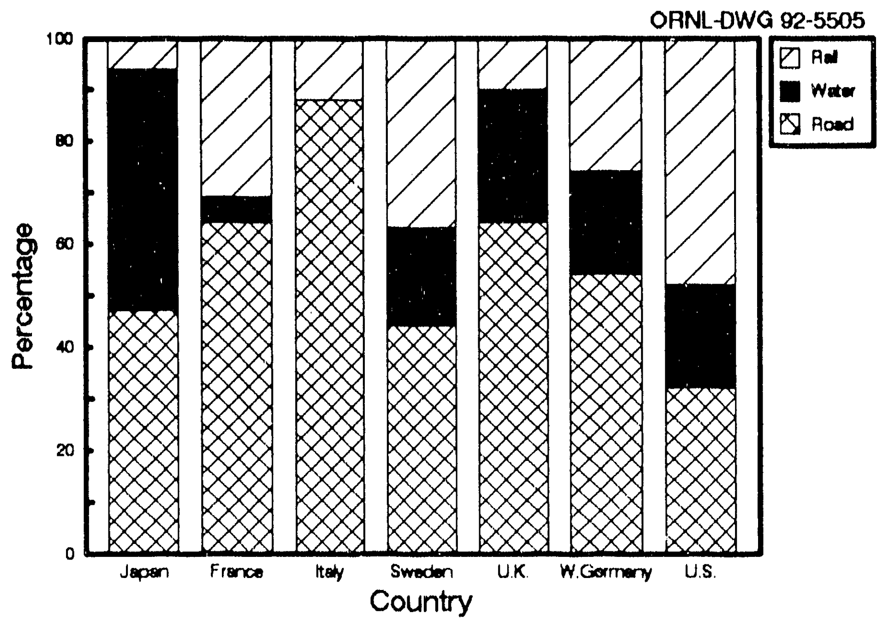
Source: See Table 1.8.

Table 1.9
Inland Surface Transport of Goods for Selected Countries, 1985
(million ton-miles)

	Road	Water	Rail
Asia:			
Japan	127,972	127,895	13,754
Europe:			
France	69,597	5,220	33,556
Italy	89,562	125	11,716
Sweden	13,159	5,593	10,929
United Kingdom	63,445	25,912	9,507
West Germany	83,330	29,951	39,770
North America:			
United States	609,593	382,161	894,816

Source:
International Road Foundation, World Road Statistics 1985-89, Washington, DC, 1990, pp. 79, 81, 83, 87, and 89.

Figure 1.11. Inland Surface Transport of Goods for Selected Countries, 1985



Source: Table 1.9.

Table 1.10
Passenger-miles by Mode for Selected Countries, 1970 and 1987
(billion passenger-miles)

	Automobiles		Buses		Rail		Air		Total	
	1970	1987	1970	1987	1970	1987	1970	1987	1970	1987
Asia:										
Japan	185	383	64	64	180	214	6	24	434	685
Europe:										
France	190	332	17	26	29	43	1	4	237	405
Italy	172[a]	277	31[a]	48	24[a]	27	1[a]	3	228[a]	355
Sweden	34	49	4	6	4	5	1	2	42	62
United Kingdom	180	309	33	25	22	24	1	2	237	362
West Germany	217	327	30	33	30	30	2	3	280	393
North America:										
United States	2,067	2,868	85	118	23	24	104	329	2,280	3,339

Source:
Schipper, Lee, et. al., Energy Use in Passenger Transport in OECD Countries: Changes between 1970 and 1987, Lawrence Berkeley Laboratory, Berkeley, CA, 1991, LBL-29830.

[a]1973 data.

From 1970 to 1987 the load factor for automobiles and buses declined in every listed country except France where the automobile load factor remained the same. The country with the largest decline in automobile load factor was the United States, while West Germany had the largest bus decline.

Table 1.11
Load Factor by Modes of Transportation, 1970 and 1987

	Automobiles		Buses		Rail	
	1970	1987	1970	1987	1970	1987
Asia:						
Japan	2.22	1.84	22.0	18.1	[a]	[a]
Europe:					[a]	[a]
France	1.85	1.85	24.2	23.1	[a]	[a]
Italy	1.97[b]	1.67	[a]	[a]	[a]	[a]
Sweden	1.85	1.58	[a]	12.4	[a]	[a]
United Kingdom	1.83	1.75	14.8	10.0	97.7[c]	98.0[c]
West Germany	1.70	1.50	22.1	15.6	127.9[c]	128.2[c]
North America:						
United States	2.20	1.70	18.1	17.6	20.4[d]	24.8[d]

Source:
Schipper, Lee, et. al., Energy Use in Passenger Transport in OECD Countries: Changes between 1970 and 1987, Lawrence Berkeley Laboratory, Berkeley, CA, 1991, LBL-29830.

[a]Data are not available.
[b]1973 data.
[c]Number of people per train.
[d]Number of people per car.

Table 1.12
Energy Use by Mode for Selected Countries, 1970 and 1987
(trillion Btu)

	Automobiles		Buses		Rail		Air		Total	
	1970	1987	1970	1987	1970	1987	1970	1987	1970	1987
<u>Asia:</u>										
Japan	488	1,219	47	54	55	64	38	96	628	1,433
<u>Europe:</u>										
France	431	773	13	28	21	23	6	14	471	839
Italy	358[a]	621	22[a]	57	17[a]	19	11[a]	19	409[a]	716
Sweden	102	151	5	9	3	4	4	9	114	172
United Kingdom	510	897	37	44	33	31	9	14	589	986
West Germany	631	1,152	24	39	30	27	13	12	699	1,230
<u>North America:</u>										
United States	9,264	11,709	109	156	61	76	950	1,401	10,384	13,342

Source:
Schipper, Lee, et. al., <u>Energy Use in Passenger Transport in OECD Countries: Changes between 1970 and 1987</u>, Lawrence Berkeley Laboratory, Berkeley, CA, 1991, LBL-29830.

[a]1973 data.

CHAPTER 2
TRANSPORTATION ENERGY CHARACTERISTICS

The U.S. was responsible for more than one-quarter of the world's petroleum consumption in 1989. Domestic crude oil production has been declining since 1985 and in 1990 was at its lowest point in the twenty year series (7.3 million barrels per day). While domestic crude oil production has declined 18.6% from 1985 to 1990, the amount of crude oil imported has increased 83.8% in that time period to meet the domestic demand. Imports in 1990 accounted for 47% of U.S petroleum consumption (Table 2.2).

Most of the petroleum consumed in the U.S. was in the transportation sector, 63.6% (Table 2.3). Despite the great use of petroleum, the transportation sector continued to account for only 27.1% of total energy use in 1990 (Table 2.6). The residential and commercial sector depended heavily on electricity in 1990 (Table 2.4). The electricity was generated using mainly coal (55%), but also using natural gas, petroleum, hydro-electric power, nuclear-electric power, and other sources (Table 2.5).

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 1989 (60.8%) (Figure 2.7). Of total transportation energy use in 1989, 72.9% was consumed by the highway mode while the nonhighway mode (which includes water, air, pipeline, and rail transportation) accounted for 20.7%. The remaining 6.4% of transportation energy use was consumed by the off-highway mode and military activities (Table 2.9).

Although the average price for all types of gasoline jumped 20 cents from 1989 to 1990 (in constant 1990 cents), the price was still below the high prices of the early 1980's. Unleaded regular gasoline prices in constant 1990 cents experienced an average decline of 5% annually from 1982 to 1990 (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 (Table 2.17). Many of these fuel price increases are due to the $22.24 price for a barrel of crude oil in 1990, a $3.30 increase from 1989 in constant 1990 dollars (Table 2.18).

Transportation's share of the gross national product (GNP) fell below 18% for the first time in 1989 and continued to decline in 1990. GNP has been growing at an average rate of 3.5% from 1982 to 1990, while transportation outlays have grown an average of 2.4% annually (Table 2.19). Transportation personal consumption expenditures (PCE) have remained near the same level since 1988, while total PCE have been growing. Transportation PCE was approximately 12.1% of total PCE in 1990 (Table 2.20).

Although consumers in 1990 spent almost four times more for a used car than they would have in 1970, the used car Consumer Price Index (CPI) declined slightly from 1989 to 1990. This is the first decline in the used car CPI since 1986 (Table 2.21). The average price of a new domestic car in constant 1990 dollars actually declined by $126 from 1989 to 1990. Import car prices continued to increase slightly in this period. The average price of a domestic car was $1,369 less than an import car in 1990 (Table 2.22). The cost of operating a car rose to 40.96 cents per mile in 1990. Gas and oil, once as much as one-quarter of the total cost to operate a car, accounted for only 13.2% of the total cost in 1990 (Table 2.23).

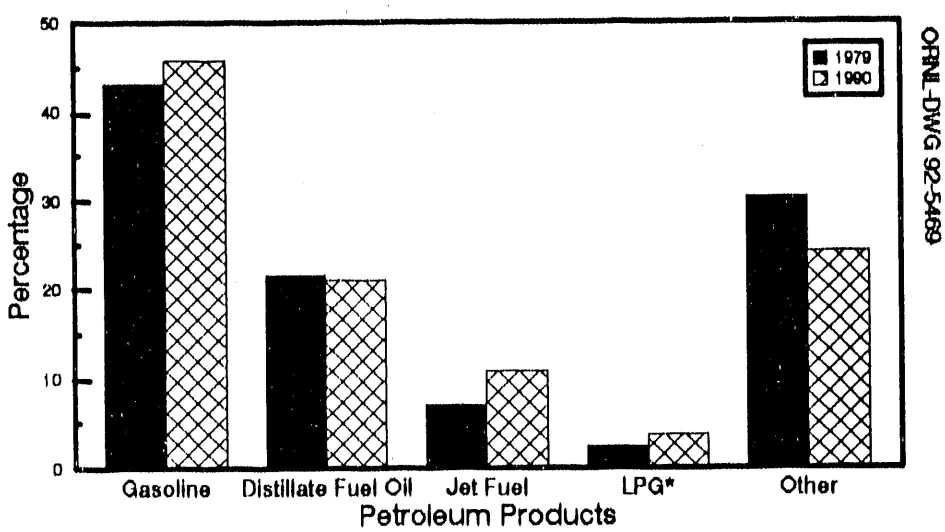
Section 2.1. Energy Consumption and Supply

Table 2.1
Refinery Yield of Petroleum Products from a Barrel of Crude Oil, 1978-90[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

Source:
Department of Energy, Energy Information Administration, Petroleum Supply Annual 1990, Vol. 1, May 1991, Table 19, p. 52, and annual.

Figure 2.1. Refinery Yield of Petroleum Products from a Barrel of Crude Oil, 1980 and 1990



* Liquefied Petroleum Gas

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, 1970-90
(million barrels per day)

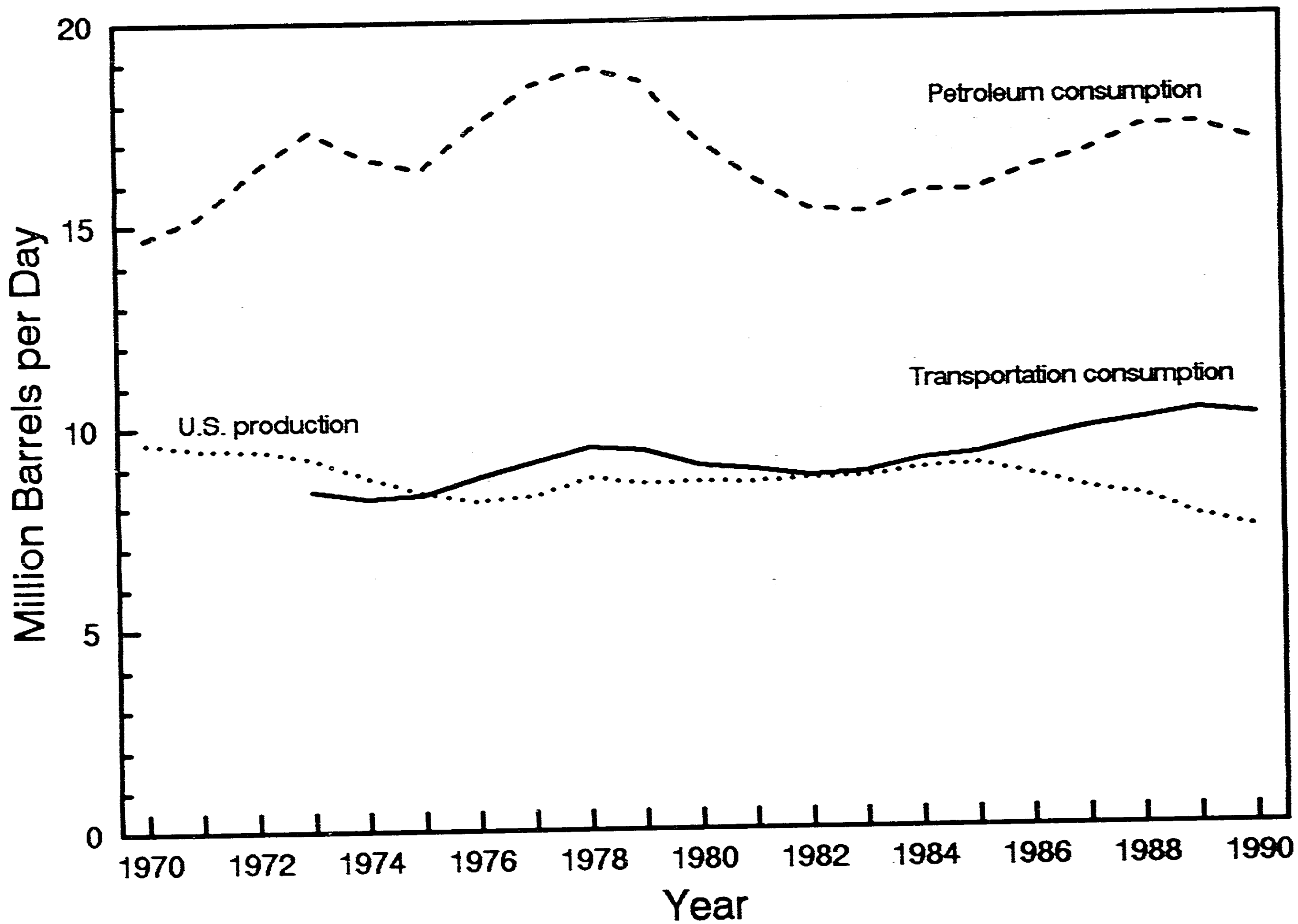
Year	Domestic crude oil production	Gross imports: Crude oil	Gross imports: Petroleum products	Gross imports: Total	U.S. Petroleum consumption[a]	World petroleum consumption	Imports as a percentage of U.S. petroleum consumption	Petroleum products as a percentage of gross imports	U.S. petroleum consumption 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	59.47	33.5	31.8	25.7	100.6
1983	8.69	3.33	1.72	5.05	15.23	58.70	33.2	34.1	25.9	101.1
1984	8.88	3.43	2.01	5.44	15.73	59.79	34.6	36.9	26.3	102.6
1985	8.97	3.20	1.87	5.07	15.73	59.87	32.2	36.9	26.3	102.9
1986	8.68	4.18	2.05	6.23	16.28	61.52	38.3	32.9	26.5	110.1
1987	8.35	4.67	2.00	6.68	16.67	62.78	40.0	30.0	26.6	117.7
1988	8.14	5.11	2.30	7.40	17.28	64.50	42.8	31.1	26.8	123.5
1989	7.61	5.84	2.22	8.06	17.33	65.80	46.5	27.5	26.3	134.6
1990	7.30	5.88	2.08	7.95	16.92	c	47.0	26.2	c	138.5
					Average annual percentage change					
1970-90	-1.4%	7.8%	0.0%	4.3%	0.7%	1.9%[d]				
1982-90	-2.1%	6.7%	3.1%	5.7%	1.3%	1.4%[d]				

Sources:
U.S. Department of Energy, Energy Information Administration, Monthly Energy Review, March 1991, pp. 35, 42-43.
World petroleum consumption - U.S. Department of Energy, Energy Information Administration, International Energy Annual 1989, February 1991, 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 1970-89 and 1982-89.

Figure 2.2. United States Petroleum Production and Consumption, 1970-90

ORNL-DWG 92-5470



Source: See Tables 2.2 and 2.3.

The transportation sector's share of petroleum consumption grew to an all-time high of 63.6% in 1990. Total petroleum consumption, however, declined in 1990 to 15.9 million barrels per day.

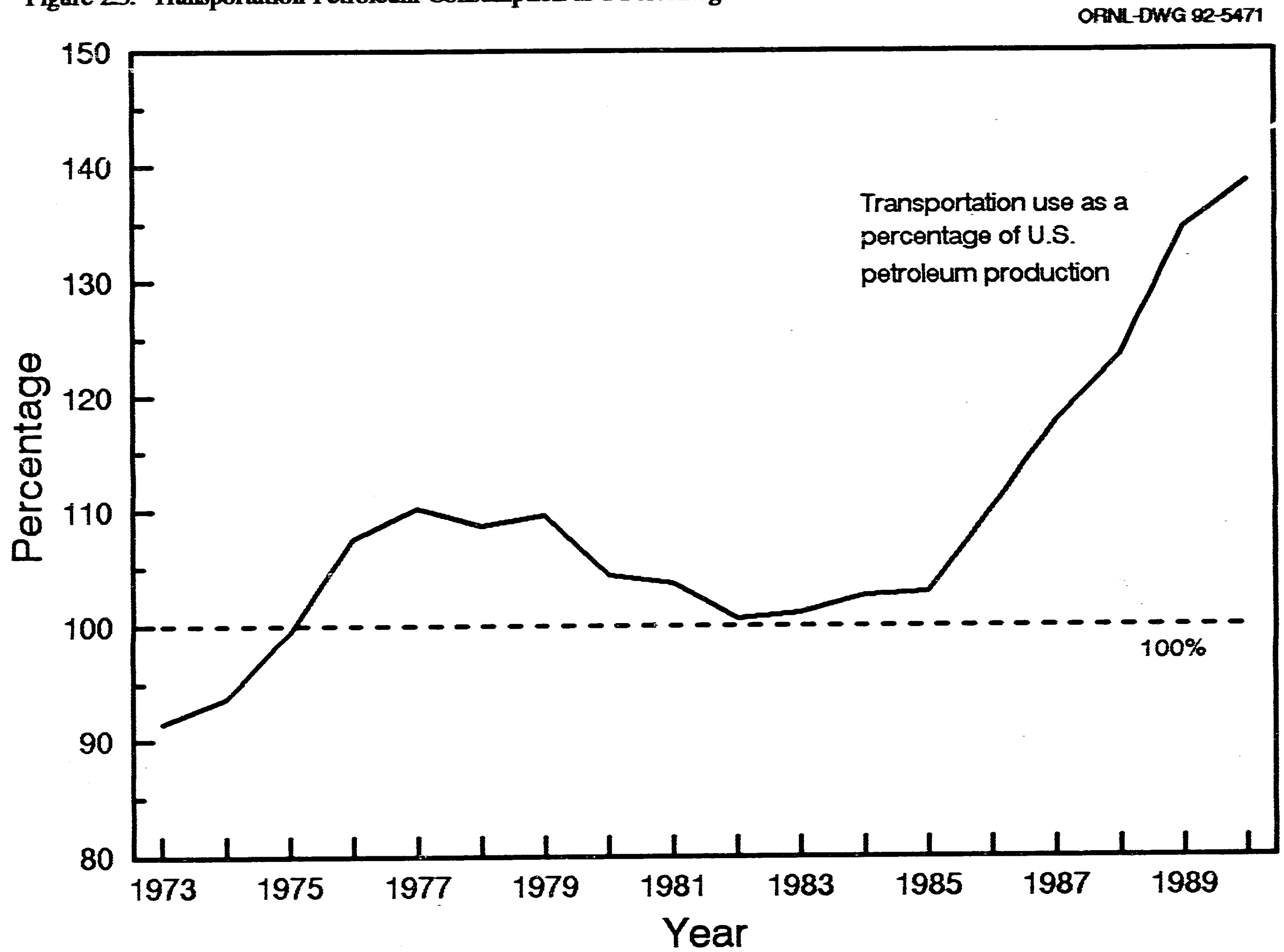
Table 2.3
Consumption of Petroleum by End-Use Sector, 1973-90
(quadrillion Btu)

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	7.80	1.57	30.24	14.28
1983	18.59	61.9%	2.50	7.42	1.54	30.05	14.19
1984	19.29	62.1%	2.59	7.90	1.29	31.07	14.68
1985	19.53	63.2%	2.57	7.73	1.09	30.92	14.61
1986	20.22	62.8%	2.58	7.95	1.45	32.22	15.22
1987	20.78	63.2%	2.62	8.21	1.26	32.87	15.53
1988	21.51	62.8%	2.69	8.46	1.56	34.22	16.16
1989	21.69	63.2%	2.63	8.21	1.69	34.22	16.16
1990	21.41	63.6%	2.50	8.49	1.25	33.65	15.90
			Average annual percentage change				
1973-90	1.1%		-3.3%	-0.4%	-5.9%	-0.2%	
1982-90	1.9%		0.3%	1.1%	-2.8%	1.3%	

Source:
U.S. Department of Energy, Energy Information Administration, Monthly Energy Review, March 1991, pp. 27, 29, 31, 33.

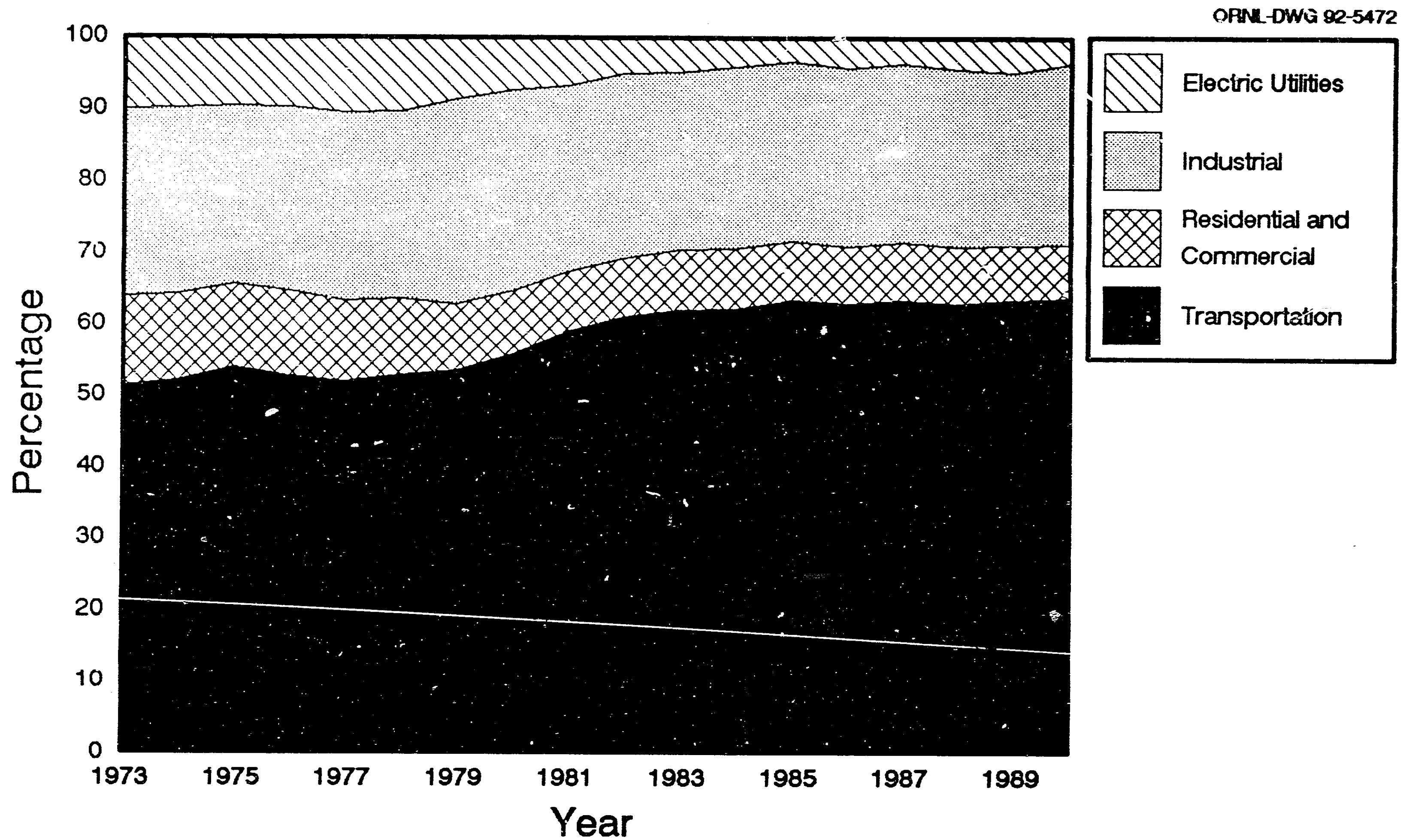
[a]Calculated from Total column. One million barrels per day of petroleum equals 2.117 quadrillion Btu per year.

Figure 2.3. Transportation Petroleum Consumption as a Percentage of Total United States Crude Oil Production, 1973-90



Source: See Tables 2.2 and 2.3.

Figure 2.4. Petroleum Use by End-Use Sector, 1973-90



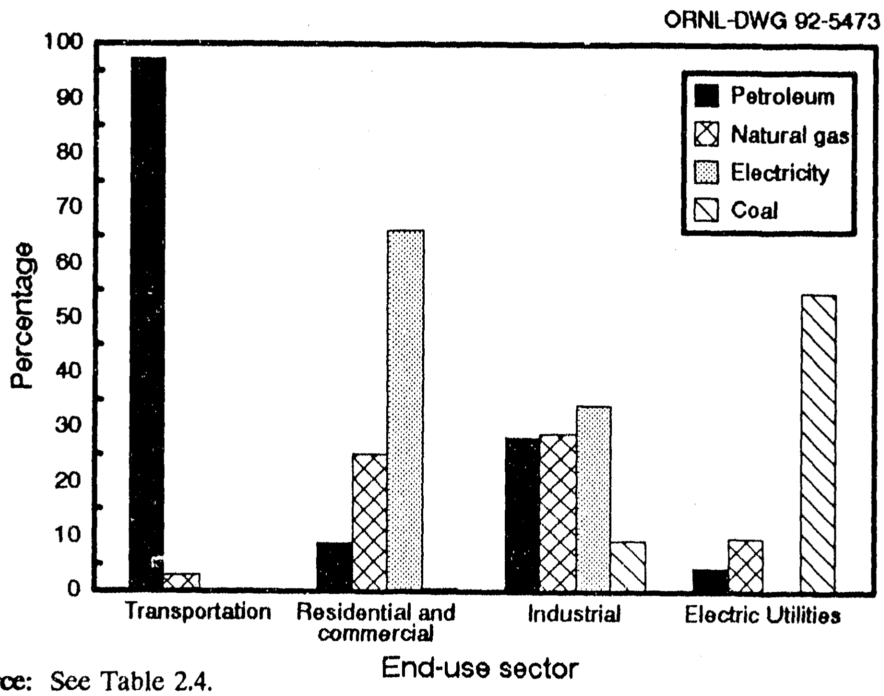
Source: See Table 2.3.

Table 2.4
Distribution of Energy Consumption by Source, 1980 and 1990
(percentage)

Energy source	Transportation		Residential and Commercial		Industrial		Electric Utilities	
	1980	1990	1980	1990	1980	1990	1980	1990
Petroleum	96.5	97.1	11.8	8.6	31.1	28.1	10.7	4.2
Natural gas[a]	3.3	2.7	29.4	24.9	27.4	28.7	15.5	9.7
Coal	0.0	0.0	0.6	0.5	10.2	9.1	49.5	54.6
Hydroelectric	0.0	0.0	0.0	0.0	0.1	0.1	12.6	9.8
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	11.2	20.9
Electricity[b]	0.2	0.2	58.2	66.0	31.2	34.0	0.0	0.0
Other[c]	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.7
	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 1991, Washington, DC, pp. 27, 29, 31, 33.

Figure 2.5. **Distribution of Energy Consumption by Sector, 1989**



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.

From 1973 to 1990 electricity generation has depended less on natural gas, petroleum, and hydroelectric power and has depended more on coal, nuclear generated electric power, and other sources. Coal continued to be the predominant source for electricity generation - 55% in 1990.

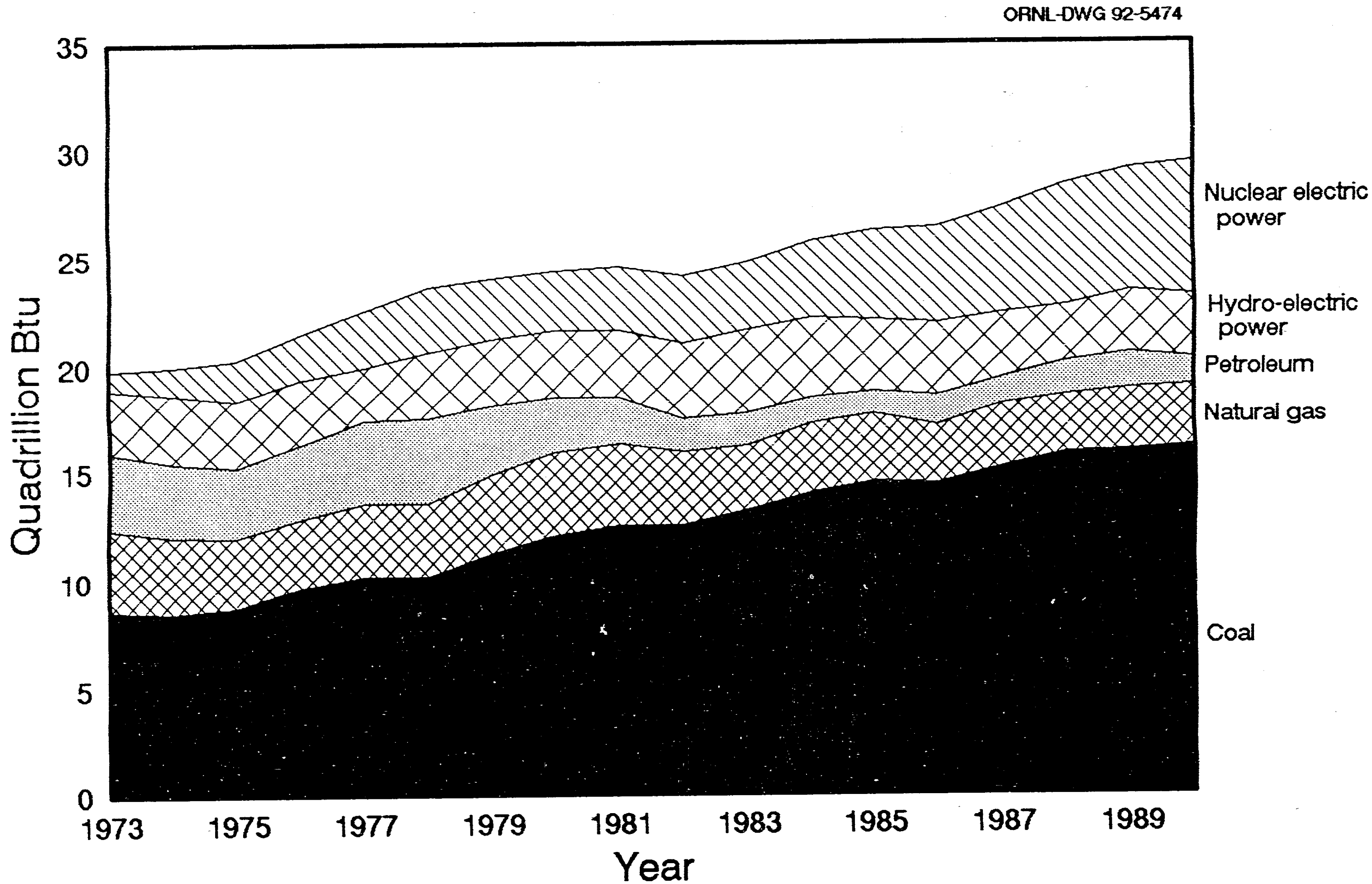
Table 2.5
Electric Utility Energy Input by Source, 1973-90
(quadrillion Btu)

Year	Coal	Natural gas	Petroleum	Hydro-electric power	Nuclear electric power	Other[a]	Total
1973	8.66	3.75	3.52	2.98	0.91	0.05	19.85
1974	8.53	3.52	3.37	3.28	1.27	0.06	20.02
1975	8.79	3.24	3.17	3.19	1.90	0.07	20.35
1976	9.72	3.15	3.48	3.03	2.11	0.08	21.57
1977	10.26	3.28	3.90	2.48	2.70	0.08	22.71
1978	10.24	3.30	3.99	3.11	3.02	0.07	23.72
1979	11.26	3.61	3.28	3.11	2.78	0.10	24.13
1980	12.12	3.81	2.63	3.09	2.74	0.11	24.51
1981	12.58	3.77	2.20	3.07	3.01	0.13	24.76
1982	12.58	3.34	1.57	3.54	3.13	0.11	24.27
1983	13.21	3.00	1.54	3.87	3.20	0.13	24.96
1984	14.00	3.22	1.27	3.73	3.55	0.17	25.98
1985	14.54	3.16	1.09	3.33	4.15	0.21	26.48
1986	14.44	2.69	1.45	3.35	4.47	0.23	26.64
1987	15.17	2.94	1.26	3.04	4.91	0.24	27.56
1988	15.85	2.71	1.56	2.61	5.66	0.24	28.63
1989	15.99	2.88	1.69	2.85	5.68	0.22	29.30
1990	16.16	2.87	1.25	2.91	6.19	0.20	29.58
			Average annual percentage change				
1973-90	3.7%	-1.6%	-5.9%	-0.1%	11.9%	8.5%	2.4%
1982-90	3.2%	-1.9%	-2.8%	-2.4%	8.9%	7.8%	2.5%

Source:
U.S. Department of Energy, Energy Information Administration, Monthly Energy Review, March 1991, p. 33.

[a]Other consists of electricity generated for distribution from wood, waste, geothermal, wind, photovoltaic, and solar thermal energy.

Figure 2.6. Electric Utility Energy Input by Source, 1973-90



Source: See Table 2.5.

Total energy use continued to increase in 1990, despite the small decline in energy use in the transportation sector and the residential and commercial sector. The transportation sector continued to account for over 27% of total energy use in 1990.

Table 2.6
Consumption of Total Energy by End-Use Sector, 1970-90[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	19.87	26.8%	26.50	27.73	74.10
1985	20.10	27.2%	26.73	27.12	73.95
1986	20.76	28.0%	26.83	26.65	74.24
1987	21.36	27.8%	27.62	27.87	76.85
1988	22.19	27.7%	29.00	29.01	80.20
1989	22.38	27.5%	29.50	29.46	81.35
1990	22.05	27.1%	29.22	30.17	81.45
		Average annual percentage change			
1970-90	1.6%		1.5%	0.3%	1.0%
1982-90	1.8%		1.7%	1.8%	1.8%

Source:
U.S. Department of Energy, Energy Information Administration, Monthly Energy Review, March 1991, Washington, DC, Table 2.2, p. 25.

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

Table 2.7
Domestic Consumption of Transportation Energy by Mode and Fuel Type, 1989
(trillion Btu)

	Gasoline	Diesel fuel	Liquefied petroleum gas	Jet fuel	Residual fuel oil	Natural gas	Electricity
HIGHWAY[a]	**13,628.4**	**3194.0**	**7.6**				
Automobiles	**8,933.1**	**120.4**					
Motorcycles	**26.1**						
Buses	**62.6**	**100.1**					
Transit	0.3	77.0					
Intercity		23.1					
School	62.3						
Trucks	**4,606.6**	**2,973.5**	**7.6**				
Light trucks[b]	3,992.9	151.4	3.0				
Other trucks	613.7	2,822.1	4.6				
OFF-HIGHWAY[a] (heavy-duty)[c]	**95.1**	**570.1**					
Construction	**31.4**	**178.5**					
Farming	**63.7**	**391.6**					
NONHIGHWAY[a]	**280.5**	**779.6**		**1,940.1**	**809.9**	**649.6**	**308.4**
Air	**41.2[d]**			**1,940.1**			
General aviation[e]	41.2			92.8			
Domestic air carriers				1,607.2			
International air carriers				240.1[f]			
Water	**239.3**	**326.8**			**809.9**		
Freight		326.8			809.9		
Domestic trade		253.3			75.3		
Foreign trade		73.5			734.6		
Recreational boats	239.3						
Pipeline						**649.6**	**245.7**
Natural gas						649.6	33.6
Crude petroleum[g]							91.0
Petroleum product[g]							67.4
Coal slurry[h]							3.7
Water[h]							50.0
Rail		**452.8**					**62.7**
Freight[i]		432.9					
Passenger		19.9					62.7
Transit							42.6
Commuter rail		7.6					14.8
Intercity		12.3					5.3
MILITARY OPERATIONS[j]	**22.7[k]**	**191.2**		**555.2**	**46.9**		
TOTAL[l]	**14,026.7**	**4,734.9**	**7.6**	**2,495.3**	**856.8**	**649.6**	**308.4**

Source: See Appendix A for Table 2.7.

[a]Civilian consumption only; military consumption shown separately.
[b]Two-axle, four-tire trucks.
[c]1985 data.
[d]Aviation gasoline.
[e]All aircraft in the U.S. civil air fleet except those operated under FAR parts 121 and 127 (i.e., air carriers larger than 30 seats and/or a payload capacity of more than 7,500 pounds). General aviation includes air taxies, commuter air carriers, and air travel clubs.
[f]This figure represents an estimate of the energy purchased in the U.S. for international air carrier consumption.
[g]1981 data.
[h]1977 data.
[i]Includes Class 1, 2, and 3 railroads.
[j]Based on fuel purchases in 1989.
[k]Includes aviation gasoline and motor gasoline.
[l]Totals may not include all possible uses of fuels for transportation (e.g., snowmobiles).

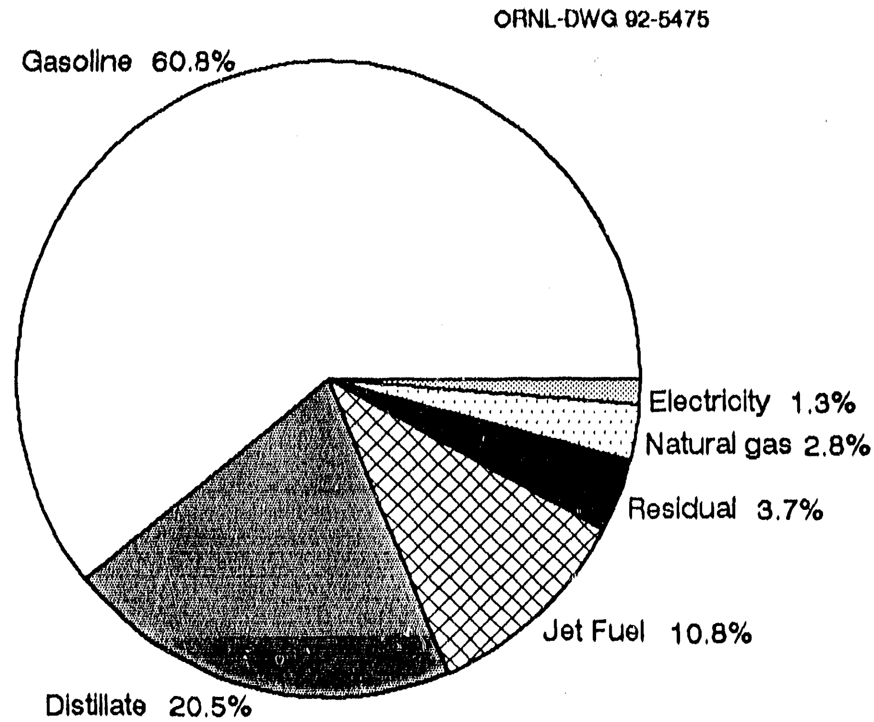
Table 2.8
Distribution of Domestic Consumption of Transportation Energy by Mode and Fuel Type, 1989
(percentage)

	Gasoline	Diesel fuel	Liquefied petroleum gas	Jet fuel	Residual fuel oil	Natural gas	Electricity
HIGHWAY[a]	**97.2**	**67.4**	**100.0**				
Automobiles	**63.7**	**2.5**					
Motorcycles	**0.2**						
Buses	**0.5**	**2.1**					
Transit	b	1.6					
Intercity		0.5					
School	0.5						
Trucks	**32.8**	**62.8**	**100.0**				
Light trucks[c]	28.5	3.2	39.5				
Other trucks	4.3	59.6	60.5				
OFF-HIGHWAY[a] (heavy-duty)[d]	**0.7**	**12.0**					
Construction	**0.2**	**3.7**					
Farming	**0.5**	**8.3**					
NONHIGHWAY[a]	**2.0**	**16.5**		**77.8**	**94.5**	**100.0**	**100.0**
Air	**0.3**[e]			**77.8**			
General aviation[f]	0.3			3.7			
Domestic air carriers				64.4			
International air carriers				9.6[g]			
Water	**1.7**	**6.9**			**94.5**		
Freight		6.9			94.5		
Domestic trade		5.4			8.8		
Foreign trade		1.6			85.7		
Recreational boats	1.7						
Pipeline						**100.0**	**79.7**
Natural gas						100.0	10.9
Crude petroleum[h]							29.5
Petroleum product[h]							21.9
Coal slurry[i]							1.2
Water[i]							16.2
Rail		**9.6**					**20.3**
Freight[j]		9.1					
Passenger		0.5					20.3
Transit							13.8
Commuter rail		0.2					4.8
Intercity		0.3					1.7
MILITARY OPERATIONS[k]	**0.2**	**4.0**		**22.2**	**5.5**		
TOTAL[l] (by fuel type)	**60.8**	**20.5**	b	**10.8**	**3.7**	**2.8**	**1.3**

Source: See Appendix A for Table 2.7.

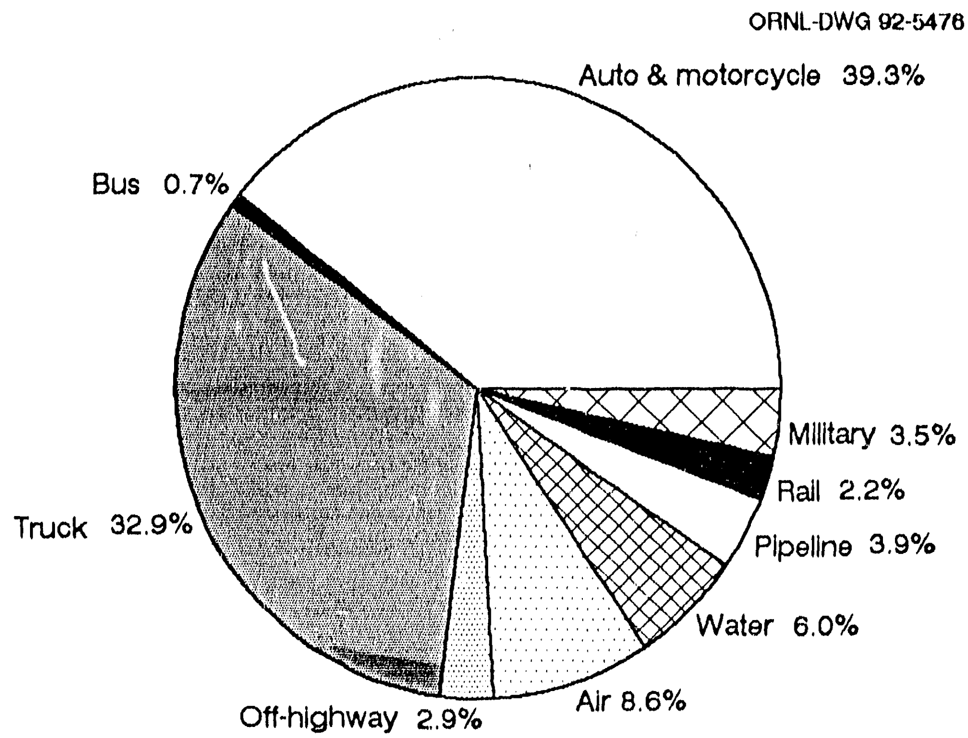
[a]Civilian consumption only; military consumption shown separately.
[b]Less than 0.05 percent.
[c]Two-axle, four-tire trucks.
[d]1985 data.
[e]Aviation gasoline.
[f]All aircraft in the U.S. civil air fleet except those operated under FAR parts 121 and 127 (i.e., air carriers larger than 30 seats and/or a payload capacity of more than 7,500 pounds). General aviation includes air taxies, commuter air carriers, and air travel clubs.
[g]This figure represents an estimate of the energy purchased in the U.S. for international air carrier consumption.
[h]1981 data.
[i]1977 data.
[j]Includes Class 1, 2, and 3 railroads.
[k]Based on fuel purchased in 1989.
[l]Totals may not include all possible uses of fuels for transportation (e.g., snowmobiles).

Figure 2.7. Distribution of Transportation Energy Use by Fuel Type, 1989



Source: See Table 2.8.

Figure 2.8. Distribution of Transportation Energy Use by Mode, 1989



Source: See Table 2.9.

Table 2.9
Transportation Energy Use by Mode, 1989

	Trillion Btu	Thousand barrels per day crude oil equivalent[a]	Percentage of total
HIGHWAY[b]	**16,830.0**	**7,949.9**	**72.9**
Automobiles	**9,053.5**	**4,276.6**	**39.2**
Motorcycles	**26.1**	**12.3**	**0.1**
Buses	**162.7**	**76.9**	**0.7**
Transit	77.3	36.5	0.3
Intercity	23.1	10.9	0.1
School	62.3	29.4	0.3
Trucks	**7,587.7**	**3,584.2**	**32.9**
Light trucks[c]	4,147.3	1,959.0	18.0
Other trucks	3,440.4	1,625.1	14.9
OFF-HIGHWAY[a] (heavy-duty)[d]	**665.2**	**314.2**	**2.9**
Construction	**209.9**	**99.1**	**0.9**
Farming	**455.3**	**215.1**	**2.0**
NONHIGHWAY[b]	**4,768.1**	**2,252.3**	**20.7**
Air	**1,981.3**	**935.9**	**8.6**
General aviation[e]	134.0	63.3	0.6
Domestic air carriers	1,607.2	759.2	7.0
International air carriers	240.1[f]	113.4	1.0
Water	**1,376.0**	**650.0**	**6.0**
Freight	1,136.7	536.9	4.9
Domestic trade	328.6	155.2	1.4
Foreign trade	808.1	381.7	3.5
Recreational boats	239.3	113.0	1.0
Pipeline	**895.3**	**422.9**	**3.9**
Natural gas	683.2	322.7	3.0
Crude petroleum[g]	91.0	43.0	0.4
Petroleum product[g]	67.4	31.8	0.3
Coal slurry[h]	3.7	1.7	0.0
Water[h]	50.0	23.6	0.2
Rail	**515.5**	**243.5**	**2.2**
Freight[i]	432.9	204.5	1.9
Passenger	82.6	39.0	0.4
Transit	42.6	20.1	0.2
Commuter rail	22.4	10.6	0.1
Intercity	17.6	8.3	0.1
MILITARY OPERATIONS[j]	**816.0**	**385.5**	**3.5**
TOTAL[k]	23,079.3	10,901.9	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]All aircraft in the U.S. civil air fleet except those operated under FAR parts 121 and 127 (i.e., air carriers larger than 30 seats and/or a payload capacity of more than 7,500 pounds). General aviation includes air taxies, commuter air carriers, and air travel clubs.
[f]This figure represents an estimate of the energy purchased in the U.S. for international air carrier consumption.
[g]1981 data.
[h]1977 data.
[i]Includes Class 1, 2, and 3 railroads.
[j]Based on fuel purchased in 1989.
[k]Totals may not include all possible uses of fuels for transportation (e.g., snowmobiles).

Transportation energy use continued to climb above 21 quads in 1989. The highway modes accounted for 78% of total transportation energy use in 1989. Light truck energy use has been increasing at a faster rate than any other mode. In 1970 light trucks accounted for only 13.2% of total highway energy use, but in 1989 the light truck share grew to 24.6% of total highway energy use.

Table 2.10
Transportation Energy Consumption by Mode, 1970-89
(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
					Average annual percentage change							
1970-89	0.3%	6.4%	2.1%	5.4%	4.5%	1.9%	2.2%	3.2%	-0.5%	-0.6%	1.5%	1.8%
1982-89	0.4%	0.6%	1.6%	5.3%	5.1%	2.3%	4.4%	0.9%	0.7%	-1.7%	1.9%	2.2%

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 2.9. Transportation Energy Consumption by Mode, 1970-89[a]

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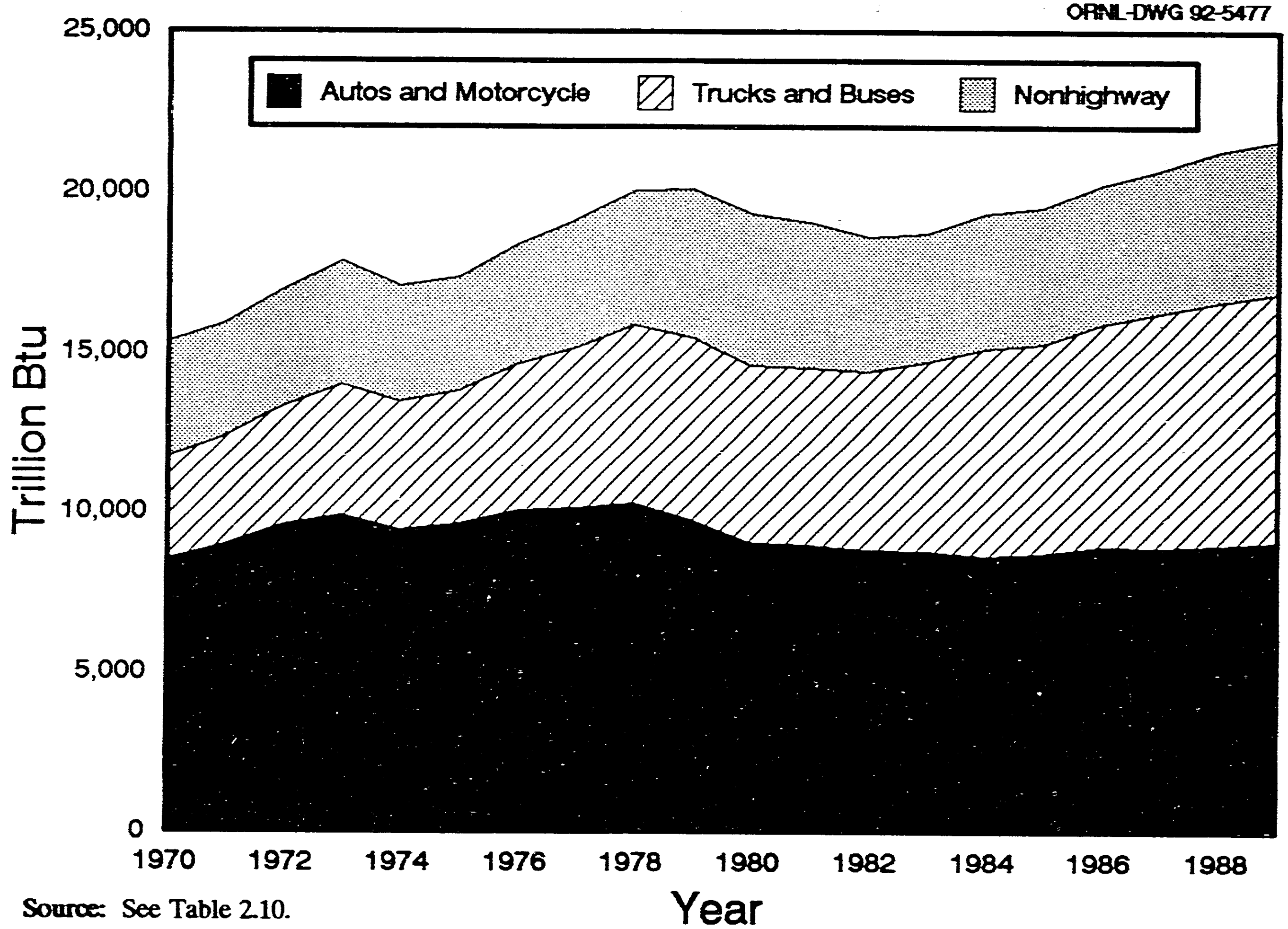


Source: See Table 2.10.

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

The special fuels share of highway fuel use increased to 16% in 1989. Highway use of special fuels has been growing at an average annual rate of 5.2% since 1982, while gasoline consumption on highways has grown only 1.7% annually.

Table 2.11
Highway Usage of Gasoline and Special Fuels, 1973-89
(million gallons)

Year	Gasoline	Special fuels[a]	Percent special fuels	Total highway fuel use
1973	100,636	9,837	8.9	110,473
1974	96,505	9,796	9.2	106,301
1975	99,354	9,631	8.8	108,985
1976	104,978	10,721	9.3	115,699
1977	107,978	11,646	9.7	119,624
1978	112,239	12,828	10.3	125,067
1979	108,126	13,989	11.5	122,115
1980	101,183	13,777	12.0	114,960
1981	99,597	14,856	13.0	114,453
1982	98,479	14,905	13.1	113,384
1983	100,106	15,975	13.8	116,081
1984	101,416	17,320	14.6	118,736
1985	103,571	17,751	14.6	121,322
1986	106,756	18,427	14.7	125,183
1987	108,702	19,046	14.9	127,748
1988	109,816	20,070	15.5	129,886
1989	110,632	21,232	16.1	131,864
		Average annual percentage change		
1973-89	0.6%	4.9%		1.1%
1982-89	1.7%	5.2%		2.2%

Source:
U.S. Department of Transportation, Federal Highway Administration, Highway Statistics 1989, Washington, DC, 1990, 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.

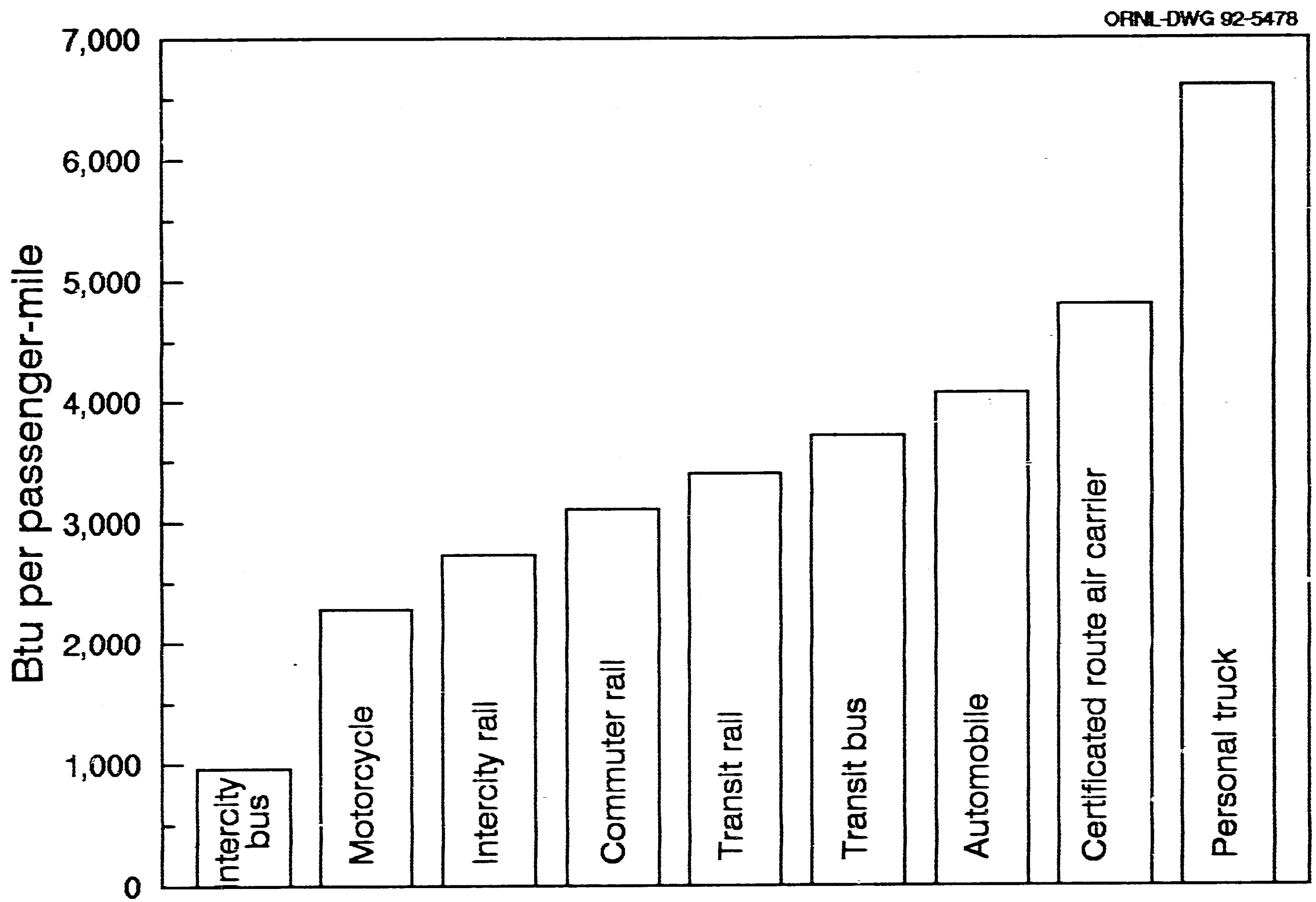
Table 2.12
Passenger Travel and Energy Use in the United States, 1989

	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	**143,081.0**	**1,485,474**	**2,228,211**	**1.5**	**6,095**	**4,063**	**9,053.5**
Personal Trucks	**26,605.1**	**289,772**	**405,681**	**1.4**	**9,247**	**6,605**	**2,679.5**
Motorcycles	**4,434.0**	**10,425**	**11,468**	**1.1**	**2,504**	**2,276**	**26.1**
Buses	**588.3**	b	**125,433**	b	b	**1,297**	**162.7**
Transit[a]	60.3	2,113	20,833	9.9	36,583	3,711	77.3
Intercity	20.3	b	24,000	b	b	963	23.1
School	507.6	4,000	80,600	20.2	15,575	773	62.3
Air	b	**8,225**	**347,345**	**44.0**	**211,696**	**5,013**	**1,741.2**
Certificated route (domestic)	b	3,747	335,145	89.4	428,930	4,796	1,607.2
General aviation	219.7	4,478 [c]	12,200	2.7	29,924	10,984	134.0
Recreational boats	**9,829.0**						**239.3**
Rail	**17.9**	**1,048**	**25,620**	**24.4**[d]	**77,290**	**3,162**	**81.0**
Intercity[e]	2.1 [f]	285 [g]	5,859 [h]	20.6[d]	56,140	2,731	16.0
Transit[i]	11.3	553	12,539	22.7[d]	77,034 [j]	3,397	42.6
Commuter	4.5	210	7,222	34.4[d]	106,667	3,102	22.4

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 2.10. Passenger Energy Intensities by Type of Carrier, 1989



Source: See Table 2.12.

Table 2.13
Energy Intensities of Passenger Modes, 1970-89

Year	Automobiles[a] (Btu per vehicle-mile)	Automobiles[a] (Btu per passenger-mile)	Buses: Transit[b] (Btu per vehicle-mile)	Buses: Transit[b] (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	c	2,453
1971	9,284	5,461	30,255	2,475	1,039	17,857	10,103	9,957	c	2,595
1972	9,383	5,519	30,352	2,454	1,016	16,956	9,017	10,340	c	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
					Average annual percentage change					
1970-89	-2.2%	-1.9%	0.7%	2.2%	-0.5%	-0.7%	-4.0%	0.3%	-2.0%[d]	1.7%
1982-89	-3.0%	-2.2%	-0.8%	2.0%	-2.5%	-0.6%	-1.0%	-2.4%	-2.0%	1.5%

Source:
See Appendix A for Table 2.13.

[a]Based on Federal Highway Administration estimates.

[b]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.

[c]Data are not available.

[d]Average annual percentage change is for years 1973-89.

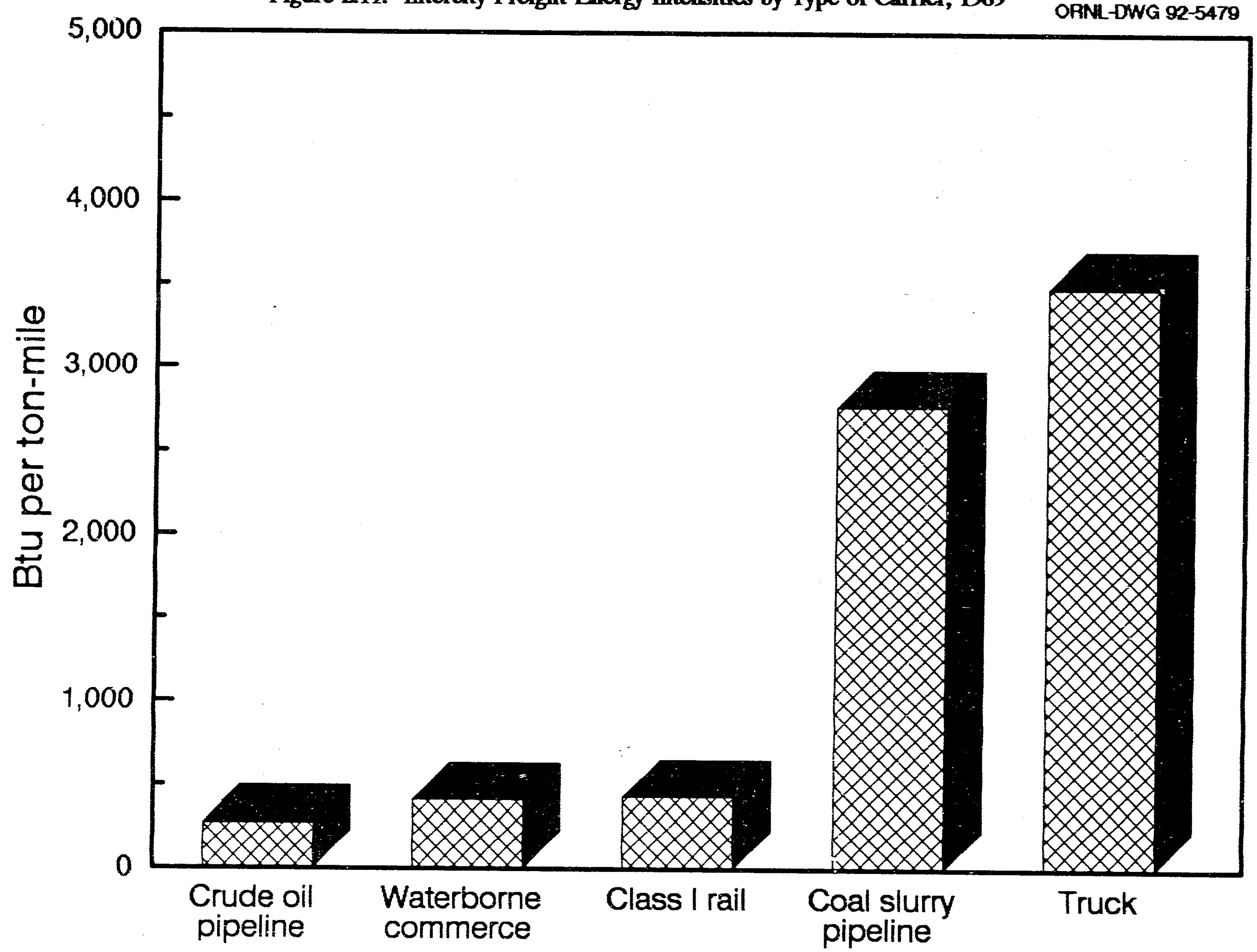
Table 2.14
Intercity Freight Movement and Energy Use in the United States, 1989

	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	**4,098**	**137,244**	**716,000**	**2,543**	**558**[a]	**3,483**	**2,493.9**
Waterborne commerce[b]	39	c	815,550	1,097	743	403	328.6
Coastal	c	c	483,889	302	1,602	c	c
Lakewise	c	c	58,308	109	535	c	c
Internal and local	c	c	273,353	686	449[d]	c	c
Pipeline	c	c	c	1,542	c	c	845.3
Natural gas	c	c	c	489	c	c	683.2
Crude oil and products	c	c	591,000	1,053	c	268	158.4
Coal slurry	c	c	1,338	5	273	2,765	3.7
Class 1 Railroads[e]	**688**	**26,196**	**1,013,841**	**1,988**	**723**	**427**	**432.9**

Source:
See Appendix A for Table 2.14.

[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 240 miles. The length has been steadily increasing for general freight and decreasing for specialized freight.
[b]Includes commerce by foreign and domestic carriers in the U.S.
[c]Data are not available.
[d]Internal only. Average length of haul for local was 15 miles.
[e]Railroad measures are: Number vehicles = Number freight cars, Vehicle-miles = car-miles, Ton miles = revenue ton-miles.

Figure 2.11. Intercity Freight Energy Intensities by Type of Carrier, 1989



Source: See Table 2.14.

All freight modes experienced energy efficiency improvements from 1970 to 1989. Domestic waterborne commerce, however, reversed this trend from 1982 to 1989 with a 1.6% decline in energy efficiency. Other trucks also declined slightly in energy efficiency from 1982 to 1989.

Table 2.15
Energy Intensities of Freight Modes, 1970-89

Year	Trucks: Light truck[a] (Btu per vehicle-mile)	Trucks: Other trucks (Btu per vehicle-mile)	Trucks: Total trucks (Btu per vehicle-mile)	Class I freight railroad (Btu per freight car-mile)	Class I freight railroad (Btu per ton-mile)	Domestic waterborne commerce (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
			Average annual percentage change			
1970-89	-1.7%	-0.2%	-1.4%	-0.1%	-2.2%	-1.6%
1982-89	-1.0%	0.2%	-0.6%	-1.4%	-3.5%	1.6%

Source:
See Appendix A for Table 2.15.

[a]Two-axle, four-tire trucks.

Table 2.16
Retail Prices for Motor Fuel, 1978-90[a]
(cents per gallon, including tax)

			Gasoline							
	Diesel Fuel		Leaded regular		Unleaded regular		Unleaded premium		Average for all gasoline types	
Year	Current	Constant 1990[b]	Current	Constant 1990[b]	Current	Constant 1990[b]	Current	Constant 1990[b]	Current	Constant 1990[b]
1978	c	c	62.6	125.4	67.0	134.2	c	c	65.2	130.6
1979	c	c	85.7	154.3	90.3	162.6	c	c	88.2	158.8
1980	101.0	160.2	119.1	188.9	124.5	197.4	c	c	122.1	193.6
1981	118.0	169.5	131.1	188.4	137.8	198.0	147.0	211.2	135.3	194.4
1982	116.0	157.0	122.2	165.4	129.6	175.5	141.5	191.6	128.1	173.4
1983	120.0	157.4	115.7	151.8	124.1	162.8	138.3	181.4	122.5	160.7
1984	122.0	153.5	112.9	142.0	121.2	152.5	136.6	171.9	119.8	150.7
1985	122.0	148.2	111.5	135.4	120.2	146.0	134.0	162.8	119.6	145.3
1986	94.0	112.0	85.7	102.1	92.7	110.5	108.5	129.3	93.1	111.0
1987	96.0	110.4	89.7	103.1	94.8	109.0	109.3	125.7	95.7	110.0
1988	95.0	104.9	89.9	99.3	94.6	104.5	110.7	122.3	96.3	106.4
1989	102.0	107.5	99.8	105.2	102.1	107.6	119.7	126.2	106.0	111.7
1990	99.0 [d]	99.5	114.9	114.9	116.4	116.4	134.9	134.9	121.7	121.7
				Average annual percentage change						
1978-90	-0.2% [e]	-4.7% [e]	5.2%	-0.7%	4.7%	-1.2%	-0.9% [f]	-4.9% [f]	5.3%	-0.6%
1982-90	-2.0%	-5.5%	-0.8%	-4.5%	-1.3%	-5.0%	-0.6%	-4.3%	-0.6%	-4.3%

Sources:
Gasoline - U.S. Department of Energy, Energy Information Administration, Monthly Energy Review March 1991, Washington, DC, Table 9.4, p. 102.
Diesel - U.S. Department of Energy, Energy Information Administration, International Energy Annual 1989, Washington, DC, February 1991, pp. 91-92.

[a] 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.
[b] Adjusted by the Consumer Price Inflation Index.
[c] Data are not available.
[d] Preliminary
[e] Average annual percentage change is for years 1980-90.
[f] Average annual percentage change is for years 1981-90.

*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.*

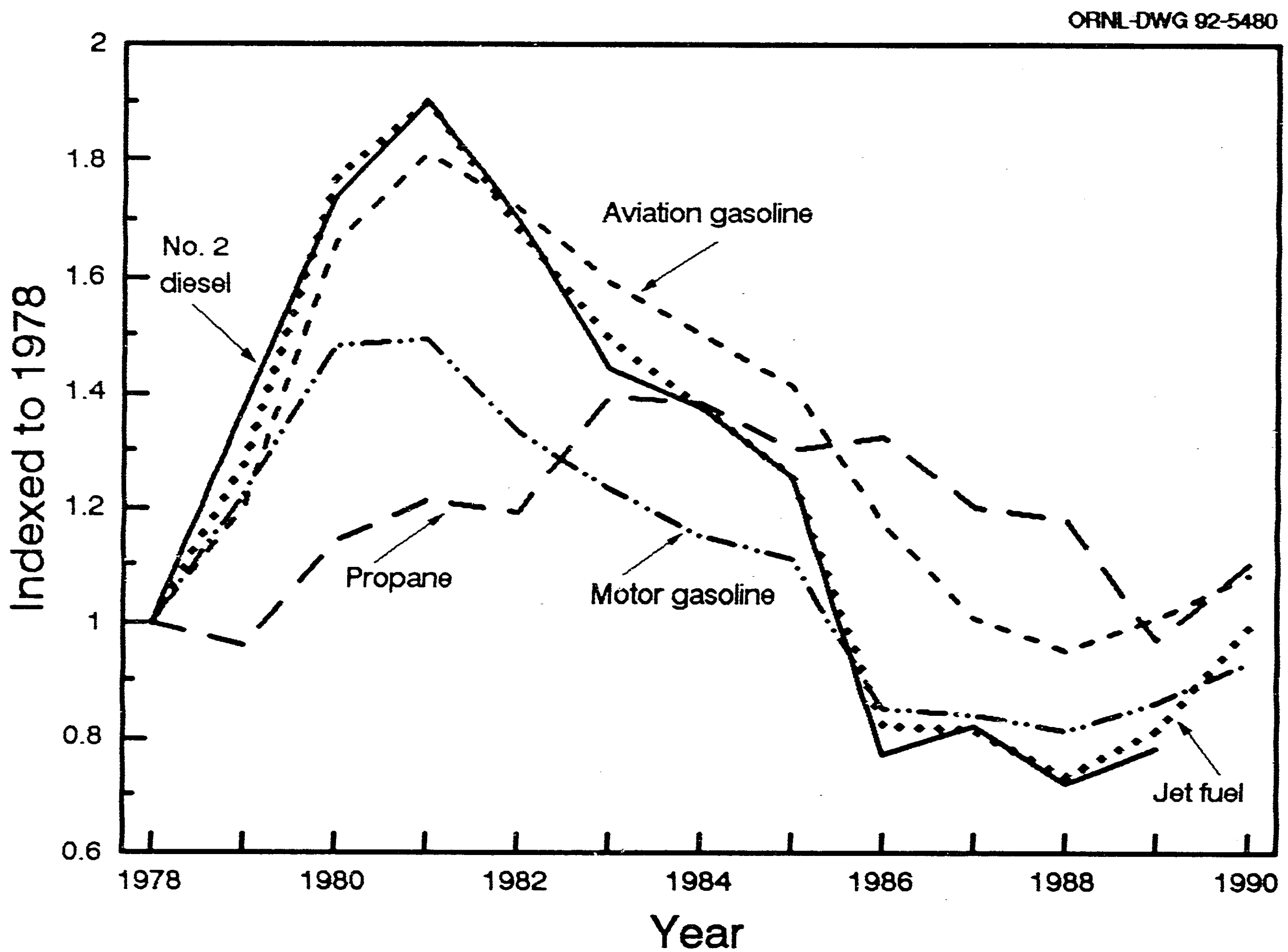
Table 2.17
Prices for Selected Transportation Fuels, 1978-90
(cents per gallon, excluding tax)

Year	Propane[a]		Finished aviation gasoline		Kerosene-type jet fuel		Diesel fuel oil[b]	
	Current	Constant 1990[d]	Current	Constant 1990[d]	Current	Constant 1990[d]	Current	Constant 1990[d]
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	61.9	64.8	99.5	104.9	59.2	62.4	56.3	59.3
1990	74.0	74.0	111.9	111.9	76.7	76.7	[c]	[c]
				Average annual percentage change				
1978-90	6.8%	0.8%	6.7%	0.1%	5.9%	-0.1%	3.7%[d]	-2.2%[d]
1982-90	2.8%	-1.0%	-2.0%	-6.4%	-2.8%	-6.4%	-6.4%[d]	-10.5%[d]

Sources:
U.S. Department of Energy, Energy Information Administration, Monthly Energy Review, March 1991, Washington, DC, Table 9.7, p. 105.
Diesel fuel oil - Association of American Railroads, Railroad Facts, 1990 edition, Washington, DC, September 1990, p. 60.

[a]Consumer grade.
[b]Wholesale cost.
[c]Data are not available.
[d]Average annual percentage change is for years 1978-89 and 1982-89.

Figure 2.12. Price Indices for Selected Transportation Fuels, 1978-90 (based on constant 1990 dollars)



Source: See Table 2.17.

On average, the price of a barrel of crude oil increased by $4.27 from 1989 to 1990. Consequently, this increase affected all of the gasoline end users, who paid an average 14.3¢ more per gallon ($6.00 per barrel) for unleaded gasoline and 15.1¢ more per gallon ($6.34 per barrel) for leaded gasoline in 1990 (current dollars).

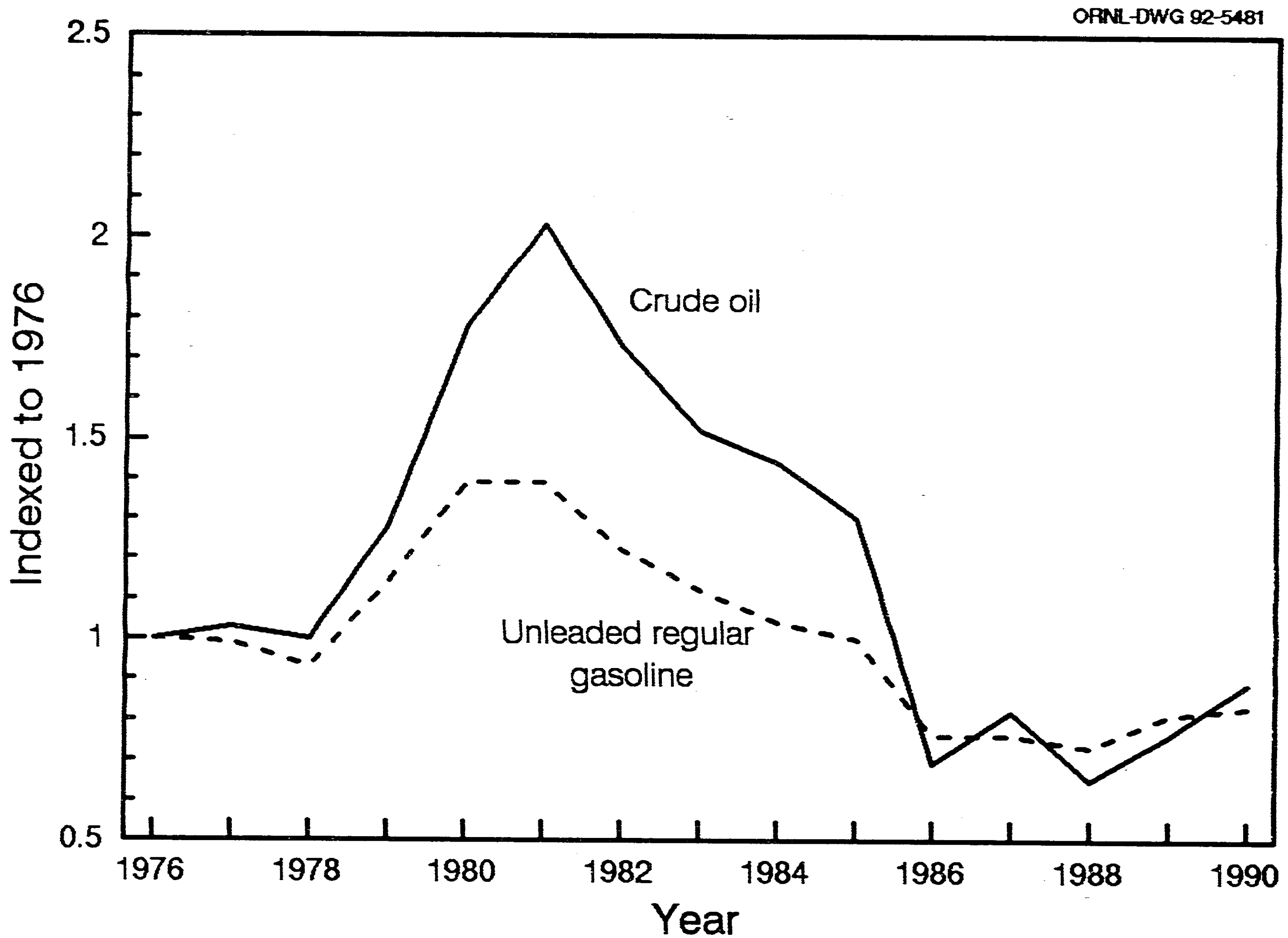
Table 2.18
Prices for a Barrel of Crude Oil and a Gallon of Gasoline, 1976-90

Year	Crude Oil[a] (dollars per barrel)		Leaded Gasoline[b] (dollars per gallon)		Unleaded Regular Gasoline[b] (dollars per gallon)	
	Current	Constant 1990[c]	Current	Constant 1990[c]	Current	Constant 1990[c]
1976	10.89	25.00	0.590	1.354	0.614	1.407
1977	11.96	25.79	0.622	1.341	0.656	1.415
1978	12.46	24.96	0.626	1.254	0.670	1.342
1979	17.72	31.90	0.857	1.543	0.903	1.626
1980	28.07	44.52	1.191	1.889	1.245	1.974
1981	35.24	50.63	1.311	1.884	1.378	1.980
1982	31.87	43.15	1.222	1.654	1.296	1.755
1983	28.99	38.03	1.157	1.518	1.241	1.628
1984	28.63	36.02	1.129	1.420	1.212	1.525
1985	26.75	32.50	1.115	1.354	1.202	1.460
1986	14.55	17.34	0.857	1.021	0.927	1.105
1987	17.90	20.58	0.897	1.031	0.948	1.090
1988	14.67	16.21	0.899	0.993	0.946	1.045
1989	17.97	18.94	0.998	1.052	1.021	1.076
1990	22.24	22.24	1.149	1.149	1.164	1.164
			Average annual percentage change			
1976-90	5.2%	-0.8%	4.9%	-1.2%	4.7%	-1.3%
1982-90	-4.4%	-8.0%	-0.8%	-4.5%	-1.3%	-5.0%

Sources:
Crude Oil - U.S. Department of Energy, Energy Information Administration, Monthly Energy Review, March 1991, Washington, DC, Table 9.1, p. 99.
Gasoline - U.S. Department of Energy, Energy Information Administration Monthly Energy Review, March 1991, Washington, DC, Table 9.4, p. 102.

[a]Refiner acquisition cost of composite (domestic and import) crude oil.
[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.

Figure 2.13. Crude Oil and Gasoline Price Indices, 1976-90
(based on constant 1990 dollars)



Source: See Table 2.18.

Transportation's share of the Gross National Product (GNP) fell below 18% for the first time in 1989 and continued to decline in 1990. GNP has been growing at an average rate of 3.5% from 1982 to 1990, while transportation outlays have grown an average of 2.4% annually.

Table 2.19
Gross National Product (GNP) as Related to Transportation, 1970-90

Year	Gross National Product (billion dollars) Current	Gross National Product (billion dollars) Constant 1990[a]	Total transportation outlays (billion dollars) Current	Total transportation outlays (billion dollars) Constant 1990[b]	Transportation outlays as a percent of GNP
1970	1,015.5	3,031.3	198.3	591.9	19.5%
1971	1,102.7	3,127.8	225.6	639.9	20.5%
1972	1,212.8	3,304.5	246.4	671.4	20.3%
1973	1,359.3	3,499.9	271.0	697.8	20.0%
1974	1,472.8	3,490.0	287.3	680.8	19.5%
1975	1,598.4	3,463.9	303.7	658.2	19.0%
1976	1,782.8	3,671.3	356.8	734.8	20.0%
1977	1,990.5	3,871.3	407.2	792.0	20.5%
1978	2,249.7	4,076.6	460.2	833.9	20.5%
1979	2,508.2	4,182.2	510.7	851.6	20.4%
1980	2,732.0	4,167.4	551.5	841.3	20.2%
1981	3,052.6	4,259.0	602.0	839.9	19.7%
1982	3,166.0	4,163.3	600.6	789.8	19.0%
1983	3,405.7	4,308.3	653.3	826.4	19.2%
1984	3,772.2	4,573.5	725.8	880.0	19.2%
1985	4,010.3	4,730.4	764.4	901.7	19.1%
1986	4,235.0	4,861.8	782.6	898.4	18.5%
1987	4,515.6	5,053.2	816.7	913.9	18.1%
1988	4,873.7	5,268.1	880.9	952.2	18.1%
1989	5,200.8	5,416.5	922.6	960.9	17.7%
1990	5,465.1	5,465.1	957.9	957.9	17.5%
		Average annual percentage change			
1970-90	8.8%	3.0%	8.2%	2.4%	
1982-90	7.1%	3.5%	6.0%	2.4%	

Sources:
1970-1986 data - U.S. Department of Commerce, Bureau of Census, Statistical Abstract of the United States 1988, p.410.
1987-1990 data - U.S. Department of Commerce, Bureau of Economic Analysis, Survey of Current Business, July, 1991, and annual.

[a]Adjusted by the implicit GNP price deflator.

Transportation personal consumption expenditures (PCE) remained constant from 1989 to 1990 using 1990 constant dollars. Total PCE, however, continued to grow in this period, causing the transportation sector's share of PCE to drop to 12.1% in 1990.

Table 2.20
Personal Consumption Expenditures (PCE) as Related to Transportation, 1970-90

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	3,238.2	3,500.3	407.5	440.5	12.6%
1989	3,450.1	3,593.2	425.7	443.4	12.3%
1990	3,657.3	3,657.3	443.4	443.4	12.1%
		Average annual percentage change			
1970-90	9.1%	3.3%	8.8%	3.0%	
1982-90	7.5%	3.9%	6.5%	2.9%	

Sources:
1970-1986 data - U.S. Department of Commerce, Bureau of Census, Statistical Abstract of the United States 1988, p.412
1987-1990 data - U.S. Department of Commerce, Bureau of Economic Analysis, Survey of Current Business, July 1990, p. 20, 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 1990; 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 1990 more than double what they did in 1970, they paid almost four times more to buy a used car in 1990 than in 1970. The Used Car CPI declined from 1989 to 1990. It is the first decline in Used Car CPI since 1986.

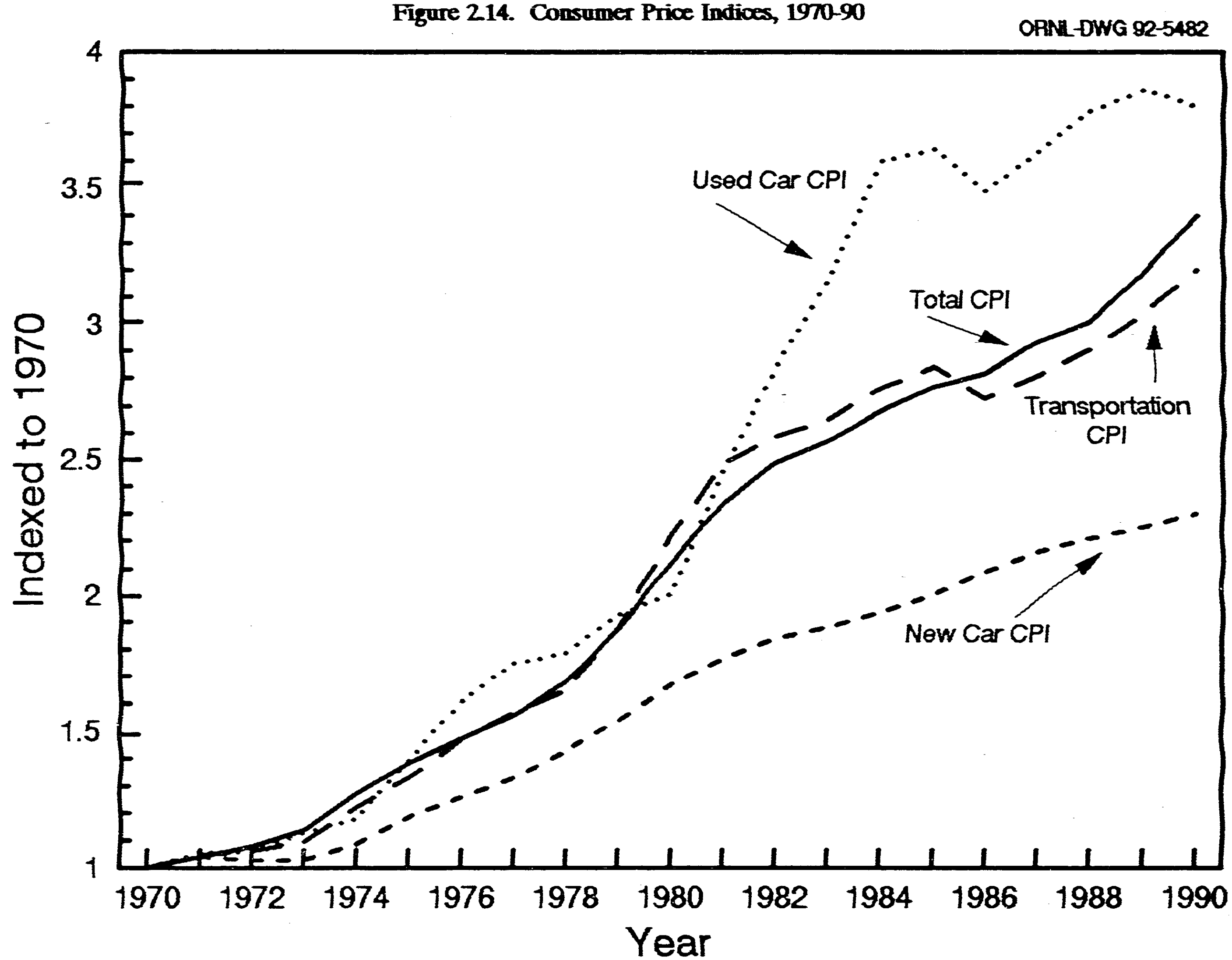
Table 2.21
Statistical Indices as Related to Transportation, 1970-90
(1970 = 1.000)

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

Sources:
U.S. Department of Commerce, Bureau of Economic Analysis, Survey of Current Business, Washington, DC, May 1991, 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 2.14. Consumer Price Indices, 1970-90



Source: See Table 2.21.

The average price of an import car in 1990 was $1,369 more than the average for a domestic car. Before 1982 the average import price was less than that of the domestic car price. Since 1982, however, the import prices have been rising at a annual rate of 3% (in constant 1990 dollars).

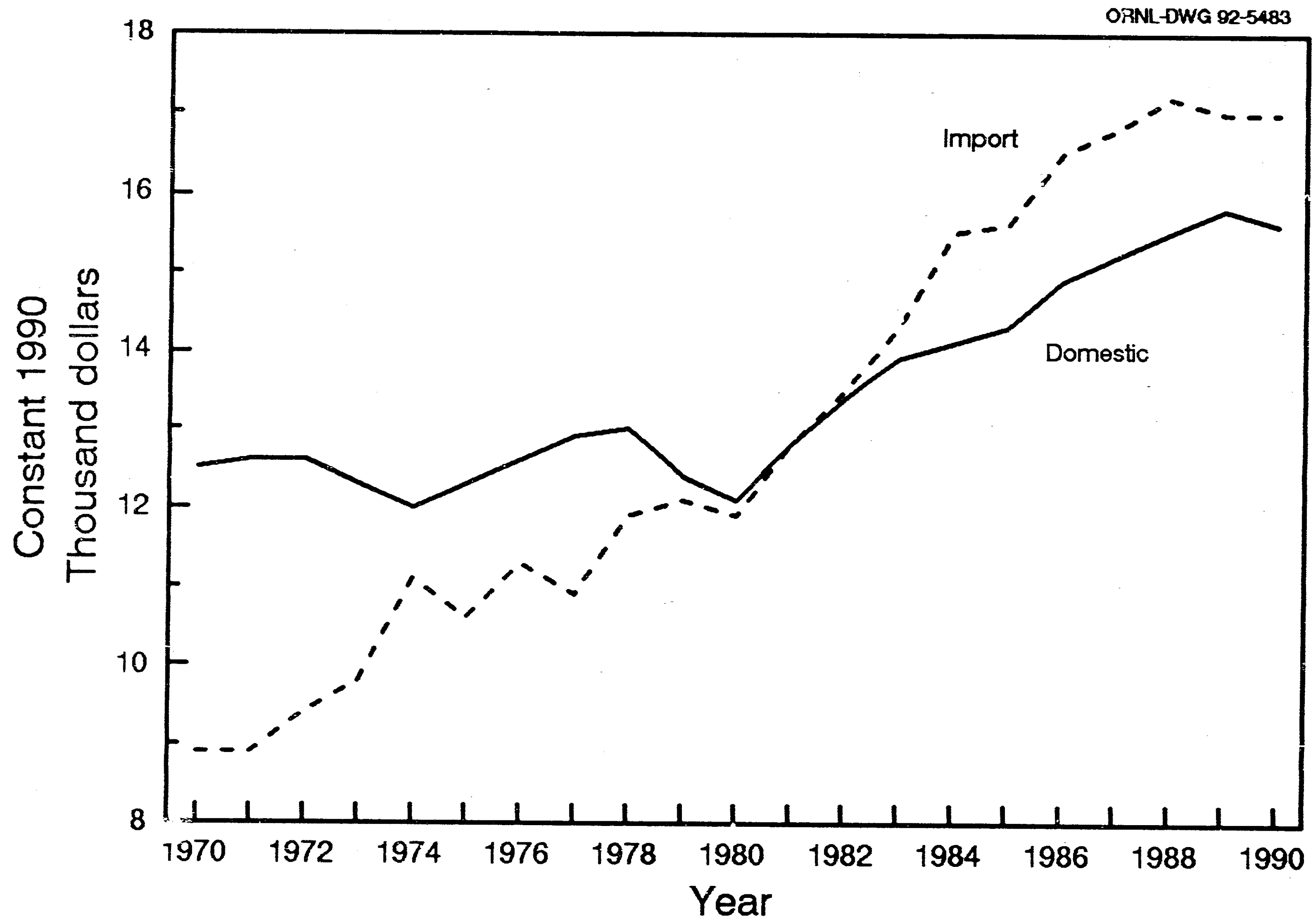
Table 2.22
Average Price of a New Car, 1970-90

	Domestic		Import		Total	
Year	Current dollars	Constant 1990 dollars[a]	Current dollars	Constant 1990 dollars[a]	Current dollars	Constant 1990 dollars[a]
1970	3,708	12,479	2,648	8,912	3,542	11,920
1971	3,919	12,645	2,769	8,935	3,742	12,074
1972	4,034	12,601	2,994	9,352	3,879	12,117
1973	4,181	12,295	3,344	9,834	4,052	11,915
1974	4,524	11,988	4,206	11,146	4,440	11,766
1975	5,084	12,344	4,384	10,645	4,950	12,019
1976	5,506	12,640	4,923	11,301	5,418	12,438
1977	5,985	12,906	5,072	10,938	5,814	12,538
1978	6,478	12,976	5,934	11,886	6,379	12,778
1979	6,889	12,403	6,704	12,070	6,847	12,327
1980	7,609	12,067	7,482	11,886	7,574	12,012
1981	8,912	12,805	8,896	12,782	8,910	12,802
1982	9,865	13,356	9,957	13,480	9,890	13,390
1983	10,559	13,850	10,873	14,262	10,640	13,956
1984	11,172	14,056	12,354	15,543	11,450	14,405
1985	11,733	14,253	12,875	15,640	12,022	14,604
1986	12,526	14,929	13,815	16,465	12,894	15,368
1987	13,239	15,223	14,602	16,790	13,657	15,703
1988	14,029	15,498	15,537	17,164	14,468	15,983
1989	14,957	15,767	16,127	17,000	15,292	16,120
1990	15,641	15,641	17,010	17,010	16,012	16,012
			Average annual percentage change			
1970-90	7.5%	1.1%	9.7%	3.3%	7.8%	1.5%
1982-90	5.9%	2.0%	6.9%	3.0%	6.2%	2.3%

Source:
Motor Vehicle Manufacturer's Association, Motor Vehicle Facts and Figures '90, Detroit, MI, 1990, p.40.

[a]Adjusted by the Consumer Price Inflation Index.

Figure 2.15. Average Price of New Cars, 1970-90



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 1990 was approximately 41 cents per mile which was only 1.7% higher than the 1989 estimate. Gas and oil costs continued to decline slightly and resulted in an all-time low share (13.2%) of total variable cost.

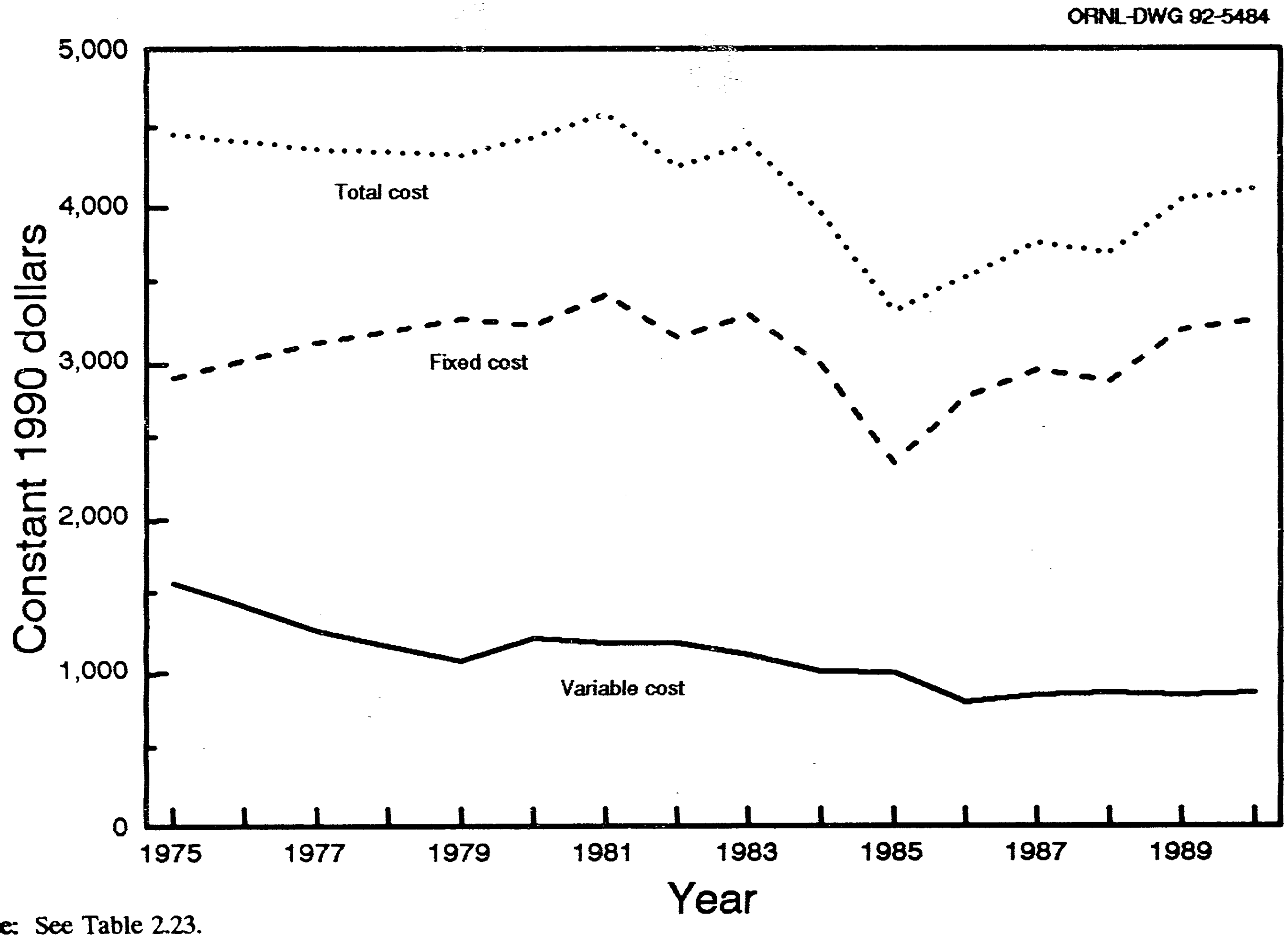
Table 2.23
Automobile Operating Costs, 1975-1990

	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	969	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]
				Average annual percentage change				
1975-84	-4.4%		-6.3%	-7.5%	-5.0%	0.3%	-1.3%	-1.3%
1985-90	-6.3%		7.1%	2.6%	-3.0%	6.9%	4.4%	4.4%

Source:
American Automobile Association, "Your Driving Costs," 1989 Edition, Fails 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 from 1985-90 are not comparable with figures before 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.

Figure 2.16. Automobile Operating Costs, 1975-90[a]



Source: See Table 2.23.

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[a]Fixed and total operating costs from 1985-90 are not comparable with figures before 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 eight 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. Section 3.7 reports data on vehicle emissions. High-occupancy vehicle (HOV) lanes are the subject of Section 3.8.

Highway energy use represented 77.9% of transportation energy use in 1989. Of the highway modes, automobiles[a] had the greatest share of energy use, 42% (Table 3.1). The automobiles[a] were also responsible for the majority of vehicle miles traveled in 1989. Light trucks with two axles and four tires have experienced a rapid increase in vehicle miles traveled, an average of 7.1% annually from 1970 to 1989 (Table 3.2).

Two separate figures for the number of automobiles and trucks in use are published each year - one from the Federal Highway Administration and one from R.L. Polk and Company. The differences in the estimates are presented in Table 3.4. The average age of automobiles grew to 7.8 years in 1990, which narrowed the gap between the automobiles and trucks to 0.2 years (Table 3.5).

Automobile sales continued to decline in 1990 to 9.3 million autos, the lowest sales figure since 1983. Imports accounted for 25.8% of sales in 1990, which has declined from a high of 31.1% in 1987 (Table 3.9). Fuel economy for the automobile population has increased from 13.5 miles per gallon in 1970 to 20.5 miles per gallon in 1989 (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.

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

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[a]Motorcycles are also included in this category.

population. The survey is based on a probability sample of private and commercial trucks registered (or licensed) in each state. The most recent survey 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 nonrevenue buses accounted for more than 80% of all buses in 1989, but accounted for only 38% of bus energy use (Tables 3.29 and 3.32). School buses have been the most efficient bus type on a vehicle-mile basis since 1970 (Table 3.33). Intercity buses travel more miles per bus than transit or school buses (Table 3.31).

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 fines collected for model year 1989 violations totaled $45,828,000 (Table 3.38). Since 1986 the Gas Guzzler tax has been assessed on automobiles with a fuel economy rating less than 22.5 miles per gallon. These tax rates, which remained constant from 1986 to 1990, doubled in 1991 (Table 3.40).

The Federal emission control requirements for automobiles, light trucks, and heavy trucks can be found in Section 3.6. These requirements were set by the Clean Air Act of 1990 (Tables 3.44 - 3.46). Because of the wide use of unleaded gasoline, the transportation sector's share of lead emissions continued to decline from a high of 87.9% in 1978 to 30.6% in 1989 (Table 3.47). The California Air Resources Board has declared emission standards for California vehicles. Ten percent of the manufacturer's fleet in 1992 should be transitional low-emission vehicles, which have more stringent standards than conventional vehicles. Low-emission vehicles and ultra-low emission vehicles will be phased into the fleet in 1997 (Table 3.49). Zero-emission vehicles must account for 10% of the manufacturer's fleet in the year 2003.

Section 3.1. Highway Vehicle Characteristics

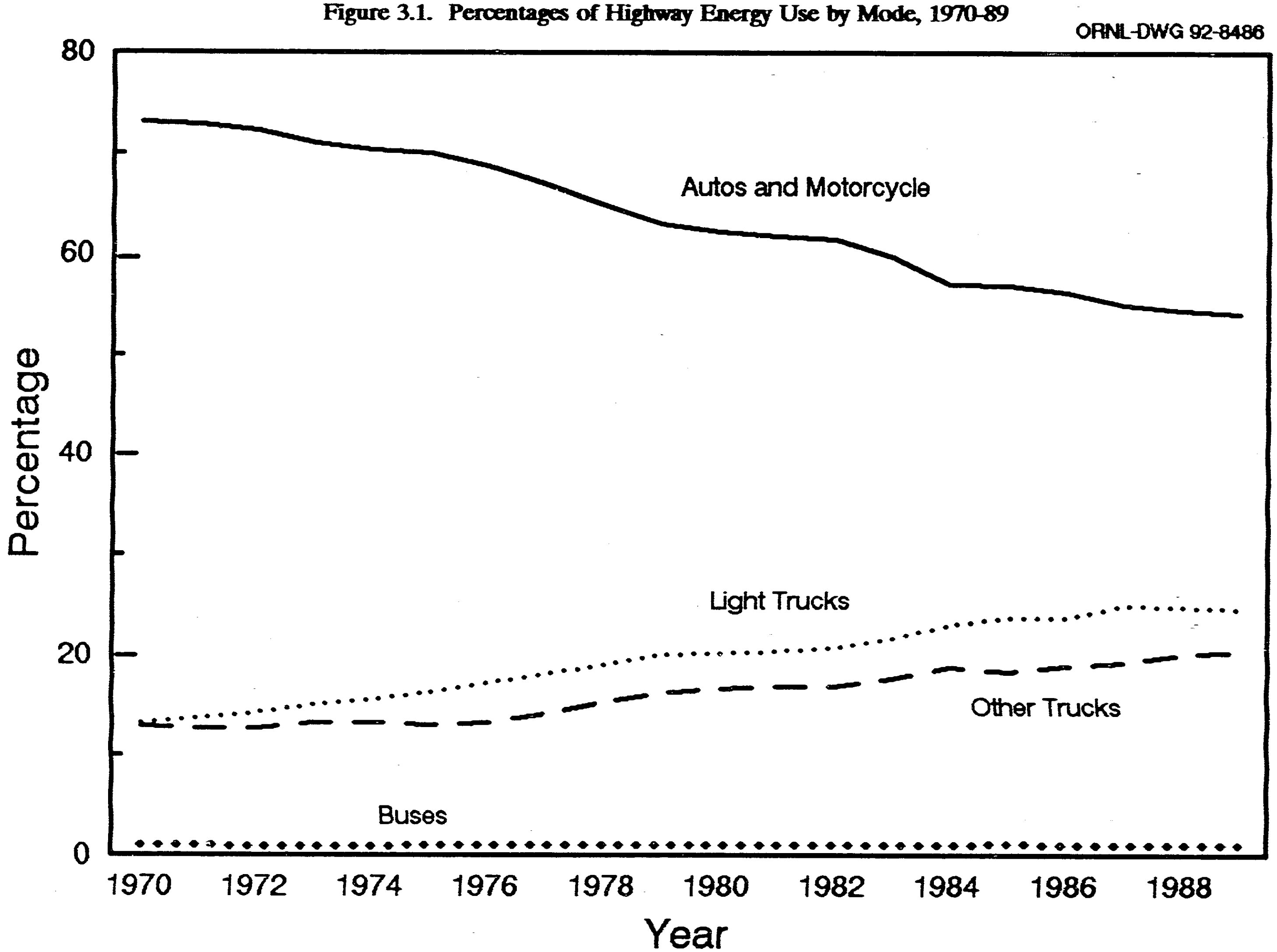
Table 3.1
Highway Energy Use by Mode, 1970-89[a]
(trillion Btu)

Year	Autos and motorcycles	Buses	Light trucks	Other trucks	Total highway	Transportation energy use[b]
1970	8,534	109	1,540	1,502	11,685	15,305
	(55.8%)	(0.7%)	(10.1%)	(9.8%)	(76.3%)	
1971	8,980	108	1,686	1,568	12,342	15,907
	(56.5%)	(0.7%)	(10.6%)	(9.9%)	(77.6%)	
1972	9,594	106	1,895	1,684	13,279	16,949
	(56.6%)	(0.6%)	(11.2%)	(9.9%)	(78.3%)	
1973	9.903	109	2,105	1,844	13,961	17,813
	(55.6%)	(0.6%)	(11.8%)	(10.4%)	(78.4%)	
1974	9,454	113	2,083	1,791	13,441	17,088
	(55.3%)	0.7%)	(12.2%)	(10.5%)	(78.7%)	
1975	9,625	119	2,240	1,789	13,773	17,329
	(55.5%)	(0.7%)	(12.9%)	(10.3%)	(79.5%)	
1976	10,035	129	2,522	1,949	14,635	18,389
	(54.6%)	(0.7%)	(13.7%)	(10.6%)	(79.6%)	
1977	10,124	132	2,738	2,155	15,149	19,071
	(53.1%)	(0.7%)	(14.4%)	(11.3%)	(79.4%)	
1978	10,285	135	3,008	2,420	15,848	20,035
	(51.3%)	(0.7%)	(15.0%)	(12.1%)	(79.1%)	
1979	9,741	137	3,094	2,510	15,482	20,101
	(48.5%)	(0.7%)	(15.4%)	(12.5%)	(77.0%)	
1980	9,063	139	2,951	2,425	14,578	19,317
	(46.9%)	(0.7%)	(15.3%)	(12.6%)	(75.5%)	
1981	8,954	143	2,964	2,461	14,522	19,065
	(47.0%)	(0.8%)	(15.5%0	(12.9%)	(76.2%)	
1982	8,839	146	2,982	2,430	14,397	18,589
	(47.5%)	(0.8%)	(16.0%)	(13.1%)	(77.4%)	
1983	8,784	145	3,196	2,599	14,724	18,728
	(46.9%)	(0.8%)	(17.1%)	(13.9%)	(78.6%)	
1984	8,635	154	3,500	2,836	15,125	19,310
	(44.7%)	(0.8%)	(18.1%)	(14.7%)	(78.3%)	
1985	8,695	161	3,630	2,924	15,411	19,659
	(44.2%)	(0.8%)	(18.5%)	(14.9%)	(78.4%)	
1986	8.940	154	3,785	3,007	15,886	20,229
	(44.2%)	(0.8%)	(18.7%)	(14.9%)	(78.5%)	
1987	8,888	157	4,032	3,137	16,214	20,704
	(42.9%)	(0.8%)	(19.5%)	(15.2%)	(78.3%)	
1988	8,994	159	4,109	3,306	16,568	21,278
	(42.3%)	(0.8%)	(19.3%)	(15.5%)	(77.9%)	
1989	9,080	163	4,147	3,440	16,830	21,598
	(42.0%)	(0.8%)	(19.2%)	(15.9%)	(77.9%)	

Source:
See Appendix A for Table 2.10.

[a]Numbers in parentheses are percentages of transportation energy use.
[b]Does not include off-highway and military transportation energy use.

Figure 3.1. Percentages of Highway Energy Use by Mode, 1970-89



Source: See Table 3.1.

Two-axle four tire trucks have doubled their share of vehicle miles traveled from 1970 (11%) to 1989 (22%). Automobiles and motorcycles were responsible for the majority of highway miles traveled in 1989 (71%). Buses were the only mode that has had a decline in vehicle miles since 1982.

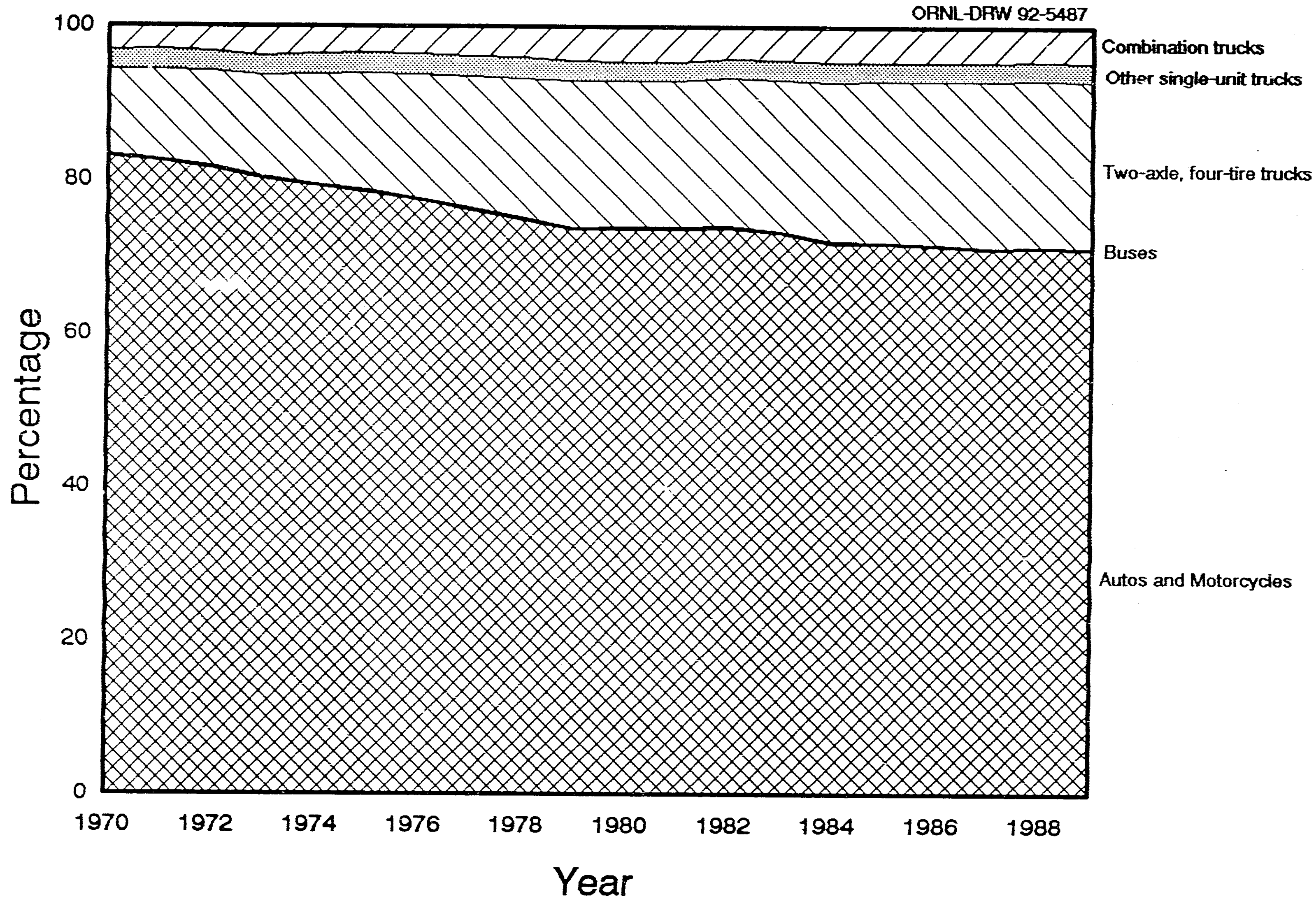
Table 3.2
Highway Vehicle Miles Traveled by Mode, 1970-89
(million miles)

Year	Automobiles and motorcycles	Buses[a]	Two-axle, four-tire trucks	Other single-unit trucks	Combination trucks	Total
1970	919,679	4,544	123,286	27,081	35,134	1,109,724
1971	969,947	4,792	137,870	28,985	37,217	1,178,811
1972	1,025,696	5,348	156,622	31,414	40,706	1,259,786
1973	1,051,175	5,792	176,833	33,661	45,649	1,313,110
1974	1,012,696	5,684	182,757	33,441	45,966	1,280,544
1975	1,039,579	6,055	200,700	34,606	46,724	1,327,664
1976	1,084,218	6,258	225,834	36,390	49,680	1,402,380
1977	1,115,592	5,823	250,591	39,339	55,682	1,467,027
1978	1,153,666	5,885	279,414	42,747	62,992	1,544,704
1979	1,122,277	5,947	291,905	42,012	66,992	1,529,133
1980	1,121,810	6,059	290,935	39,813	68,678	1,527,295
1981	1,141,517	6,241	296,343	39,568	69,134	1,552,803
1982	1,176,166	5,823	306,141	40,212	66,668	1,595,010
1983	1,206,783	5,199	327,643	43,409	69,754	1,652,788
1984	1,233,703	4,640	357,999	46,560	77,367	1,720,269
1985	1,269,651	4,876	373,072	46,980	79,600	1,774,179
1986	1,312,921	5,087	389,123	48,413	82,696	1,838,240
1987	1,364,836	5,318	415,449	49,537	86,064	1,921,204
1988	1,439,603	5,466	439,496	51,239	90,158	2,025,962
1989	1,495,899	5,685	456,699	53,190	95,567	2,107,040
			Average annual percentage change			
1970-89	2.6%	1.2%	7.1%	3.6%	5.4%	3.4%
1982-89	3.5%	-0.3%	5.9%	4.1%	5.3%	4.1%

Source:
U.S. Department of Transportation, Federal Highway Administration, Highway Statistics 1989, Washington, DC, 1990, Table VM-1, p.181, and annual.

[a]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. Percentages of Highway Vehicle Miles Traveled by Mode, 1970-89



Source: See Table 3.2.

Table 3.3
Vehicle Stock, New Sales and New Registrations in United States, 1989 Calendar Year[a]

	Vehicle stock[b] (thousands)	New Sales: Domestic (thousands)	New Sales: Domestic percentage of total	New Sales: Import[c] (thousands)	New Sales: Import percentage of total	New Sales: Total (thousands)	New Sales: Total percentage by class	New Registrations: Domestic (thousands)	New Registrations: Domestic percentage by class	New Registrations: Import[c] (thousands)	New Registrations: Total (thousands)
Autos[d]	**123,276**	**7,073**	**72.4**	**2,699**	**27.6**	**9,772**	**100.0**	**6,313**	**100.0**	**3,440**	**9,853**
Two seaters	2,806	35	25.0	105	75.0	140	1.4	37	0.6	e	e
Minicompact	4,092	0	0.0	22	100.0	22	0.2	0	0.0	e	e
Subcompact	28,322	700	35.5	1,269	64.4	1,969	20.1	767	12.1	e	e
Compact	30,218	2,553	72.4	974	27.6	3,527	36.1	1,848	29.3	e	e
Midsize	34,980	2,433	88.4	318	11.6	2,751	28.2	2,501	39.6	e	e
Large	22,858	1,351	99.2	11	0.8	1,362	13.9	1,160	18.4	e	e
Fleets of ten or more	8,431[f]	e	e	e	e	e	e	1,666	80.2	411	2,077
Personal autos	114,845	e	e	e	e	e	e	e	e	e	7,776
Motorcycles	**4,434[g]**	**120[h]**	**23.8**	**385[h]**	**76.2**	**505[h]**	**100.0**	e	e	e	**294[g]**
Recreational vehicles	e	**396**	**100.0**	**0**	**0.0**	**396**	**100.0**	e	e	e	e
Trucks[i]	**53,202**	**4,215**	**87.0**	**631**	**13.0**	**4,846**	**100.0**	**4,371**	**100.0**	**731**	**5,102**
Light	48,893	3,949	86.8	598	13.2	4,547	93.8	4,025	92.1	715	4,740
Medium	1,224	36	66.7	18	33.3	54	1.1	65	1.5	12	77
Light-heavy	904	33	86.8	5	13.2	38	0.8	35	0.8	2	37
Heavy-heavy	2,181	197	95.6	9	0.4	206	4.3	246	5.6	2	248

Source:
See Appendix A for Table 3.3.

[a]Totals may not equal sum of components due to rounding.
[b]Vehicle stock as of July 1, 1989.
[c]Includes domestic-sponsored imports.
[d]These figures represent only those automobiles that could be matched to the Environmental Protection Agency size classes.
[e]Data are not available.
[f]Federal Government fleet data for 1989 were not available; therefore, the 1989 data were assumed to be equal to the 1988 Federal Government fleet figures.
[g]Includes mostly on-highway motorcycles. Many states do not require registration for off-highway vehicles.
[h]Includes motorcycles, scooters, and all-terrain vehicles for on and off highway use.
[i]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.

Both the Federal Highway Administration (FHWA) and R. L. Polk and Company report figures on the automobile and truck population. The two estimates, however, differ by as much as 18.1% 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 include vans in the automobile count until 1970; since 1980 all vans have been counted as trucks.

Table 3.4.
Automobiles and Trucks in Use, 1970-1990
(thousands)

	Automobiles			Trucks		
Years	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
1971	92,718	83,138	11.5	19,871	18,462	7.6
1972	97,082	86,439	12.3	21,308	19,773	7.8
1973	101,985	89,805	13.6	23,244	21,412	8.6
1974	104,856	92,608	13.2	24,630	23,312	5.7
1975	106,704	95,241	12.0	25,781	24,813	3.9
1976	110,189	97,818	12.6	27,876	26,560	5.0
1977	112,288	99,904	12.4	29,314	28,222	3.7
1978	116,573	102,957	13.2	31,336	30,565	2.5
1979	118,429	104,677	13.1	32,914	32,583	1.0
1980	121,601	104,564	16.3	33,667	35,268	-4.5
1981	123,098	105,839	16.3	34,644	36,069	-4.0
1982	123,902	106,867	15.9	35,382	36,987	-4.3
1983	126,444	108,961	16.0	36,723	38,143	-3.7
1984	128,158	112,019	14.4	37,507	40,143	-6.6
1985	131,864	114,662	15.0	39,196	42,387	-7.5
1986	135,431	117,268	15.5	40,069	44,826	-10.6
1987	137,208	119,849	14.5	41,144	47,344	-13.1
1988	141,252	121,519	16.2	42,529	50,221	-15.3
1989	143,026	122,758	16.5	43,609	53,202	-18.0
1990	143,550	123,276	16.4	44,479	56,023	-20.6

Sources:

FHWA - U.S. Department of Transportation, Federal Highway Administration, Highway Statistics 1989, Washington, DC, 1990, Table VM-1, p.181, and annual.

R. L. Polk - R. L. Polk and Company, Detroit, Michigan.

The Fuel Economy Gap for All Automobiles and Light Trucks in Operation

Concerns about the difference between on-road fuel economy and Environmental Protection Agency (EPA) tested fuel economy have resulted in related data collection and analysis. Research, conducted separately by the Department of Energy (DOE), EPA, Ford Motor Company, General Motors Corporation and Mitsubishi Motors Corporation, concluded that there is a discrepancy between actual and tested fuel economy (termed "the gap"). The gap discovered in past analyses ranged from seven to 20 percent for automobiles and 12 to 20 percent for light trucks. These analyses were based on individual model years from 1978 to 1984.

Gap estimates have been produced for the first time which apply to all automobiles and light trucks in operation. Light trucks include all light utility vehicles (vans, four-wheel drives, etc.) having a gross vehicle weight (GVW) of 8,500 pounds or less. The tested fuel economy data used in this analysis were from the National Highway Safety Administration's (NHTSA) verified EPA tested fuel economy data, measured in miles per gallon (mpg). These data were compared against on-road fuel economy data acquired from (1) the Federal Highway Administration (FHWA) Highway Statistics 1989, (2) the Department of Energy, Energy Information Administration, 1988 Residential Transportation Energy Consumption Survey (RTECS), and (3) the Bureau of the Census, 1987 Census of Transportation, Truck Inventory and Use Survey (TIUS). Tested fuel economy data were not available for light trucks prior to the year 1976; therefore, these data were estimated based on available tested fuel economy data and prior on-road fuel economy data. The following table presents the composite gap estimates for all automobiles and trucks in operation up to the listed year.

Years	Sources	Automobile gap	Light truck gap
Pre-1974 to 1989	NHTSA/FHWA	-15.2%	
Pre-1974 to 1988	NHTSA/RTECS	-16.1%	
Pre-1976 to 1989	NHTSA/FHWA		-28.3%
Pre-1976 to 1988	NHTSA/RTECS		-20.9%
Pre-1978 to 1987	NHTSA/TIUS		-21.8%

The Gas Mileage Guide, published every year by DOE/EPA, and the mileage stickers on new vehicles have fuel economy estimates that are 15% lower than tested mpg values. It appears that all cars on the road have a gap that is similar to the gap applied to new cars since 1984. Light trucks appear to have a larger gap. See Appendix A for methodology of gap estimates.

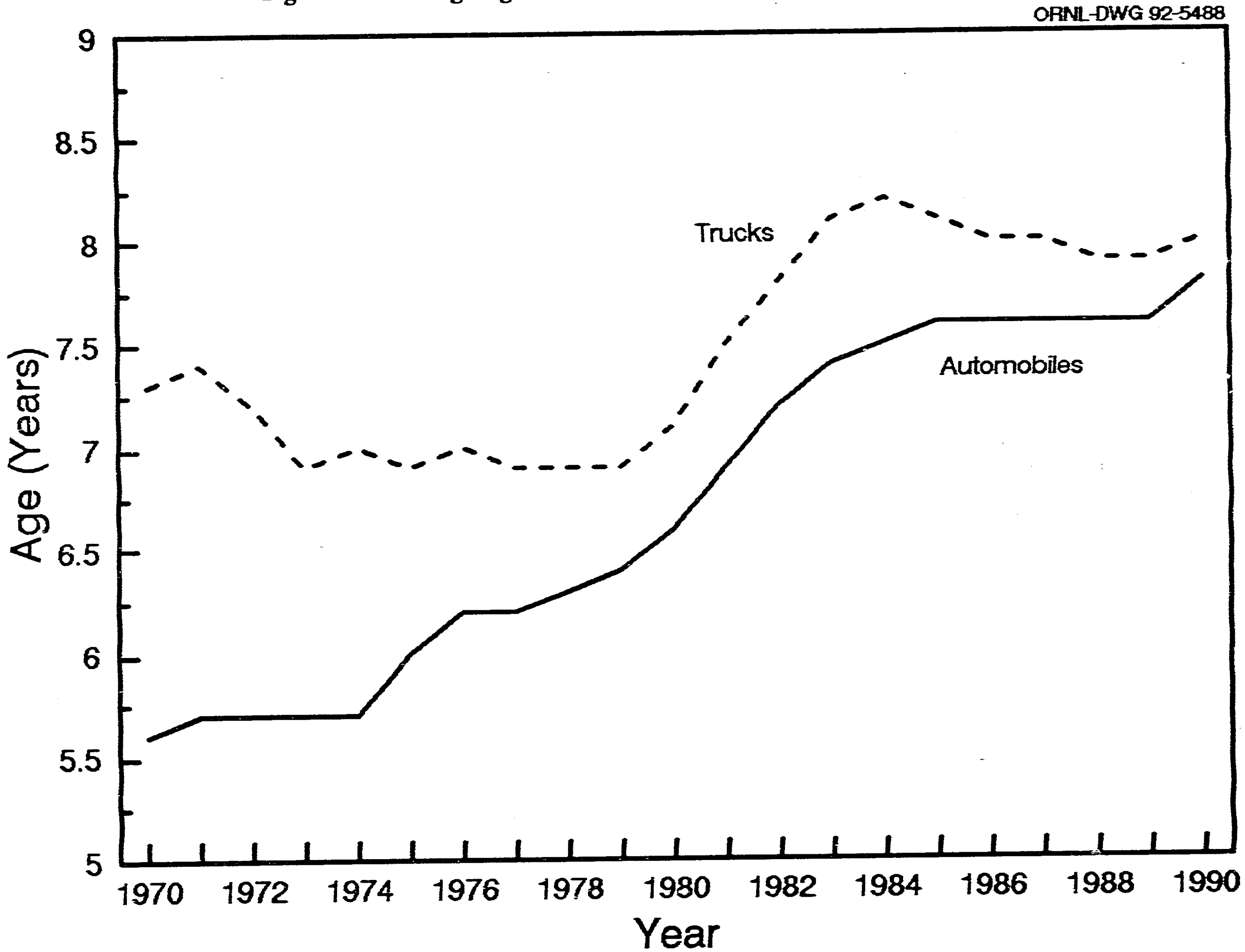
The average age of automobiles increased to 7.8 years in 1990; the average age had remained steady at 7.6 years since 1985. The average age gap between cars and trucks narrowed even further in 1990 to 0.2 years.

Table 3.5
Average Age of Automobiles and Trucks in Use, 1970-1990
(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

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

Figure 3.3. Average Age of Automobiles and Trucks in Use, 1970-90



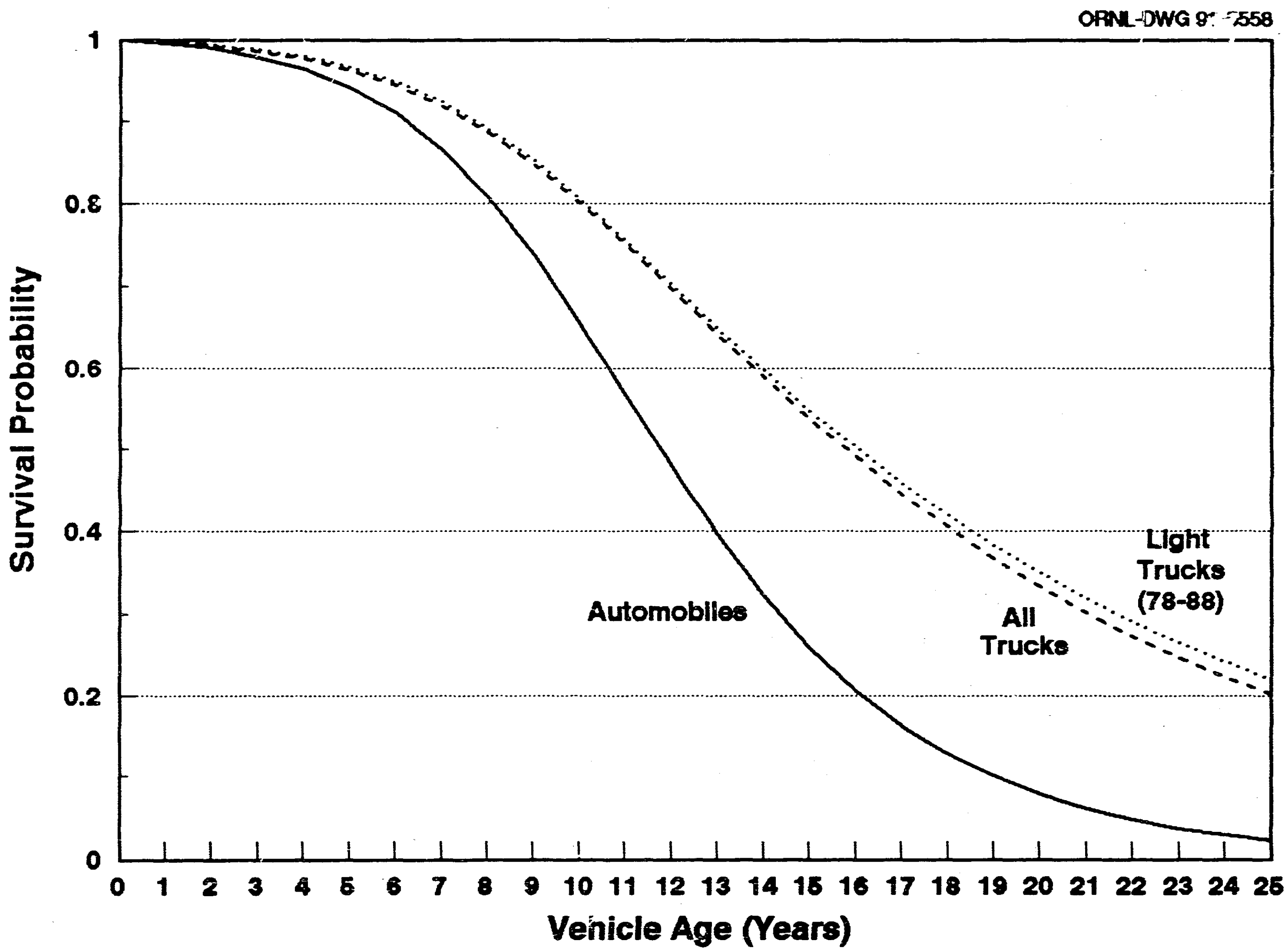
Source: See Table 3.5.

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

Vehicle Age (Years)	Automobiles (1978-89) Scrappage Rate	Automobiles (1978-89) Survival Rate	All Trucks (1978-89) Scrappage Rate	All Trucks (1978-89) Survival Rate	Light Trucks (1978-88) Scrappage Rate	Light Trucks (1978-88) 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



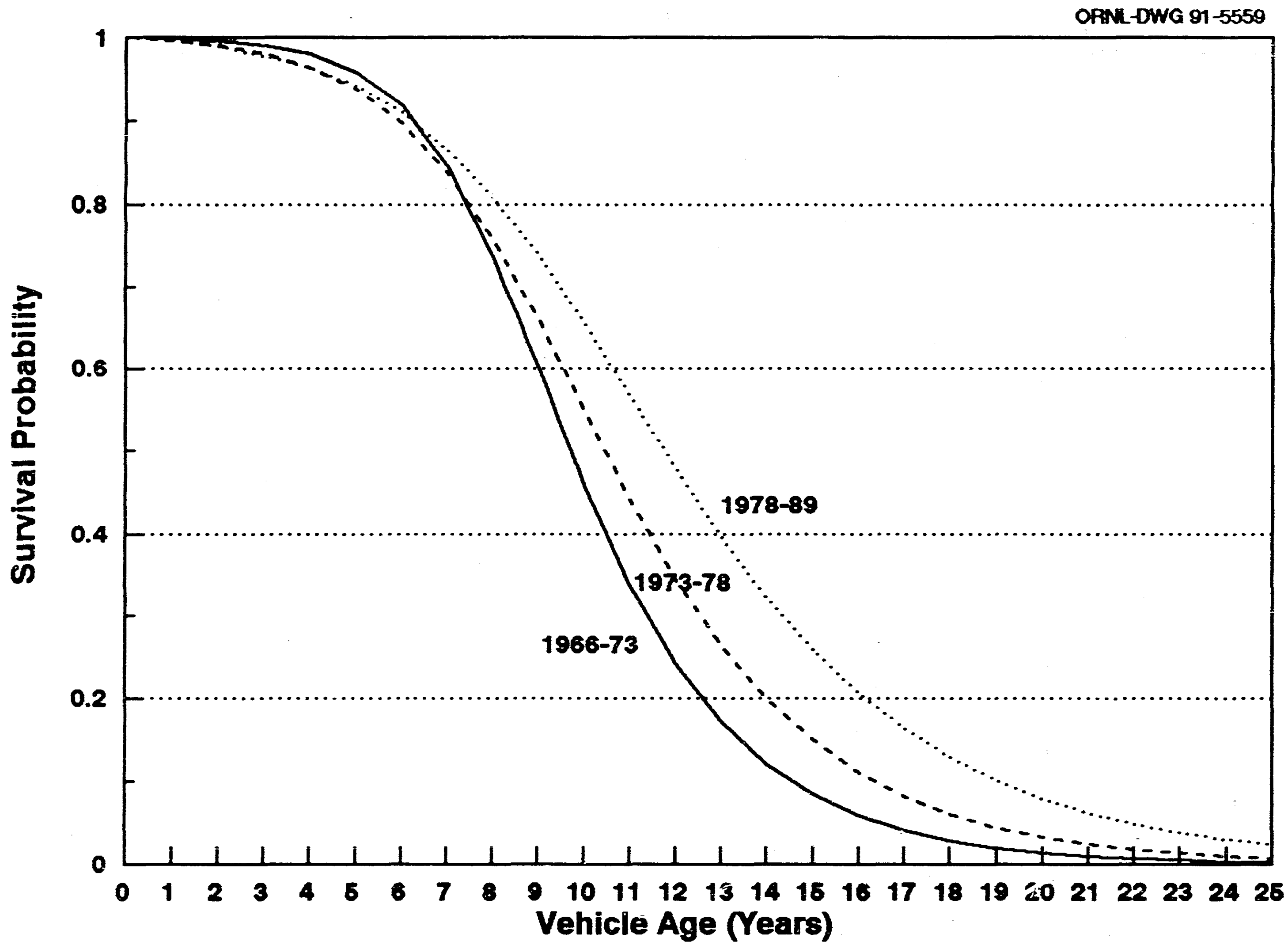
Source: See Table 3.6.

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



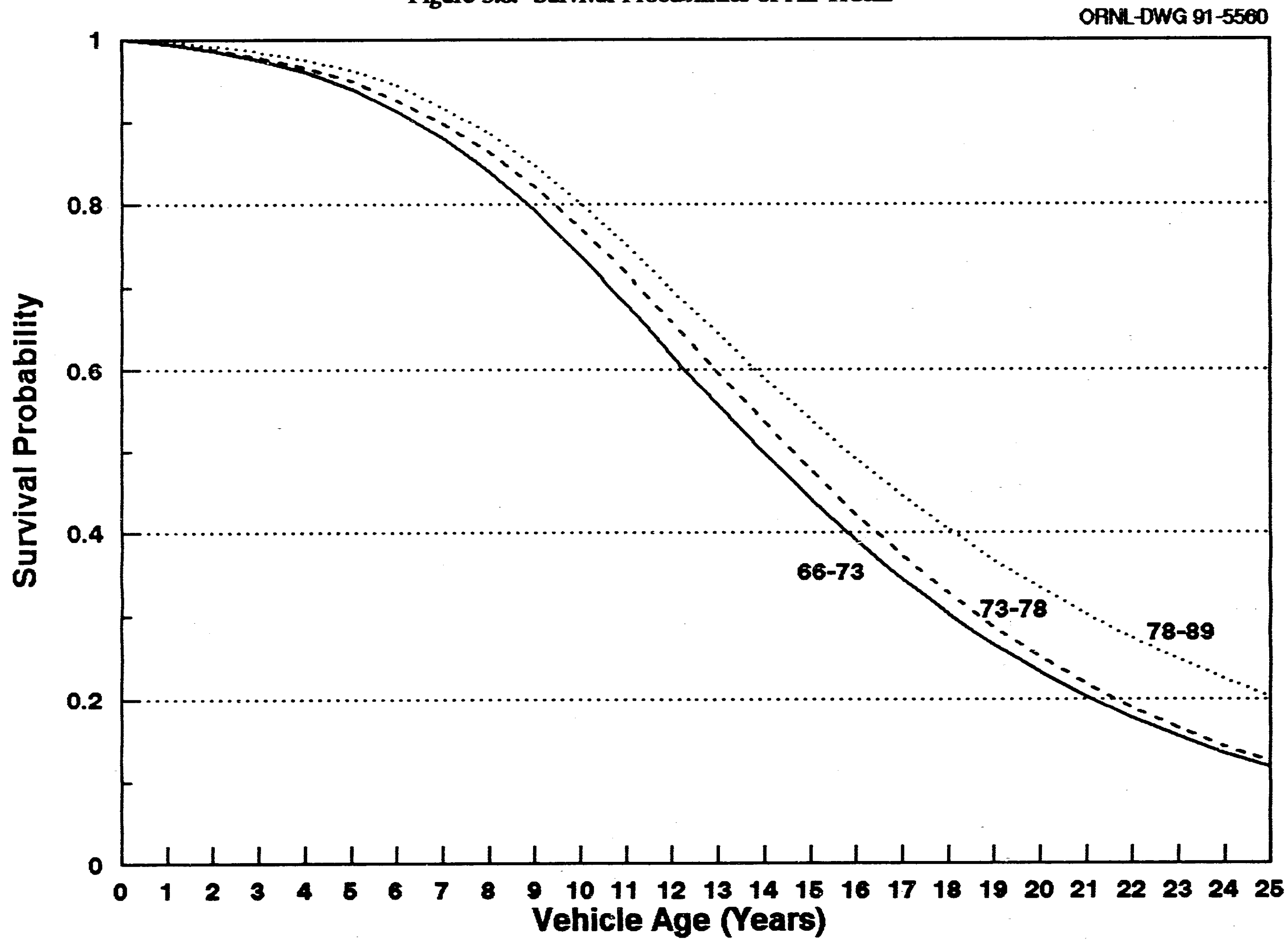
Source: See Table 3.7.

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.

Section 3.2. Automobiles

Automobile sales continued to decline in 1990. Diesels have accounted for less than 1% of total automobile sales since 1985.

Table 3.9
New Retail Automobile Sales in the United States, 1970-90

Calendar Year	Domestic	Import[a]	Total	Percentage import	Diesel (thousands)	Percentage diesel
	(thousands)					
1970	7,119	1,285	8,404	15.3	b	b
1971	8,681	1,568	10,249	15.3	6	0.06
1972	9,327	1,623	10,950	14.8	6	0.05
1973	9,676	1,763	11,439	15.4	6	0.06
1974	7,454	1,399	8,853	15.8	18	0.20
1975	7,053	1,571	8,624	18.2	27	0.31
1976	8,611	1,499	10,110	14.8	23	0.22
1977	9,109	2,074	11,183	18.5	37	0.34
1978	9,312	2,002	11,314	17.7	115	1.02
1979	8,341	2,332	10,673	21.8	271	2.54
1980	6,581	2,398	8,979	26.7	387	4.31
1981	6,209	2,327	8,536	27.3	521	6.10
1982	5,759	2,223	7,982	27.9	355	4.44
1983	6,795	2,387	9,182	26.0	192	2.09
1984	7,952	2,439	10,391	23.5	151	1.45
1985	8,205	2,838	11,043	25.7	91	0.82
1986	8,215	3,238	11,453	28.3	42	0.37
1987	7,081	3,197	10,278	31.1	17	0.16
1988	7,526	3,099	10,626	29.2	2	0 01
1989	7,073	2,825	9,898	28.5	13	0.13
1990	6,897	2,404	9,301	25.8	7	0.08
		Average annual percentage change				
1970-90	-0.2%	3.2%	0.5%		-0.8%[c]	
1982-90	2.3%	1.0%	1.9%		-38.8%	

Sources:

1970-90 Domestic and import data - Motor Vehicle Manufacturers Association, Motor Vehicle Facts and Figures, Detroit, MI, 1991, p. 15, and annual.

1970-90 Diesel data - H. A. Stark (ed), Ward's Communications, Inc., Ward's Automotive Yearbook, Detroit, MI, 1991, p. 61, and annual.

[a]Does not include import tourist deliveries.
[b]Data are not available.
[c]Average annual percentage change is for years 1971-90.

Compared to 1970, the automobile population has shifted toward older automobiles in 1990. Fifty percent of the automobile population in 1970 was 4.9 years old or older while half of the automobile population in 1989 was 6.5 years old or older. The percent of cars 10 years old and older has more than doubled from 11.7% in 1970 to 30.7% in 1990.

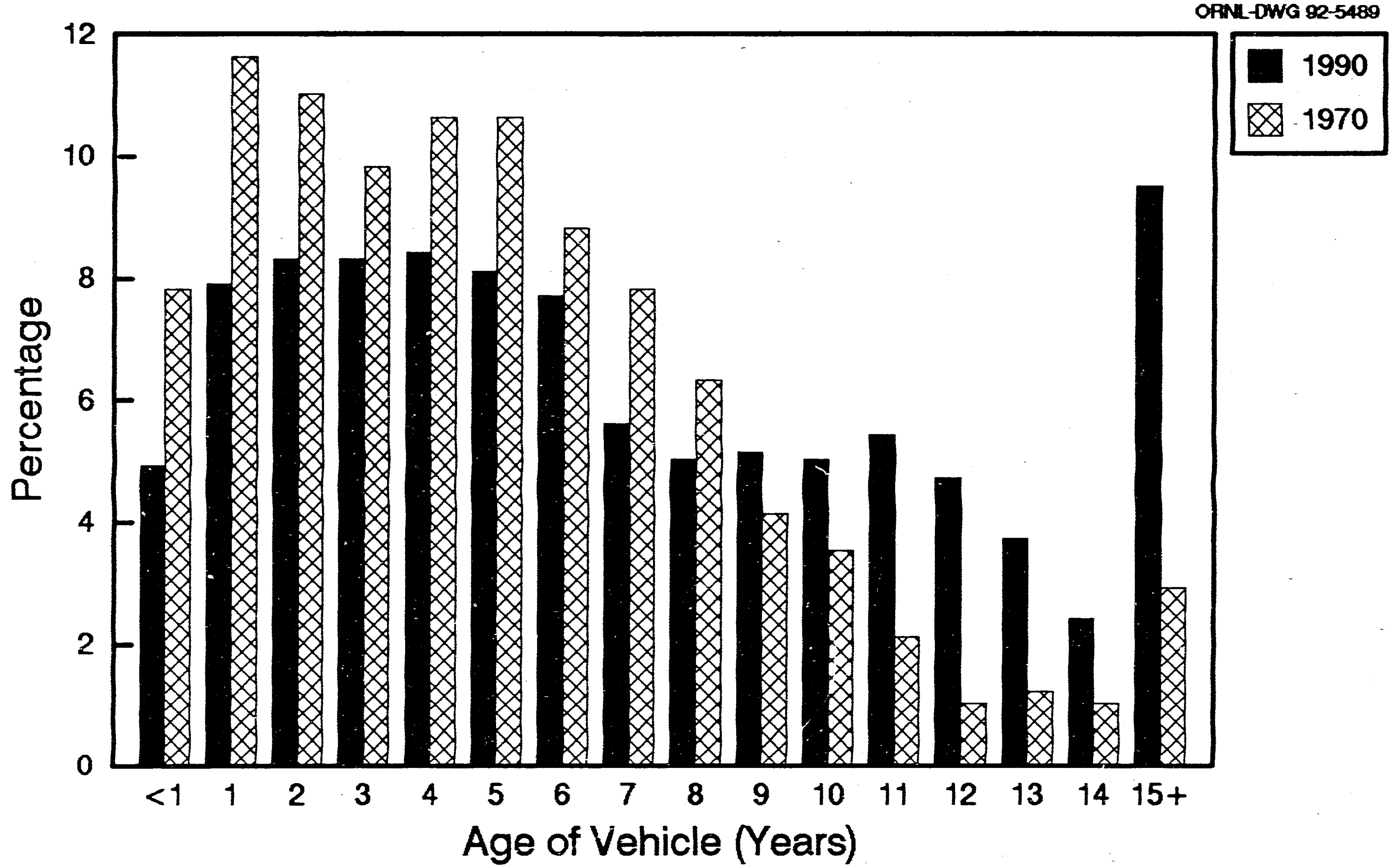
Table 3.10
Automobiles in Use by Age, 1970 and 1990

	1970			1990		
Age (years)	Vehicles (thousands)	Actual percentage	Cumulative percentage	Vehicles (thousands)	Actual percentage	Cumulative percentage
Under 1[a]	6,288	7.8	7.8	6,062	4.9	4.9
1	9,299	11.6	19.4	9,729	7.9	12.8
2	8,816	11.0	30.3	10,245	8.3	21.1
3	7,878	9.8	40.1	10,140	8.3	29.4
4	8,538	10.6	50.8	10,366	8.4	37.8
5	8,506	10.6	61.3	9,989	8.1	45.9
6	7,116	8.8	70.2	9,549	7.7	53.6
7	6,268	7.8	78.0	6,884	5.6	59.2
8	5,058	6.3	84.3	6,188	5.0	64.2
9	3,267	4.1	88.3	6,323	5.1	69.3
10	2,776	3.5	91.8	6,111	5.0	74.3
11	1,692	2.1	93.9	6,624	5.4	79.7
12	799	1.0	94.9	5,791	4.7	84.4
13	996	1.2	96.1	4,569	3.7	88.1
14	794	1.0	97.1	2,981	2.4	90.5
15 and older	2,336	2.9	100.0	11,720	9.5	100.0
Subtotal	80,427	100.0		123,270	100.0	
Age not given[b]	22			6		
Total	80,449			123,276		
Average age		5.55			7.78	
Median age		4.93			6.54	

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

[a]Automobiles sold as of July 1 of each year.
[b]Approximately 22,000 automobiles in 1970 and 6,000 in 1990 could not be classified by age.

Figure 3.7. Automobiles in Use by Age, 1970 and 1990



Source: See Table 3.10.

Although 69% of all automobiles in operation in 1990 were less than 10 years old, those autos were responsible for 78% of automobile travel.

Table 3.11
Automobiles in Operation
and Vehicle Travel by Age of Vehicle, 1990

Vehicle age (years)	Number in operation			Estimated vehicle travel	
	Vehicles (thousands)	Actual percentage	Cumulative percentage	Actual percentage	Cumulative percentage
Under 1[a]	6,062	4.9	4.9	6.2	6.2
1	9,729	7.9	12.8	10.3	16.5
2	10,245	8.3	21.1	10.2	26.8
3	10,140	8.2	29.3	9.7	36.5
4	10,366	8.4	37.8	9.5	46.0
5	9,989	8.1	45.9	8.4	54.4
6	9,549	7.7	53.6	8.2	62.5
7	6,884	5.6	59.2	5.5	68.0
8	6,188	5.0	64.2	5.1	73.1
9	6,323	5.1	69.3	4.5	77.5
10	6,111	5.0	74.3	4.4	81.9
11	6,624	5.4	79.7	4.4	86.3
12	5,791	4.7	84.4	3.6	89.9
13	4,569	3.7	88.1	2.7	92.6
14	2,981	2.4	90.5	1.7	94.3
15 and older	11,720	9.5	100.0	5.7	100.0
Subtotal	123,270	100.0		100.0	
Age not given[b]	6				
Total	123,276				

Sources:
Number of vehicles in operation by age - R. L. Polk and Company, 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, 1990.
[b]Approximately 6,000 automobiles could not be classified by age.

Automobile registrations rose 1.3% from 1988 to 1989, while automobile travel rose 3.9% in this same period. The fuel economy for the automobile population reached 20 miles per gallon in 1989; as the older autos are scrapped, they are replaced by newer fuel efficient autos which raises the population fuel economy.

Table 3.12
Summary Statistics fo. Passenger Cars, 1970-89

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	143,081	1,485,474	72,332	20.5
		Average annual percentage change		
1970-89	2.5%	2.6%	0.3%	2.2%
1982-89	2.1%	3.5%	0.5%	3.0%

Source:
U.S. Department of Transportation, Federal Highway Administration, Highway Statistics 1989, Washington, DC, 1990, Table VM-1, p. 181, 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.

It is a common misconception that new vehicles are driven more miles than they are actually driven. 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)	Nationwide Personal Transportation Study[a]				Residential Transportation Energy Consumption Survey[b]		
	1969	1977	1983	1990	1983	1985	1988
Under 1	17,500	11,800	14,200	19,800	13,400	12,700	12,900
1	16,100	13,400	17,000	16,900	13,000	13,000	13,400
2	13,200	13,400	14,000	16,300	12,700	12,600	12,600
3	11,400	12,100	12,500	14,400	12,100	12,400	12,100
4	11,700	11,300	11,400	13,800	11,300	11,100	11,500
5	10,000	10,700	11,000	12,600	9,700	10,600	10,600
6	10,300	10,500	9,900	12,900	9,700	10,000	10,800
7	8,600	9,500	9,400	12,400	9,500	9,700	10,000
8	10,900	8,600	8,700	12,300	8,700	8,900	10,300
9	8,000	8,800	8,100	11,200	8,400	8,600	8,900
10 and older	6,500	7,100	6,900	9,300	8,700	8,400	7,500
All vehicles	11,600	10,300	10,400	12,600	9,400	9,900	10,200

Sources:

Nationwide Personal Transportation Study - 1969-83: D. Klinger and J. Richard Kuzmyak, COMSIS Corporation, 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: U.S. Department of Transportation, Federal Highway Administration, Office of Highway Information Management, Nationwide Personal Transportation Study, Public Use Tape, 1991.

Residential Transportation Energy Consumption Survey - Energy Information Agency, Office of Markets and End Use, Energy End Use Division, 1983, 1985, and 1988 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.

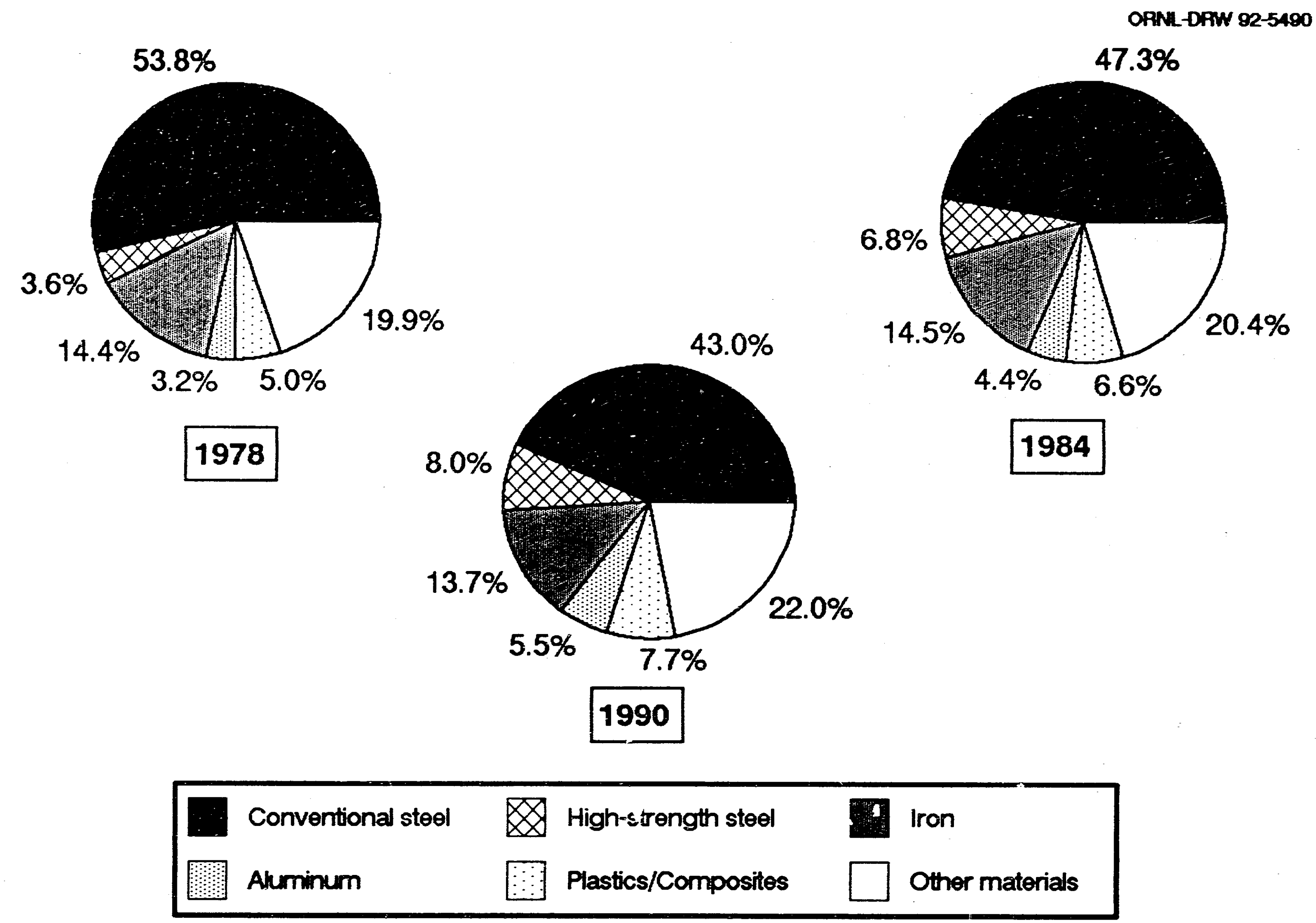
The average domestic automobile lost 598 pounds from 1978 to 1990. Much of the weight loss was due to the declining use of conventional steel and iron and the increasing use of aluminum and plastics. Conventional steel, however, remained the predominant component of automobiles in 1990 with a 43% share of total materials.

Table 3.14
Average Material Consumption for a Domestic Automobile, 1978, 1984, and 1990

Material	1978 Pounds	1978 Percentage	1984 Pounds	1984 Percentage	1990 Pounds	1990 Percentage
Conventional steel	1,860.0	53.8	1,487.5	47.3	1,246.5	43.0
High-strength steel	127.5	3.6	214.0	6.8	233.0	8.0
Stainless steel	25.0	0.7	29.0	0.9	31.5	1.1
Other steels	56.0	1.6	45.0	1.4	53.0	1.8
Iron	503.0	14.4	454.5	14.5	398.0	13.7
Aluminum	112.0	3.2	137.0	4.4	158.5	5.5
Rubber	141.5	4.1	133.5	4.2	128.0	4.4
Plastics/Composites	176.0	5.0	206.5	6.6	222.0	7.7
Glass	88.0	2.5	87.0	2.8	82.5	2.8
Copper	39.5	1.1	44.0	1.4	46.0	1.6
Zinc die castings	28.0	0.8	17.0	0.5	19.0	0.7
Power metal parts	16.0	0.5	18.5	0.6	23.0	0.8
Fluids & lubricants	189.0	5.4	180.0	5.7	167.0	5.8
Other materials	112.5	3.2	88.0	2.8	88.0	3.0
Total	3,494.0	100.0	3,141.5	100.0	2,896.0	100.0

Source:
H. A. Stark (ed), Ward's Communications, Inc., Wards Automotive Yearbook, Detroit, MI, 1991, p. 44.

Figure 3.8. Average Material Consumption for a Domestic Automobile, 1978, 1984, and 1990



Source: See Table 3.14.

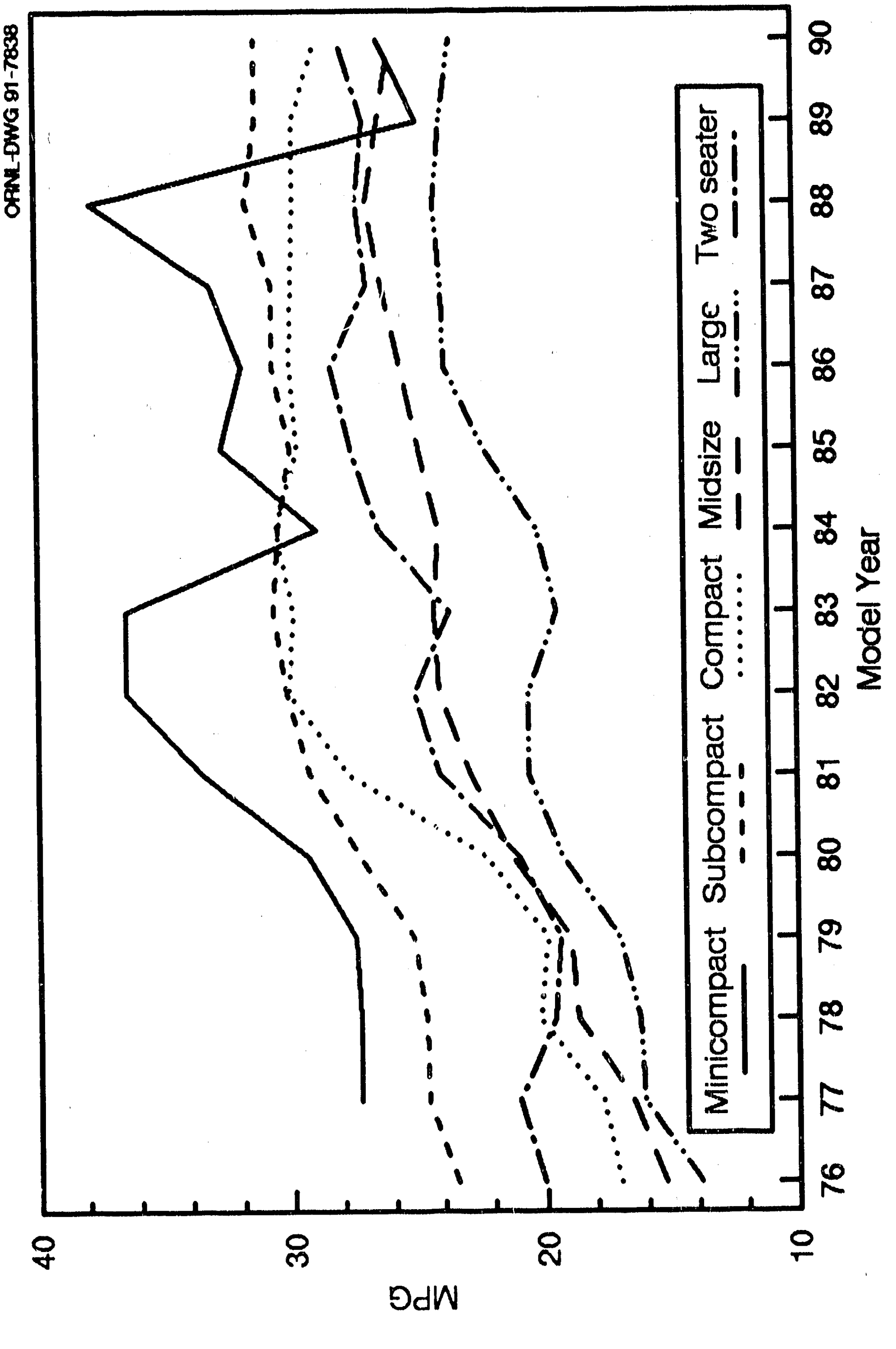
Table 3.15
Model Year Sales, Market Shares, and Sales-Weighted Fuel Economies of New Domestic and Import Automobiles, Model Years 1976-1990[a]

	1976	1980	1982	1984	1986	1988	1989	1990
MINICOMPACT								
Total sales, units		428,346	221,699	41,368	191,490	84,186	20,677	76,698
Market share, %		4.7	2.9	0.4	1.7	0.8	0.2	0.8
Fuel economy, mpg		29.4	36.5	29.0	31.9	37.8	24.9	26.4
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
Market share, %	27.1	37.8	31.4	24.6	21.2	19.1	19.3	22.0
Fuel economy, mpg	23.5	27.3	30.2	30.5	30.7	31.7	31.3	31.3
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
Market share, %	29.3	6.6	17.0	27.1	34.5	40.5	36.3	34.2
Fuel economy, mpg	17.1	22.3	30.1	30.6	30.0	29.8	29.8	28.9
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
Market share, %	18.7	33.8	33.1	30.0	26.9	24.6	28.9	27.2
Fuel economy, mpg	15.3	21.3	24.1	24.1	25.6	26.9	26.4	25.9
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
Market share, %	22.8	14.7	13.0	14.7	13.2	13.2	13.8	13.9
Fuel economy, mpg	13.9	19.3	20.6	20.2	23.8	24.2	23.9	23.5
TWO SEATER								
Total sales, units	199,716	215,964	202,929	328,968	275,470	196,127	158,884	170,465
Market share, %	2.1	2.4	2.6	3.2	2.5	1.8	1.6	1.8
Fuel economy, mpg	20.1	21.0	25.1	26.5	28.4	27.3	27.0	28.0
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
Market share, %	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Fuel economy, mpg	17.2	23.2	2[illegible].3	26.3	27.9	28.5	28.0	27.6

Source:
Williams, Linda S. and Patricia S. Hu, Highway Vehicle MPG and Market Shares Report: Model Year 1990, Oak Ridge National Laboratory, ORNL-6672, Oak Ridge, TN, April 1991, p. 3-4.

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

Figure 3.9. Fuel Economies of New Domestic and Import Automobiles by Size Class, 1976-90



Source: See Table 3.15.

Section 3.3. Trucks

Light trucks sales declined again in 1990 but continued to account for almost 94% of total truck sales. Also, light trucks accounted for 32.8% of all light-duty vehicle sales in 1990, an increase of 1% from 1989. The import share of light truck sales reversed a decreasing trend growing to 13.2% in 1990.

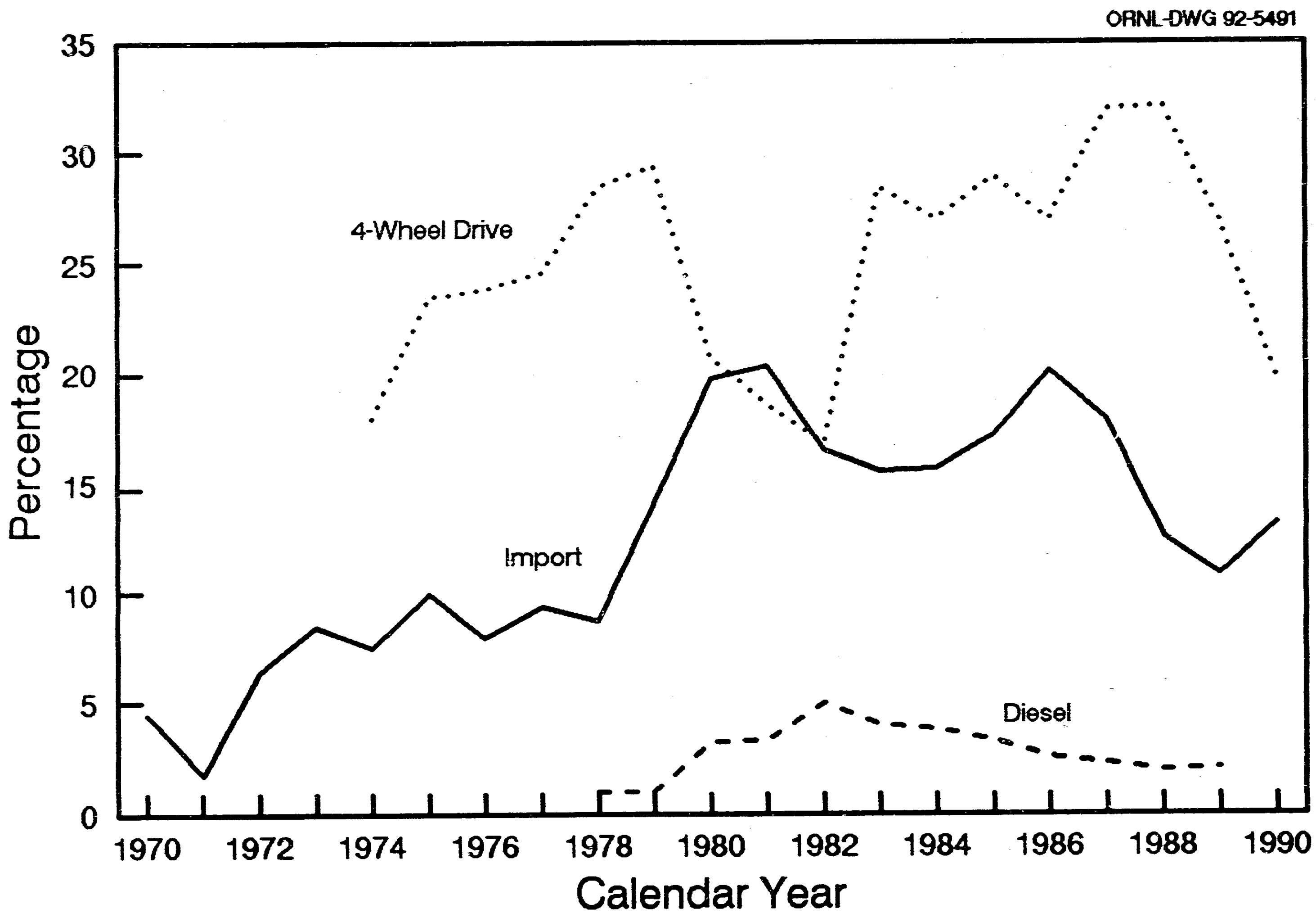
Table 3.16
New Retail Sales of Light Trucks in the United States, 1970-90

		Percentages				
Calendar Year	Light truck sales[a] (thousands)	Import of total light truck	Diesel of total light truck	Four-wheel drive on domestic light trucks	Light trucks of light duty vehicle sales[b]	Light trucks of total truck sales
1970	1,463	4.5	[c]	[d]	14.8	80.4
1971	1,757	4.8	[c]	[d]	14.6	83.4
1972	2,239	6.4	[c]	[d]	16.7	83.3
1973	2,745	8.5	[c]	[d]	18.8	84.2
1974	2,338	7.5	[c]	18.0	20.3	84.2
1975	2,281	10.0	[c]	23.4	20.1	87.9
1976	2,956	8.0	[c]	23.8	22.0	89.8
1977	3,430	9.4	[c]	24.6	22.8	89.7
1978	3,808	8.8	1.0	28.5	24.5	89.2
1979	3,311	14.1	1.0	29.4	22.4	88.7
1980	2,440	19.7	3.2	20.7	19.8	88.9
1981	2,189	20.3	3.3	18.6	19.2	89.8
1982	2,470	16.5	5.0	16.8	23.0	92.8
1983	2,984	15.6	4.0	28.5	24.2	93.6
1984	3,863	15.7	3.8	27.0	26.9	93.0
1985	4,458	17.2	3.3	29.1	28.7	93.6
1986	4,594	20.1	2.6	27.0	28.6	94.3
1987	4,610	17.9	2.3	32.0	31.0	93.9
1988	4,800	12.6	2.0	32.1	31.1	93.2
1989	4,610	10.9	2.1	26.9[e]	31.8	93.3
1990	4,548	13.2	2.2[e]	19.8[e]	32.8	93.9
		Average annual percentage change				
1970-89	6.3%					
1982-89	9.4%					

Sources:
Four-wheel drive - 1970-88: H. A. Stark (ed.), Ward's Communications, Inc., Ward's Automotive Yearbook, Detroit, MI, 1989, p. 168, and annual.
1989-90: H. A. Stark (ed.), Ward's Communications, Inc., Ward's Automotive Reports, Factory Installation Report, Detroit, MI, August 20, 1990.
All other - Motor Vehicle Manufacturers Association, Motor Vehicle Facts and Figures '91, Detroit, MI, 1991, pp. 11, 15, 19, and annual.

[a]Includes domestic, domestic-sponsored import, and import trucks of 10,000 pounds gross vehicle weight and less.
[b]Light-duty vehicles include cars and light trucks.
[c]Indicates less than 1 percent.
[d]Data are not available.
[e]Based on factory installations.

Figure 3.10. Import, Diesel, and Four-Wheel Drive Shares of Light Truck Sales, 1970-90



Source: See Table 3.16.

Table 3.17
New Retail Domestic Truck Sales by Gross Vehicle Weight, 1970-90[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
				Average annual percentage change					
1970-90	5.4%	6.3%	2.2%	4.2%	-12.1%	-6.6%	4.9%	2.6%	4.9%
1982-90	14.6%	4.4%	36.9%	75.9%	25.8%	-2.8%	5.3%	9.7%	10.3%

Source:
Motor Vehicle Manufacturers Association, Motor Vehicle Facts and Figures '91, Detroit, MI, 1991, p. 18-19, 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.

Although the average age of trucks has increased by only 0.65 years from 1970 to 1990, the percentage of trucks ten years old or older has grown from 29.2% in 1970 to 36.1% in 1990.

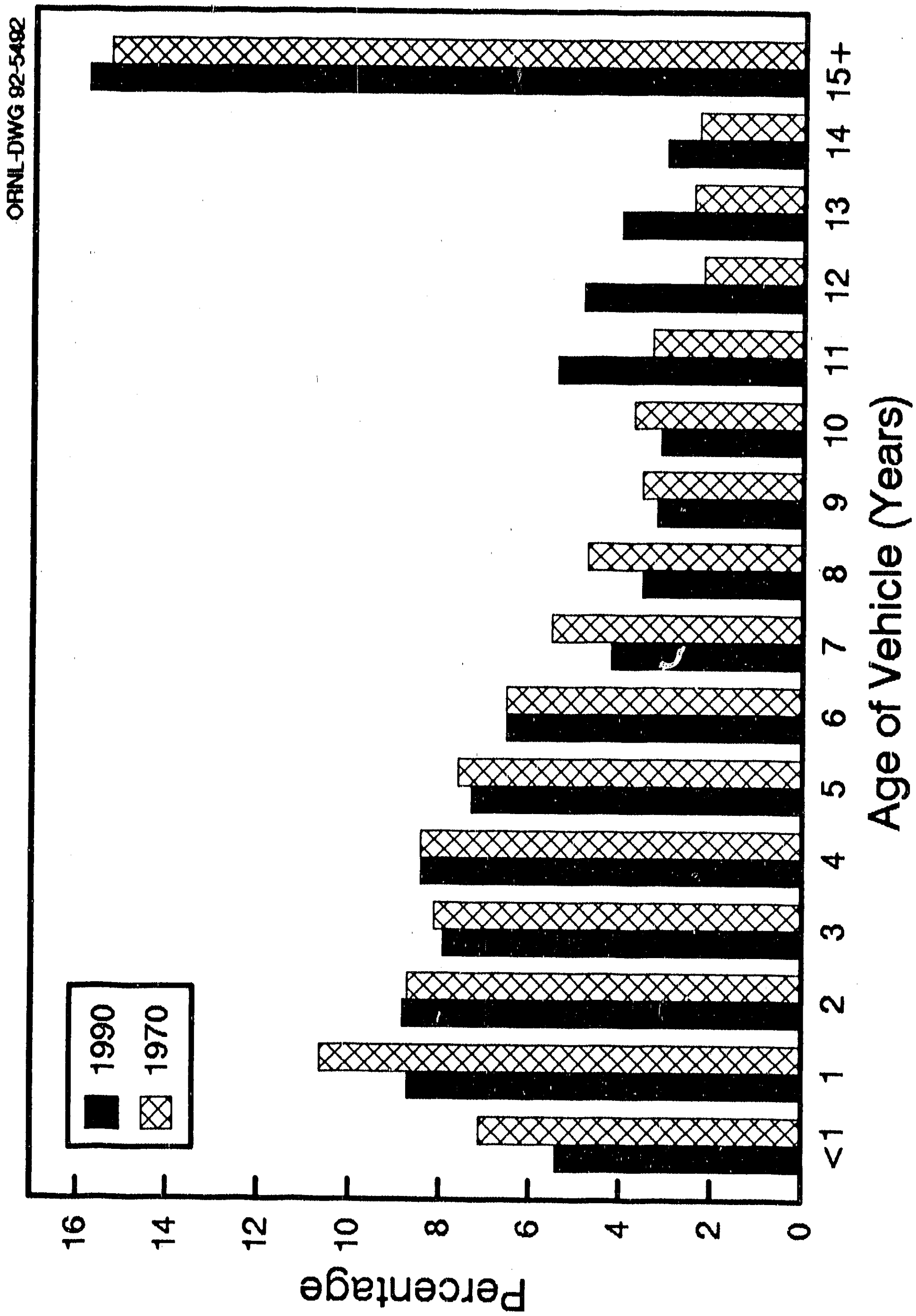
Table 3.18
Trucks in Use by Age, 1970 and 1990

	1970			1990		
Age (years)	Vehicles (thousands)	Actual percentage	Cumulative percentage	Vehicles (thousands)	Actual percentage	Cumulative percentage
Under 1[a]	1,262	7.1	7.1	3,011	5.4	5.4
1	1,881	10.6	17.8	4,872	8.7	14.1
2	1,536	8.7	26.5	4,913	8.8	22.8
3	1,428	8.1	34.6	4,435	7.9	30.8
4	1,483	8.4	43.0	4,704	8.4	39.2
5	1,339	7.6	50.5	4,097	7.3	46.5
6	1,154	6.5	57.1	3,641	6.5	53.0
7	975	5.5	62.6	2,332	4.2	57.1
8	826	4.7	67.3	1,978	3.5	60.7
9	621	3.5	70.8	1,813	3.2	63.9
10	658	3.7	74.5	1,722	3.1	67.0
11	583	3.3	77.8	3,020	5.4	72.4
12	383	2.2	80.0	2,675	4.8	77.1
13	417	2.4	82.3	2,255	4.0	81.2
14	414	2.3	84.7	1,687	3.0	84.2
15 and older	2,710	15.3	100.0	8,862	15.8	100.0
Subtotal	17,670	100.0		56,019	100.0	
Age not given[b]	15			4		
Total	17,685			56,023		
Average age		7.33			7.98	
Median age		5.93			6.54	

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

[a]Trucks sold as of July 1 of each year.
[b]Approximately 15,000 trucks in 1970 and 4,000 in 1990 could not be classified by age.

Figure 3.11. Trucks in Use by Age, 1970 and 1990



Source: See Table 3.18.

Data from the 1987 TIUS (the most recent data available on national truck population characteristics) were used to estimate 1990 truck travel patterns by vehicle age group. Trucks which were 10 years old or older accounted for 36.1% of the truck population but represented only 21.2% of total truck travel in 1990.

Table 3.19
Trucks in Operation
and Vehicle Travel by Age of Vehicle, 1990

Vehicle age (years)	Number in operation			Estimated vehicle travel		Average annual miles per vehicle
	Vehicles (thousands)	Actual percentage	Cumulative percentage	Actual percentage	Cumulative percentage	
Under 1[a]	3,011	5.4	5.4	6.7	6.7	14,900.5
1	4,872	8.7	14.1	12.3	19.1	16,852.8
2	4,913	8.8	22.8	12.3	31.4	16,719.0
3	4,435	7.9	30.8	10.7	42.1	16,074.2
4	4,704	8.4	39.2	9.9	52.0	14,005.1
5	4,097	7.3	46.5	8.6	60.6	13,952.4
6	3,641	6.5	53.0	7.5	68.1	13,687.0
7	2,332	4.2	57.1	4.4	72.6	12,643.5
8	1,978	3.5	60.7	3.4	75.9	11,387.2
9	1,813	3.2	63.9	2.9	78.8	10,665.3
10	20,221	36.1	100.0	21.2	100.0	6,960.1
Subtotal	56,019	100.0		100.0		
Age not given[b]	4					
Total	56,023					

Sources:
Number of trucks in operation by age - R. L. Polk and Company, 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 for 1989. 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, 1990.
[b]Approximately 4,000 vehicles could not be classified by age.

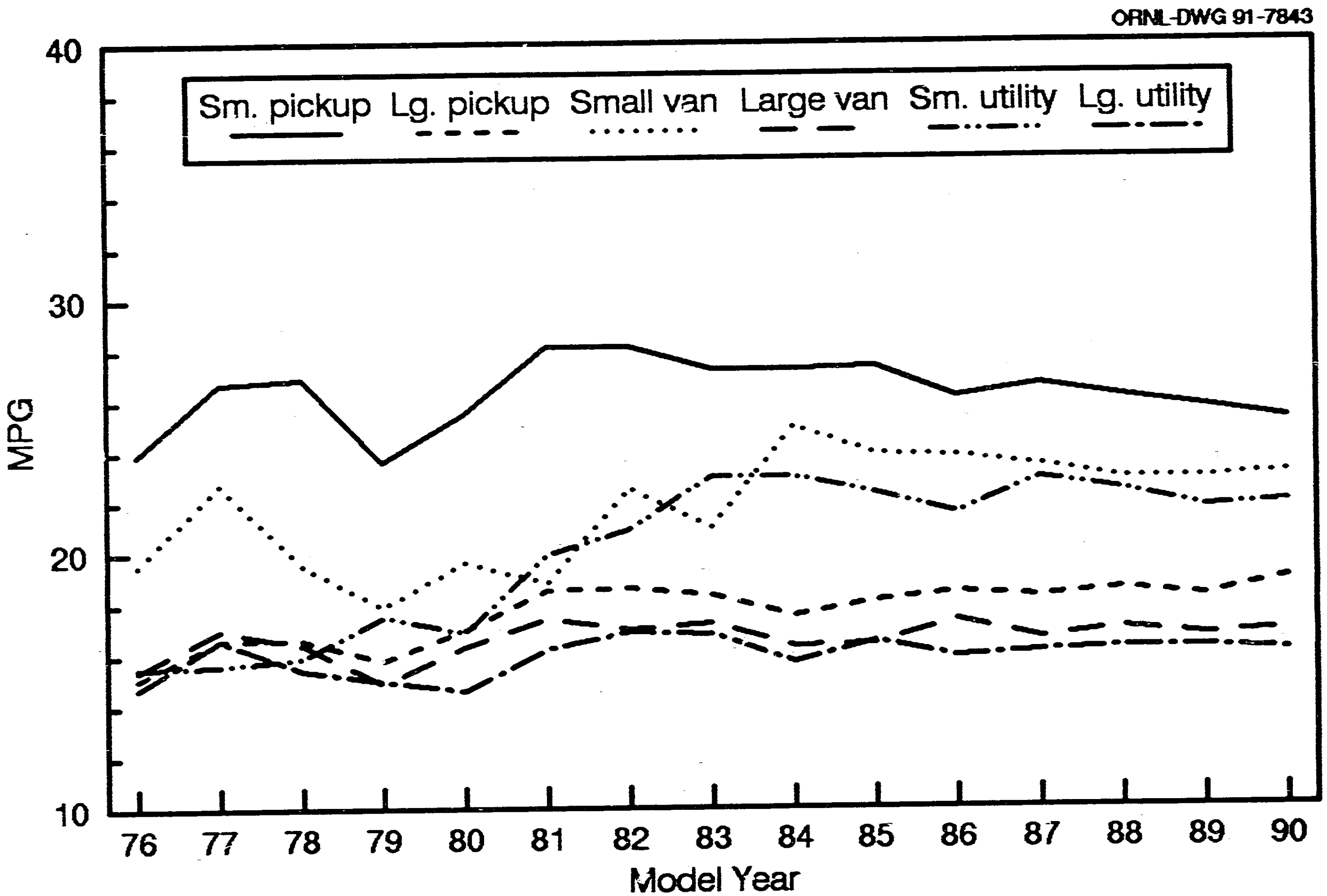
Table 3.20
Model Year Sales, Market Shares, and Sales-Weighted Fuel Economies of New Domestic and Import Light Trucks, Model Years 1976-1990[a]

	1976	1980	1982	1984	1986	1988	1989	1990
SMALL PICKUP								
Total sales, units	170,351	516,412	579,263	1,012,298	1,225,570	1,026,551	877,839	678,488
Market share, %	7.1	23.3	27.2	28.0	27.0	21.6	18.4	15.0
Fuel economy, mpg	23.9	25.5	28.1	27.2	26.1	26.1	25.7	25.2
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
Market share, %	66.4	50.3	46.9	33.7	29.2	30.6	33.2	34.9
Fuel economy, mpg	15.1	17.0	18.6	17.5	18.4	18.5	18.2	18.9
SMALL VAN								
Total sales, units	18,651	13,649	11,964	222,798	640,936	851,384	859,311	932,693
Market share, %	0.8	0.6	0.6	6.2	14.1	18.0	18.0	20.7
Fuel economy, mpg	19.5	19.6	22.5	25.0	23.8	22.9	22.9	23.1
LARGE VAN								
Total sales, units	574,745	328,065	379,110	545,595	510,558	486,981	471,762	398,877
Market share, %	24.1	14.8	17.8	15.1	11.3	10.3	9.9	8.8
Fuel economy, mpg	15.4	16.3	17.0	16.3	17.3	17.0	16.7	16.9
SMALL UTILITY								
Total sales, units	4,716	75,875	28,376	398,000	598,652	701,005	747,550	738,294
Market share, %	0.2	3.4	1.3	11.0	13.2	14.8	15.7	16.4
Fuel economy, mpg	15.5	16.9	20.9	23.0	21.5	22.4	21.7	21.9
LARGE UTILITY								
Total sales, units	32,427	167,288	133,355	215,271	233,625	223,824	228,664	192,544
Market share, %	1.4	7.5	6.3	6.0	5.2	4.7	4.8	4.3
Fuel economy, mpg	14.7	14.6	16.9	15.7	15.9	16.2	16.2	16.1
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
Market share, %	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

Source:
Williams, Linda S. and Patricia S. Hu, Highway Vehicle MPG and Market Shares Report: Model Year 1990 ORNL-6672, Oak Ridge National Laboratory, Oak Ridge, TN, April 1991, p. 4-3

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

Figure 3.12. Fuel Economies of New Domestic and Import Light Trucks by Size Class, 1976-90



Source: See Table 3.20.

TRUCK POPULATION

Tables 3.21-3.23 present the Federal Highway Administration's (FHWA) data on the U.S. truck population. The FHWA classifies trucks into three categories: two-axle, four-tire trucks; other single-unit trucks; and combination trucks. Other single-unit trucks are single-unit trucks with more than two axles or more than four tires; combination trucks are tractor-trailer combinations. Figure 3.13 compares 1989 registrations, fuel economy, vehicle travel, and fuel use for each truck type. Observations from these graphs follow.

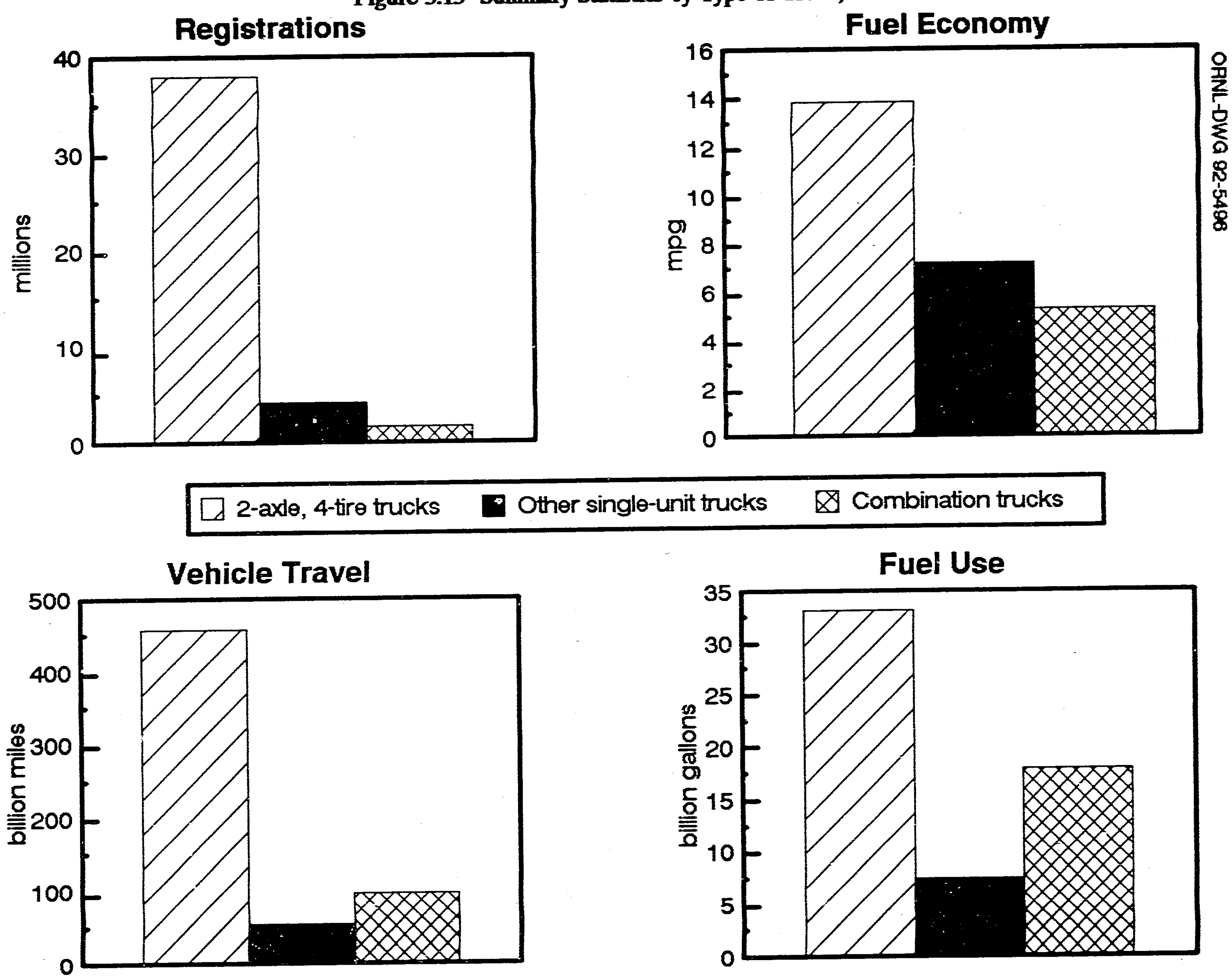
- Light trucks had the best fuel economy of all truck types (13.8 mpg), but also used the most fuel (33 billion gallons) in 1989. This was due to the large population of light trucks (38 million trucks) and the amount of vehicle travel (457 billion miles).

- Although registrations of combination trucks were less than half that of other single-unit trucks (1.6 million and 4.1 million trucks, respectively), combination trucks used twice as much fuel as other single-unit trucks (18 billion and 7 billion gallons, respectively) because of the combination truck's higher vehicle travel and lower fuel economy.

- Combination trucks accounted for only 3.6% of the truck population in 1989, but almost 16% of all truck miles.

- Other single-unit trucks, which accounted for 9.4% of the truck population, had the lowest vehicle travel (8.8%) and least fuel use (12.2%) in 1989.

Figure 3.13 Summary Statistics by Type of Truck, 1989



Source: See Tables 3.21 - 3.23.

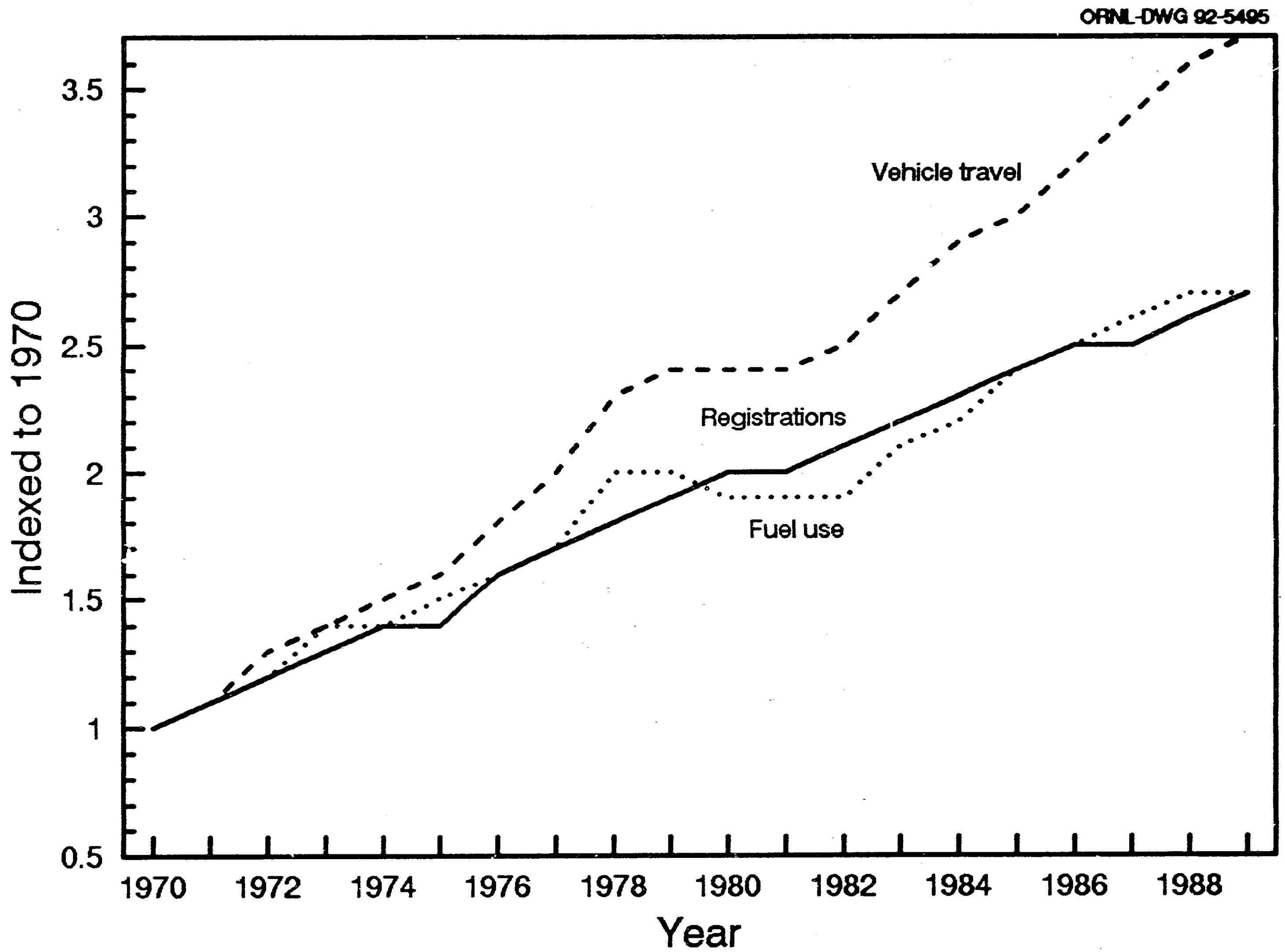
Two-axle, four-tire truck average fuel economy reached an all-time high of 13.8 mpg in 1989. These trucks are being driven longer distances each year evidenced by a 3.9% increase in vehicle travel in 1989, while registrations increased by only 2.1%.

Table 3.21
Summary Statistics for Two-Axle, Four-Tire Trucks, 1970-1989

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	21,055	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	37,862	456,699	33,068	13.8
		Average annual percentage change		
1970-89	5.3%	7.1%	5.3%	1.7%
1982-89	3.5%	5.9%	4.8%	1.1%

Source:
U.S. Department of Transportation, Federal Highway Administration, Highway Statistics 1989, Washington, DC, 1990, Table VM-1, p. 181, and annual.

Figure 3.14. Registrations, Vehicle Travel, and Fuel Use for Two-Axle, Four-Tire Trucks, 1970-89



Source: See Table 3.21.

The number of other single-unit trucks rose above 4 million in 1989 for the first time since 1984. Other single-unit truck travel has been increasing at a much faster rate than the number of trucks from 1970 to 1989. The increase in travel resulted in increases in fuel use because of the relatively constant fuel economy over the time period.

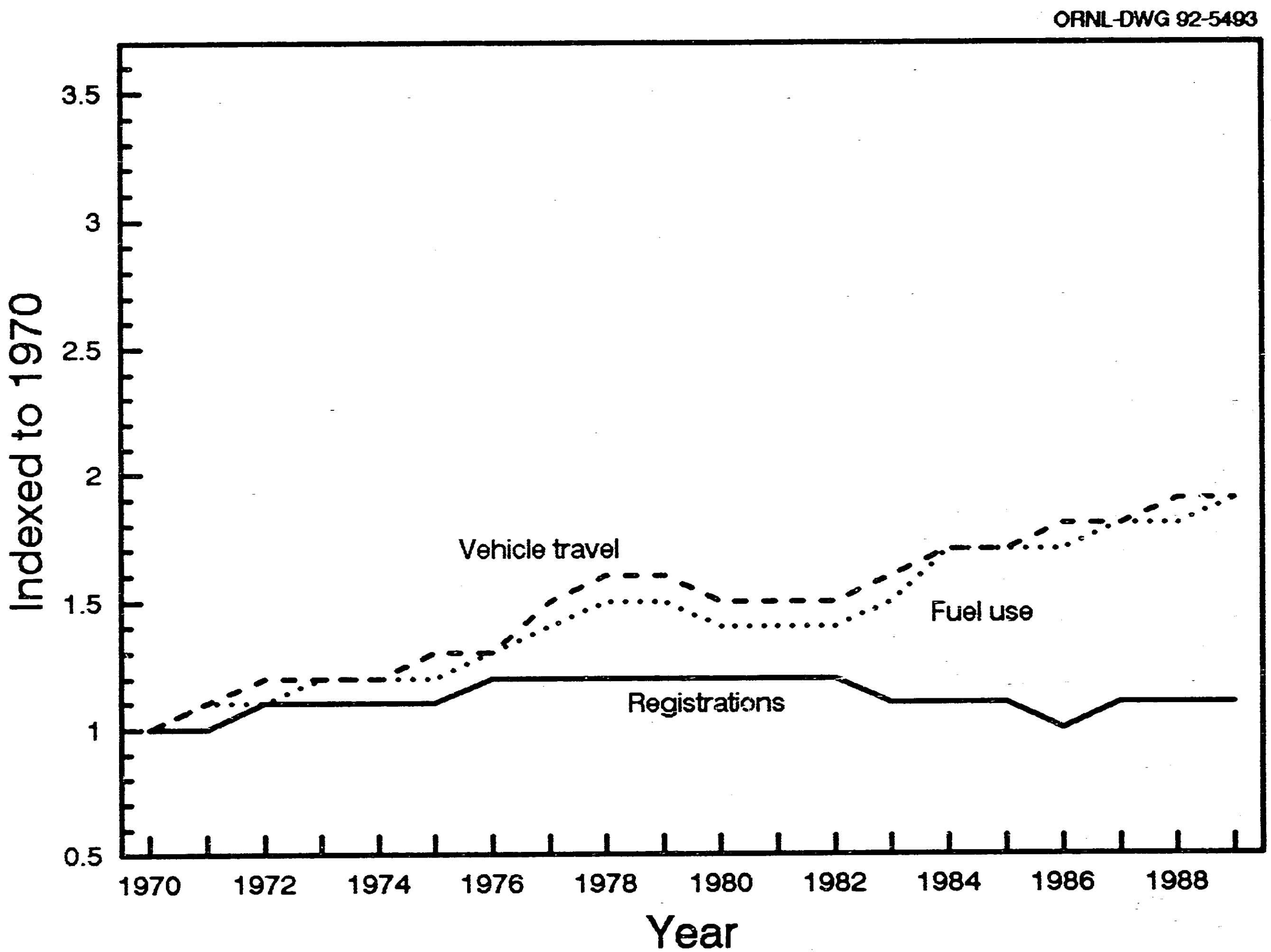
Table 3.22
Summary Statistics for Other Single-Unit Trucks[a], 1970-89

Year	Registrations (thousands)	Vehicle travel (million miles)	Fuel use (million gallons)	Fuel economy (miles per gallon)
1970	3,681	27,081	3,968	6.8
1971	3,770	28,985	4,212	6.9
1972	3,918	31,414	4,560	6.9
1973	4,131	33,661	4,859	6.9
1974	4,211	33,441	4,687	7.1
1975	4,232	34,606	4,825	7.2
1976	4,350	36,390	5,140	7.1
1977	4,450	39,339	5,559	7.1
1978	4,518	42,727	6,106	7.0
1979	4,505	42,012	6.036	7.0
1980	4,374	39,813	5,557	7.2
1981	4,455	39,568	5,574	7.1
1982	4,325	40,212	5,661	7.1
1983	4,204	43,409	6,118	7.1
1984	4,061	46,560	6,582	7.1
1985	3,927	46,980	6,735	7.0
1986	3,850	48,308	6,929	7.0
1987	3,884	49,537	7,091	7.0
1988	3,957	51,239	7,260	7.1
1989	4,103	53,190	7,415	7.2
		Average annual percentage change		
1970-89	0.6%	3.6%	3.3%	0.3%
1982-89	-0.7%	4.1%	3.9%	0.2%

Source:
U.S. Department of Transportation, Federal Highway Administration, Highway Statistics 1989, Washington, DC, 1990, Table VM-1, p. 181, and annual.

[a]Other single-unit trucks are defined as all single-unit trucks with more than two axles or more than four tires.

Figure 3.15. Registrations, Vehicle Travel, and Fuel Use for Other Single-Unit Trucks[a], 1970-89



Source: See Table 3.22.

[a]Other single-unit trucks are defined as all single-unit trucks with more than two axles or more than four tires.

Combination truck registrations in 1989 grew to over 1.5 million trucks. Vehicle travel for combinations has grown at a higher annual rate than truck registrations from 1982 to 1989. With fuel economy of combination trucks remaining relatively stable from 1982 to 1989, increases in the amount of travel primarily contributed to the increases in fuel use during this period.

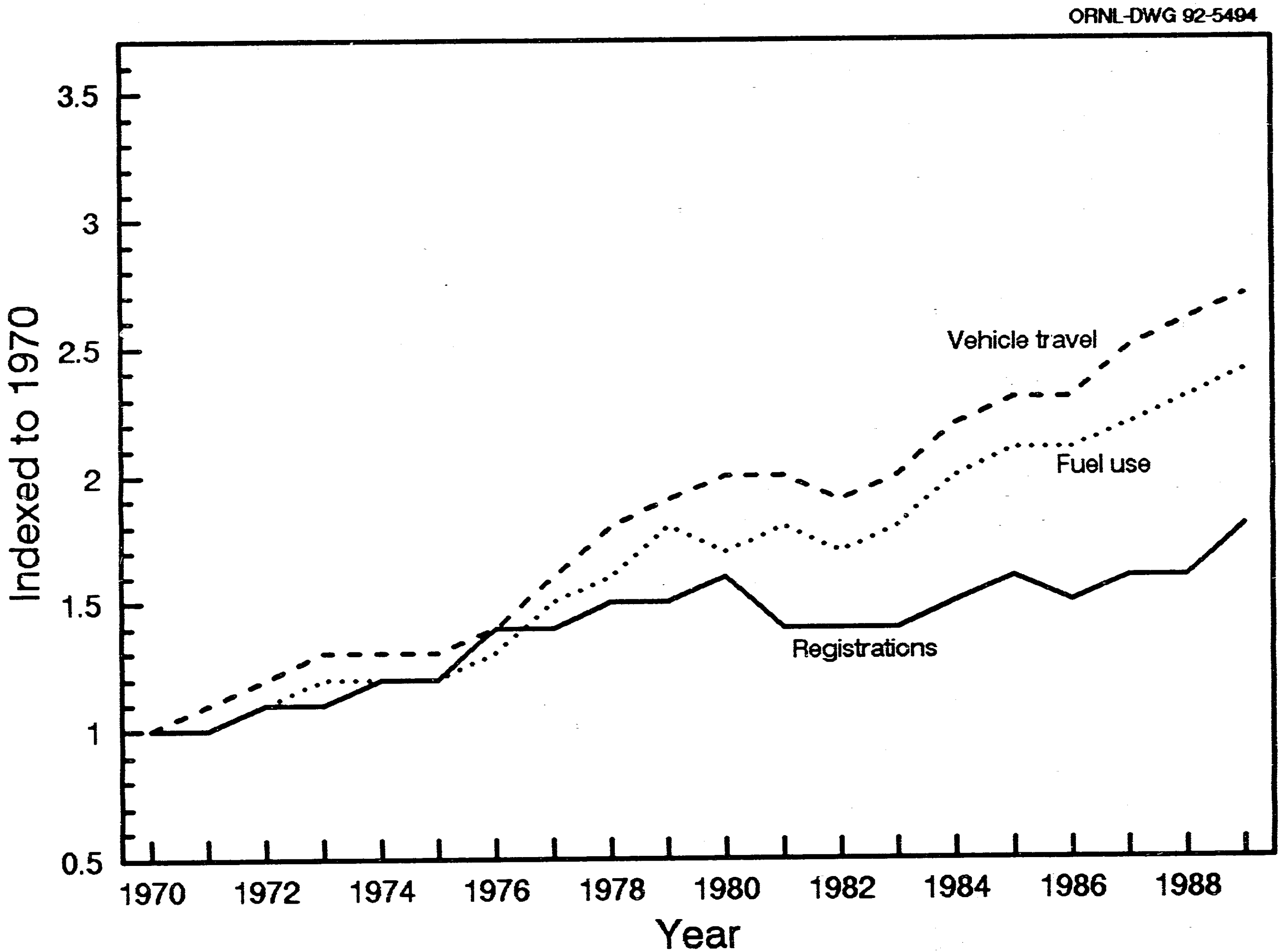
Table 3.23
Summary Statistics for Combination Trucks, 1970-1989

Year	Registrations (thousands)	Vehicle travel (million miles)	Fuel use (million gallons)	Fuel economy[a] (miles per gallon)
1970	905	35,134	7,347	4.8
1971	919	37,217	7,595	4.9
1972	961	40,706	8,120	5.0
1973	1,029	45,649	9,026	5.1
1974	1,085	45,966	8,800	5.2
1975	1,131	46,724	8,653	5.4
1976	1,225	49,680	9,536	5.2
1977	1,240	55,683	10,673	5.2
1978	1,342	62,992	12,113	5.2
1979	1,386	66,992	12,864	5.2
1980	1,417	68,678	12,703	5.4
1981	1,261	69,134	12,960	5.3
1982	1,265	66,668	12,636	5.3
1983	1,304	69,754	13,447	5.2
1984	1,340	77,367	14,781	5.2
1985	1,403	79,600	15,280	5.2
1986	1,399	81,833	15,716	5.2
1987	1,419	86,064	16,493	5.2
1988	1,476	90,158	17,123	5.3
1989	1,589	95,567	17,892	5.3
		Average annual percentage change		
1970-89	3.0%	5.4%	4.8%	0.5%
1982-89	3.3%	5.3%	5.1%	0.0%

Source:
Department of Transportation, Federal Highway Administration, Highway Statistics 1989, Washington, DC, 1990, Table VM-1, p. 181, and annual.

[a]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 3.26.

Figure 3.16. Registrations, Vehicle Travel, and Fuel Use for Combination Trucks, 1970-89



Source: See Table 3.23.

Table 3.24. Estimates of the Number of Trucks and Vehicle Miles of Travel (VMT) for Trucks Greater than 10,000 Pounds and Operating in Interstate Commerce, 1967-89

	For-Hire			Private			Total	
Year	VMT (millions)	No. of trucks (thous.)	VMT per truck	VMT (millions)	No. of trucks (thous.)	VMT per truck	VMT (millions)	No. of trucks (thous.)
1967	14,841.7	253.2	58,616.5	28,929.9	1,537.6	18,814.9	43,771.6	1,790.8
1968	15,577.4	262.4	59,365.1	30,364.0	1,593.3	19,057.3	45,941.4	1,855.7
1969	16,306.8	274.9	59,319.0	31,785.7	1,669.7	19,036.8	48,092.5	1,944.6
1970	16,610.9	279.7	59,388.3	32,378.5	1,698.4	19,064.1	48,989.4	1,978.1
1971	17,179.0	279.7	61,419.3	33,485.9	1,698.0	19,720.8	50,664.9	1,977.7
1972	18,344.6	287.9	63,718.6	35,757.8	1,748.3	20,452.9	54,102.4	2,036.2
1973	20,194.4	317.2	63,664.6	38,343.3	1,822.3	21,041.2	58,537.7	2,139.5
1974	19,961.1	344.0	58,026.5	36,918.2	1,870.6	19,736.0	56,879.3	2,214.6
1975	19,917.6	368.9	53,991.9	35,883.1	1,898.2	18,903.8	55,800.7	2,267.1
1976	20,788.7	410.7	50,617.7	36,481.9	1,999.8	18,242.8	57,270.6	2,410.5
1977	22,872.3	427.9	53,452.4	39,098.2	1,972.3	19,823.7	61,970.5	2,400.2
1978	24,892.1	441.5	56,380.7	44,497.7	2,245.0	19,820.8	69,389.8	2,686.5
1979	25,467.2	436.7	58,317.4	47,608.8	2,438.6	19,523.0	73,076.0	2,875.3
1980	25,116.5	423.7	59,278.9	49,101.2	2,622.2	18,725.2	74,217.7	3,045.9
1981	24,322.9	359.4	67,676.4	49,725.4	2,454.3	20,260.5	74,048.3	2,813.7
1982[a]	22,567.1	343.8	65,640.2	48,241.1	2,589.6	18,628.8	70,808.2	2,933.4
1983	23,611.6	354.4	66,624.2	50,474.1	2,669.4	18,908.4	74,085.7	3,023.8
1984	26,188.6	364.2	71,907.2	55,982.9	2,743.1	20,408.6	82,171.5	3,107.3
1985	26,944.4	381.3	70,664.6	57,598.7	2,872.1	20,054.6	84,543.1	3,253.4
1986	27,700.3	380.2	72,857.2	59,214.4	2,863.9	20,676.1	86,914.7	3,244.1
1987	29,223.8	385.7	75,768.4	62,471.3	2,904.8	21,506.2	91,695.1	3,290.5
1988[b]	30,831.2	391.2	78,811.9	65,907.3	2,946.3	22,369.5	96,738.5	3,337.5
1989[b]	32,527.0	396.8	81,973.3	69,532.4	2,988.4	23,267.4	102,059.4	3,385.2
				Average Annual Percentage Change				
1967-89	3.6%	2.1%	1.5%	4.1%	3.1%	1.0%	3.9%	2.9%
1975-89	3.6%	0.5%	3.0%	4.8%	3.3%	1.5%	4.4%	2.9%
1982-89	5.4%	2.1%	3.2%	5.4%	2.1%	3.2%	5.4%	2.1%

Source:

Hu, Patricia S., Tommy Wright, Shaw-Pin Miaou, Stacy Davis, and Dennis Beal, Estimating Commercial Truck VMT of Interstate Motor Carriers: Executive Summary, Oak Ridge National Laboratory, Oak Ridge, TN, January 1989, p. 14.

[a]1982 Truck Inventory and Use Survey public use tape.

[b]Assuming the annual growth rate was identical to the one observed from 1986 to 1987.

Based on the 1977, 1982, and 1987 Truck Inventory and Use Surveys (TIUS), almost 45% of total truck gasoline consumption was for personal use in 1977 and 1982, and this percentage rose to 58% in 1987.

Table 3.25
Truck Gasoline and Diesel Consumption by Major Use, 1977, 1982, and 1987 TIUS[a]

	Total gallons of gasoline (millions)			Total gallons of diesel (millions)		
Major use	1977	1982	1987	1977	1982	1987
Agricultural activity	3,097	2,665	2,347	653	645	997
Construction	2,214	1,431	1,739	976	707	1,120
Contractor activity	[b]	2,253	2,652	[b]	144	268
Daily rental	115	142	143	202	277	309
For hire	738	551	435	4,619	5,711	7,411
Forestry	248	549	219	461	293	456
Manufacturing	537	494	532	1,131	1,102	1,096
Mining	196	312	181	234	239	251
Other	248	292	1	84	13	1
Personal	10,436	10,919	18,314	3	73	323
Retail trade	1,540	1,335	1,506	546	512	578
Services	1,885	1,549	1,770	213	185	455
Utilities	587	597	462	40	42	86
Wholesale trade	1,865	1,326	1,085	1,380	1,145	1,284
Not in use	8	17	4	6	5	1
Total	**23,714**	**24,432**	**31,390**	**10,548**	**11,093**	**14,636**

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.
[b]Data are not included in the 1977 TIUS.

Table 3.26
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 3.27
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.

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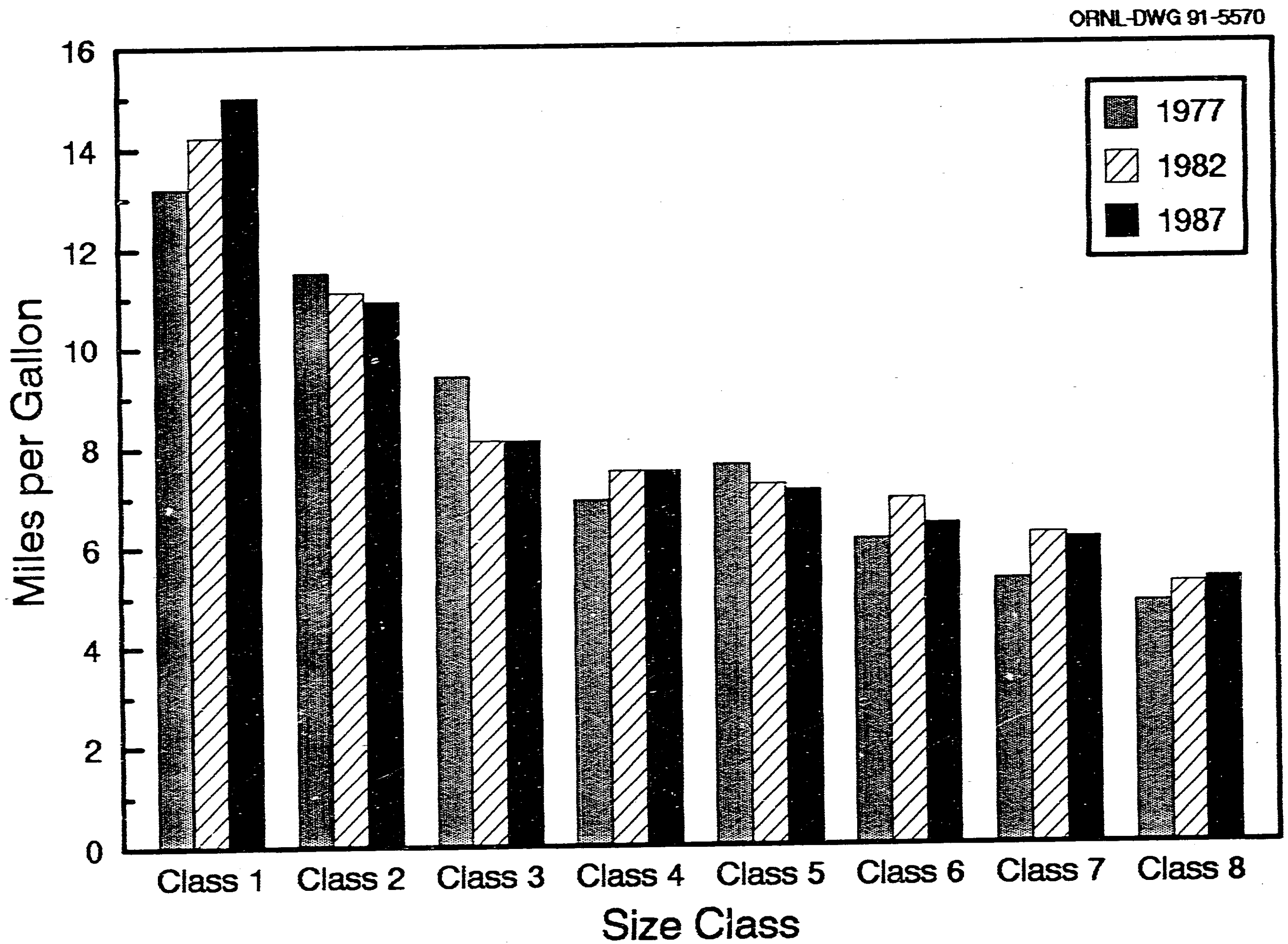
[a]Truck Inventory and Use Survey.

Figure 3.17. Truck Fuel Economy by Size Class, 1977, 1982, and 1987



Source: See Table 3.26.

Table 3.28
Summary Statistics for Trucks by Size Class and Fuel Type, 1977, 1982, and 1987[a]

	Number of trucks (thousands)			Average annual truck travel (miles)			Fuel economy (mpg)		
	1977	1982	1987	1977	1982	1987	1977	1982	1987
Gasoline									
Light	22,522.9	29,696.7	39,944.5	10,610	9,805	10,599	12.8	13.6	13.9
Medium	1,720.6	1,098.9	872.2	10,066	8,853	8,594	8.3	7.7	7.3
Light-heavy	858.1	671.1	575.2	9,756	7,538	6,762	6.2	6.8	6.0
Heavy-heavy	633.1	440.0	376.9	12,296	9,378	8,300	4.8	5.4	5.4
Diesel									
Light	12.9	301.5	948.9	12,828	18,223	11,216	9.1	24.9	16.8
Medium	25.9	68.0	151.4	17,413	17,745	12,985	7.4	8.0	8.6
Light-heavy	48.1	96.6	185.0	22,057	21,859	14,668	5.4	7.7	6.8
Heavy-heavy	1,002.2	1,164.7	1,449.5	49,156	46,778	47,259	4.8	5.2	5.3
Liquid Petroleum Gas									
Light	57.2	169.1	34.3	15,880	14,748	11,216	11.2	9.6	15.5
Medium	11.6	18.5	3.4	12,753	15,002	12,985	5.6	5.5	5.2
Light-heavy	15.7	22.3	4.9	13,572	15,530	14,668	5.1	5.1	4.9
Heavy-heavy	6.8	11.1	2.6	18,720	17,968	17,765	4.6	4.0	5.0
Total[b]	**26,921.8**	**33,834.4**	**44,572.2**	**12,065**	**11,151**	**11,877**	**9.4**	**10.6**	**11.5**

Sources:
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]In the 1977 Truck Inventory and Use Survey (TIUS) approximately 7,000 trucks did not report fuel type or size class; for the 1982 TIUS, this number rose to 76,000 trucks; and for the 1987 TIUS, 23,400 trucks did not report the information. Government trucks are not included in this survey. 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.
[b]Totals may not equal the sum of the individual components because some respondents did not report this information.

Section 3.4. Buses

School and other nonrevenue buses continued to account for more than 80% of total buses in 1989. The total number of buses increased by 1.5% in 1989, mainly due to the increases in the number of school buses and "other" buses.

Table 3.29
Buses in Operation by Type, 1970-89

Year	Transit[a] Motor bus	Transit[a] Trolley coach[b]	Intercity bus	School and other nonrevenue[c]	Other[d]	Total
1970	49,700	1,050	22,000	288,700	16,112	377,562
1971	49,150	1,037	21,900	307,300	17,688	397,075
1972	49,075	1,030	21,400	318,200	17,161	406,866
1973	48,286	794	20,800	336,000	19,040	424,920
1974	48,700	718	21,000	356,900	19,730	447,048
1975	50,811	703	20,500	368,300	21,842	462,156
1976	52,382	685	20,100	381,498	23,674	478,339
1977	51,968	645	20,300	393,810	24,038	490,761
1978	52,866	593	20,250	398,804	32,841	505,354
1979	54,490	725	20,680	415,117	35,753	526.765
1980	59,411	823	21,400	418,255	28,930	528,789
1981	60,393	751	21,500	432,813	28,437	543,894
1982	62,114	763	22,000	442,133	32,190	559,200
1983	62,093	686	23,500	470,727	25,878	582,884
1984	63,497	664	25,000	471,461	23,049	593,671
1985	57,285	676	20,200	480,400	34,924	593,485
1986	61,586	680	20,300	479,076	35,672	593,728
1987	61,000	671	20,100	486,753	36,544	602,055
1988	60,388	710	19,887	498,907	35,777	615,669
1989	60,250	725	20,043	507,628	36,394	625,040
			Average annual percentage change			
1970-89	1.0%	-1.9%	-0.5%	3.0%	4.4%	2.7%
1982-89	-0.4%	-0.7%	-1.3%	2.0%	1.8%	1.6%

Sources:
Transit buses - American Public Transit Association, 1990 Transit Fact Book, Washington, DC, September 1990, p. 10, and annual.
Intercity buses - 1970-84: American Bus Association, 1984 Annual Report, Washington, DC, and annual.
1985-88: U.S. Department of Transportation, Transportation Systems Center, National Transportation Statistics, Cambridge, MA, August 1990, Figure 5, p. 8, and annual.
1989: Estimated as 38% of commercial buses (less transit motor buses). Commercial bus total found in Highway Statistics 1989, Table MV-10.
Other buses - Derived by subtracting Transit, Intercity, and School buses from Total buses.
School buses and Total buses - U.S. Department of Transportation, Federal Highway Administration, Highway Statistics 1989, Washington, DC, 1990, Table MV-10, p. 20, and annual.

[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]Trolley coach - a rubber tired transit vehicle that usually draws its power from overhead wires.
[c]Includes some industrial and other private buses.
[d]Includes government buses, private buses, and other miscellaneous buses.

Although school buses comprise 81% of the bus vehicle stock, only 56% of bus vehicle travel was attributed to school buses in 1989. Intercity buses, which were 3.2% of vehicle stock in 1989, accounted for 15% of bus travel.

Table 3.30
Passenger and Vehicle Travel by Bus Type, 1970-89

Year	Passenger travel (million miles)		Vehicle travel (million miles)		
	Transit bus[a]	Intercity bus	Transit bus[a]	Intercity bus	School bus
1970	18,120	25,300	1,409	1,209	2,100
1971	16,810	25,500	1,375	1,202	2,212
1972	16,180	25,600	1,308	1,182	2,359
1973	16,170	26,400	1,370	1,178	2,412
1974	17,910	27,700	1,431	1,195	2,450
1975	18,300	25,400	1,526	1,126	2,500
1976	18,890	25,100	1,581	1,118	2,862
1977	19,730	25,700	1,623	1,102	2,950
1978	20,708	25,400	1,631	1,081	2,991
1979	21,393	27,200	1,634	1,132	2,980
1980	21,790	27,400	1,677	1,162	2,900
1981	21,012	27,100	1,685	1,134	2,960
1982	19,987	26,900	1,669	1,115	3,062
1983	20,047	26,500	1,678	1,120	3,098
1984	21,595	27,100	1,845	1,098	3,400
1985	21,161	23,800	1,863	933	3,448
1986	21,528	23,700	1,897	1,021	3,700
1987	20,926	23,000	2,076	991	3,900
1988	21,379	23,100	1,866	996	4,100
1989	20,833	24,000	2,113	1,034	4,000
			Average annual percentage change		
1970-89	0.7%	-1.6%	2.2%	-0.8%	3.9%
1982-89	0.6%	-0.3%	3.4%	-1.1%	3.4%

Sources:

Transit buses - 1970-89: American Public Transit Association, 1990 Transit Fact Book, Washington, DC, September 1990, pp. 55, 56, and annual.

Intercity buses - 1970-84: American Bus Association, Annual Report, Washington, DC, Annual.
1985-89: Eno Transportation Foundation, Transportation in America, Ninth edition, Washington, DC, 1991, p. 47.
1986-89 vehicle travel: Estimated using passenger travel and an average load factor of 23.2.

School buses - 1970-84: U.S. Department of Transportation, Federal Highway Administration, Highway Statistics 1984, Washington, DC, Table VM-1, p. 175, and annual.
1985-87: U.S. Department of Transportation, Research and Special Programs Administration, National Transportation Statistics, 1989, Figure 2, p. 7, and annual.
1988-89: National Safety Council, Accident Facts, 1990 Edition, Chicago, IL, p. 71, and annual.

[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.

The average intercity bus traveled 47% more than the average transit bus in 1989 and traveled 5.5 times more than the average school bus. School buses travel much less in a year than the other bus types.

Table 3.31
Average Annual Miles per Bus by Type, 1970-89
(miles)

Year	Transit bus[a]	Intercity bus	School bus
1970	28,350	54,955	7,274
1971	27,976	54,886	7,198
1972	26,653	55,234	7,414
1973	28,373	56,635	7,179
1974	29,384	56,905	6,865
1975	30,033	54,927	6,788
1976	30,182	55,622	7,502
1977	31,231	54,286	7,491
1978	30,852	53,383	7,500
1979	29,987	54,739	7,179
1980	28,227	54,299	6,934
1981	27,901	52,744	6,839
1982	26,870	50,682	6,926
1983	27,024	47,660	6,581
1984	29,056	43,920	7,212
1985	32,522	46,188	7,177
1986	30,802	50,296	7,723
1987	31,590	49,304	8,012
1988	30,900	50,083	8,218
1989	35,071	51,589	7,880
	Average annual percentage change		
1970-89	1.1%	0.3%	0.4%
1982-89	3.9%	-0.3%	1.9%

Source:
Annual miles were obtained by dividing the total vehicles miles (from Table 3.30) by the number of vehicles (from Table 3.29).

[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.

Transit buses accounted for nearly half of total bus energy use in 1989. The energy used by transit buses peaked in 1989 at 77.3 trillion Btu, which is in part due to the greater vehicle miles traveled by transit buses in 1989. School bus energy use declined slightly in this time period, as did school bus vehicle travel.

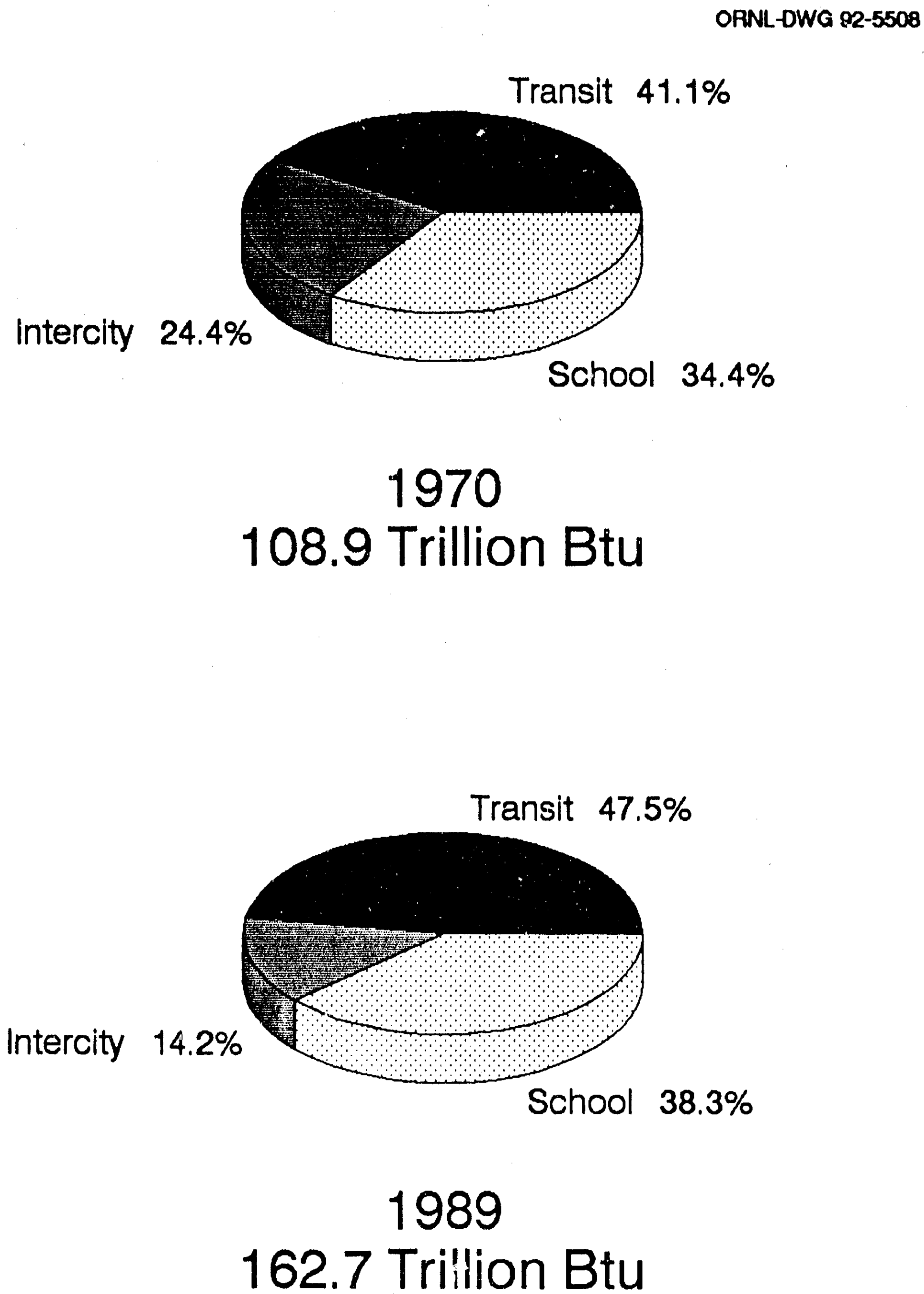
Table 3.32
Energy Consumption by Type of Bus, 1970-89
(trillion Btu)

Year	Transit bus[a]	Intercity bus	School bus
1970	44.8	26.6	37.5
1971	41.6	26.5	39.5
1972	39.7	26.0	40.0
1973	42.0	25.9	40.9
1974	45.1	26.3	41.6
1975	51.5	24.8	42.6
1976	54.7	25.0	48.8
1977	57.0	24.7	50.1
1978	59.7	24.2	50.9
1979	59.8	26.2	50.6
1980	61.3	29.3	47.5
1981	63.6	31.3	48.5
1982	64.7	30.9	49.9
1983	63.7	31.1	50.3
1984	69.2	33.8	50.7
1985	72.4	31.5	57.0
1986	75.6	20.6	57.8
1987	74.3	21.6	60.9
1988	73.0	22.3	63.9
1989	77.3	23.1	62.3
	Average annual percentage change		
1970-89	2.9%	-0.7%	2.7%
1982-89	2.6%	-4.1%	3.2%

Source:
See Appendix A for Table 2.10.

[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.

Figure 3.18. Energy Consumption by Type of Bus, 1970 and 1989



Source: See Table 3.32.

The school bus has been the most energy efficient bus operation, on a per vehicle-mile basis, since 1970. Transit buses continued to be the least energy efficient buses on a per vehicle-mile and per passenger-mile basis. However, transit bus energy intensity dropped below 37,000 Btu per vehicle-mile in 1989 for the first time since 1980.

Table 3.33
Historical Energy Intensities by Type of Bus, 1970-88

Year	Btu per passenger-mile		Btu per vehicle-mile		
	Transit bus[a]	Intercity bus	Transit bus[a]	Intercity bus	School bus
1970	2,472	1,051	31,796	22,002	17,857
1971	2,475	1,039	30,255	22,047	17,857
1972	2,454	1,016	30,352	21,997	16,956
1973	2,597	981	30,657	21,986	16,957
1974	2,518	949	31,516	22,008	16,980
1975	2,814	976	33,748	22,025	17,040
1976	2,896	996	34,598	22,361	17,051
1977	2,889	961	35,120	22,414	16,983
1978	2,883	953	36,603	22,387	17,018
1979	2,795	963	36,597	23,145	16,980
1980	2,813	1,069	36,553	25,215	16,379
1981	3,027	1,155	37,745	27,601	16,385
1982	3,237	1,149	38,766	27,713	16,296
1983	3,177	1,174	37,962	27,768	16,236
1984	3,204	1,247	37,507	30,783	14,912
1985	3,421	1,323	38,862	31,722	16,531
1986	3,512	869	39,873	20,176	15,622
1987	3,542	939	38,557	[b]	15,615
1988	3,415	965	39,121	[b]	15,585
1989	3,711	963	36,583	[b]	15,575
			Average annual percentage change		
1970-89	2.2%	-0.5%	0.7%	-0.5%[c]	-0.7%
1982-89	2.0%	-2.5%	-0.8%	-7.6%[c]	-0.6%

Source:
Energy intensities by passenger-mile were calculated by dividing energy use (from Table 3.32) by passenger-miles (from Table 3.30). Energy intensities by vehicle-mile were calculated by dividing energy use (from Table 3.32) by vehicle-miles (from Table 3.30).

[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 1970-86 and 1982-86.

Total new registrations of domestic non-household fleet vehicles declined in 1990. The large automobile shares of registrations jumped to 19.6% in 1990, while the midsize share declined to 45%.

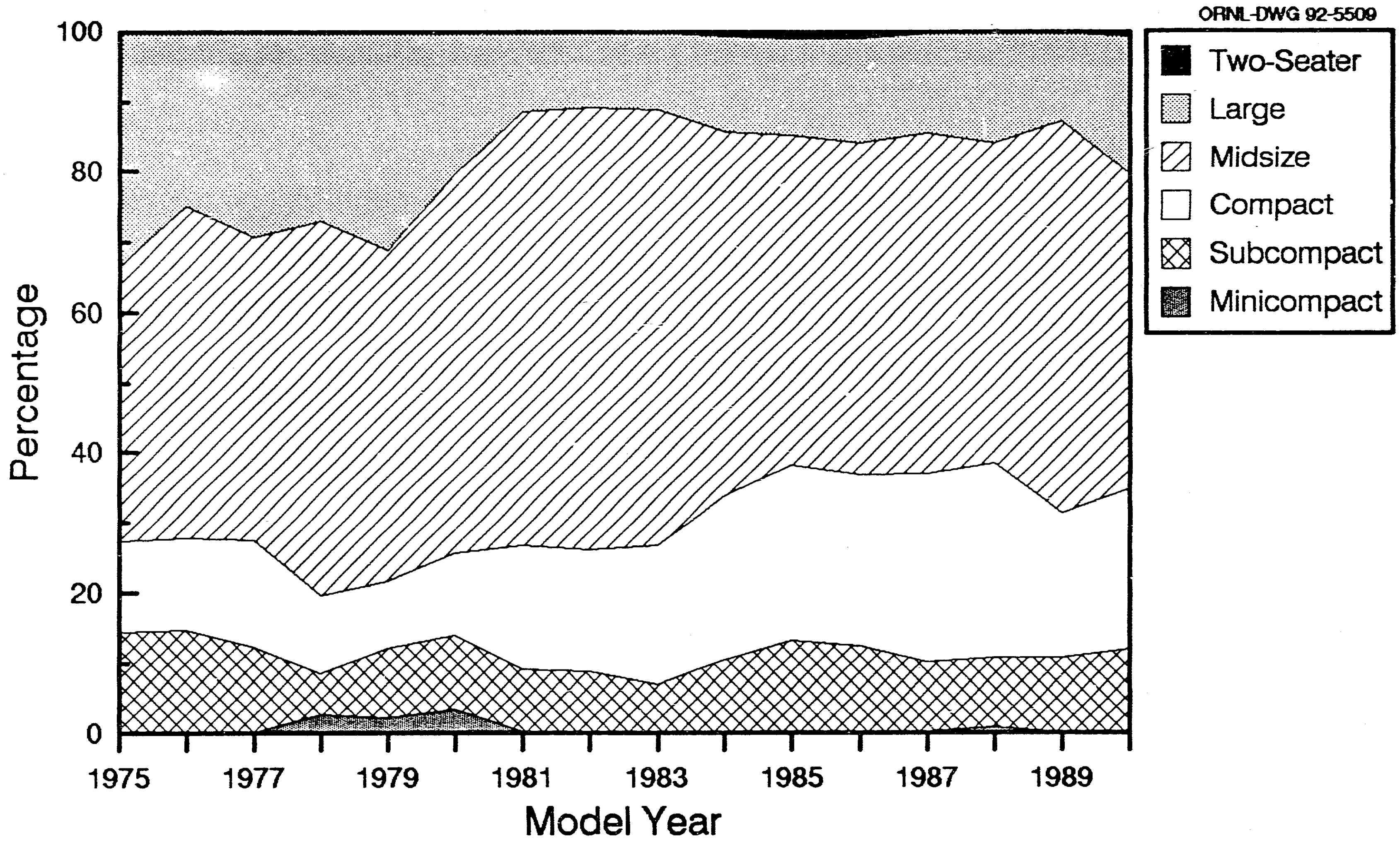
Table 3.34
Distribution of New Domestic Fleet Automobile Registrations by Size Class, 1975-90

Model Year	Percentage						Total New Registrations
	Minicompact	Subcompact	Compact	Midsize	Large	Two seater	
1975	0.0	14.3	12.9	39.3	33.2	0.2	966,099
1976	0.0	14.7	12.9	47.4	24.7	0.3	1,044,485
1977	0.0	12.2	15.1	43.2	29.2	0.3	1,182,292
1978	2.6[a]	5.8	11.1	53.4	26.8	0.2	1,379,630
1979	2.2	9.8	9.5	47.3	31.0	0.3	1,371,782
1980	3.3	10.6	11.6	54.1	20.2	0.2	1,130,119
1981	0.2	8.8	17.5	61.9	11.2	0.4	1,133,013
1982	0.0	8.7	17.3	63.0	10.7	0.3	1,022,588
1983	0.0	6.9	19.6	62.2	11.1	0.2	1,137,976
1984	0.0	10.3	23.3	52.0	13.6	0.7	1,483,790
1985	0.0	13.1	25.0	47.0	13.7	1.1	1,536,299
1986	0.0	12.4	24.2	47.4	14.9	1.0	1,507,559
1987	0.2	9.8	26.8	48.6	14.2	0.5	1,500,683
1988	0.7	10.0	27.6	45.8	15.5	0.4	1,618,971
1989	0.0	10.7	20.4	56.0	12.7	0.2	1,665,888
1990	0.0	11.9	22.7	45.0	19.6	0.2	1,601,875
			Average annual percentage change				
1975-90							3.4%
1982-90							6.6%

Source:
Bobit Publishing Company, Automotive Fleet Research Department, Automotive Fleet Factbook, Redondo Beach, CA, 1990, p. 22, and annual. Percentages were derived by classifying data into Environmental Protection Agency size classes.

[a] In 1978, Ford Pinto and Mercury Bobcat changed size classes from subcompact to minicompact. Both models were discontinued in 1982.

Figure 3.19. New Registrations of Domestic Fleet Automobiles by Size Class, 1975-90



Source: See Table 3.34.

Table 3.35
Automobile Fleets by Use, 1970-90
(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[d]	553	244	144	907	8,431	10,592
1990	3,823	2,020	653[d]	551	249	141	990	8,427	10,607
	Average annual percentage change								
1970-90	2.1%	4.7%	-0.2%	1.4%	0.9%	-1.0%	5.9%[e]	2.5%	0.3%
1982-90	1.8%	2.6%	1.0%	0.5%	1.4%	0.0%	10.1%[e]	2.5%	0.6%

Source:
Bobit Publishing Company, Automotive Fleet Research Department, Automotive Fleet Fact Book, Redondo Beach, CA, 1991, p. 16, 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 1989 and 1990 are not available; therefore, the data are assumed to be equal to the 1987 federal government figures.

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

Figure 3.20. Distribution of Automobile Fleets by Use, 1990

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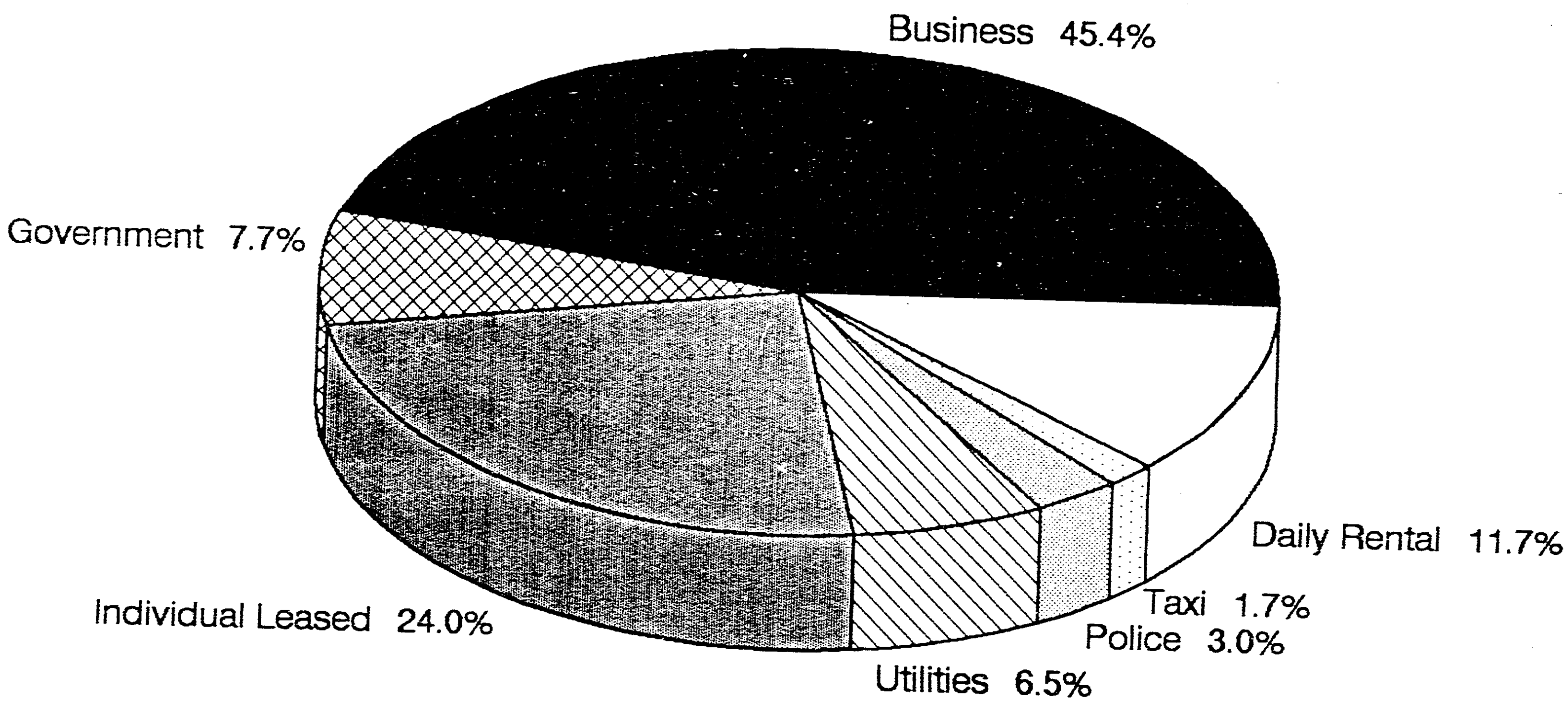


Source: See Table 3.35.

Table 3.36
Federal Government Vehicles by Agency, Fiscal Year 1988

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	86,884	2,393	96,866	13,884	4,977	205,004
Government Printing Office	6	0	59	0	0	65
Library of Congress	1	0	0	0	0	1
Department of the State	1,220	0	1,187	772	67	3,246
Department of the Treasury	8,559	11	1,485	51	2	10,108
Department of Justice	14,888	138	4,440	479	92	20,037
Department of the Interior	1,663	111	8,499	2,753	1,674	14,700
Department of Agriculture	3,911	41	24,049	4,154	518	32,673
Department of Commerce	93	14	376	189	14	686
Department of Labor	175	12	412	13	6	618
Department of Health & Human Services	90	9	276	91	55	521
Department of Transportation	80	8	394	126	45	653
Department of Energy	1,853	255	6,586	1,829	751	11,274
Agency for International Development	370	22	204	57	16	979
American Battle Monuments Commission	13	0	37	12	0	62
Environmental Protection Agency	303	3	301	13	9	629
Federal Communications Commission	61	0	34	4	0	99
Federal Emergency Management Agency	35	14	76	9	9	143
General Services Administration	50,869	1,605	44,230	2,001	1,347	100,052
International Boundry & Water Commission	0	0	7	10	23	40
Merit Systems Protection Board	0	0	1	0	0	1
National Aeronautics & Space Administration	135	11	714	219	49	1,155
National Gallery of Art	0	0	3	1	0	4
National Science Foundation	23	8	122	27	2	182
Overseas Private Investment Corporation	1	0	0	0	0	1
Panama Canal Commission	186	13	524	79	45	847
Peace Corps	147	9	214	3	0	373
Railroad Retirement Board	1	0	0	0	0	1
Smithsonian Institution	23	6	154	44	24	251
Tennessee Valley Authority	1,513	4	1,303	733	159	3,712
United State Information Agency	455	12	323	29	0	819
U.S. Soldiers' and Airmen's Home	12	6	25	6	10	59
Veterans Administration	198	81	494	180	60	1,103
UNITED STATES POSTAL SERVICE	12,260	13	128,326	10,805	3,574	154,978
MILITARY AGENCIES	22,937	6,417	102,105	14,027	8,214	153,700
Army	8,292	2,484	24,890	5,781	2,147	43,594
Navy	3,624	997	23,728	2,707	2,204	33,260
Marine Corps	725	321	4,730	841	607	7,224
Air Force	6,327	2,574	43,603	3,658	3,034	59,196
Civil Works, Corps of Engineers	721	21	4,412	982	204	6,340
Defense Agencies	3,248	20	742	58	18	4,086
TOTAL	122,081	8,823	327,297	38,716	16,765	513,682

Source:
U.S. General Services Administration, Federal Supply Service, Federal Motor Fleet Report, Washington, DC, September 1990, p. 27.

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

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.

Table 3.37
Corporate Average Fuel Economy (CAFE)
Standards versus Sales-Weighted Fuel Economy Estimates
for Automobiles and Light Trucks, 1978-91[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	29.8	28.0	20.0	20.2	23.0	20.7
1991	27.5	27.4	29.8	28.3	20.2	20.9	23.0	21.3

Source:
U.S. Department of Transportation, NHTSA, "Summary of Fuel Economy Performance," Washington, DC, September 1991.

[a]Only vehicles with at least 75 percent domestic content can be counted in the average fuel economy for a manufacturer.

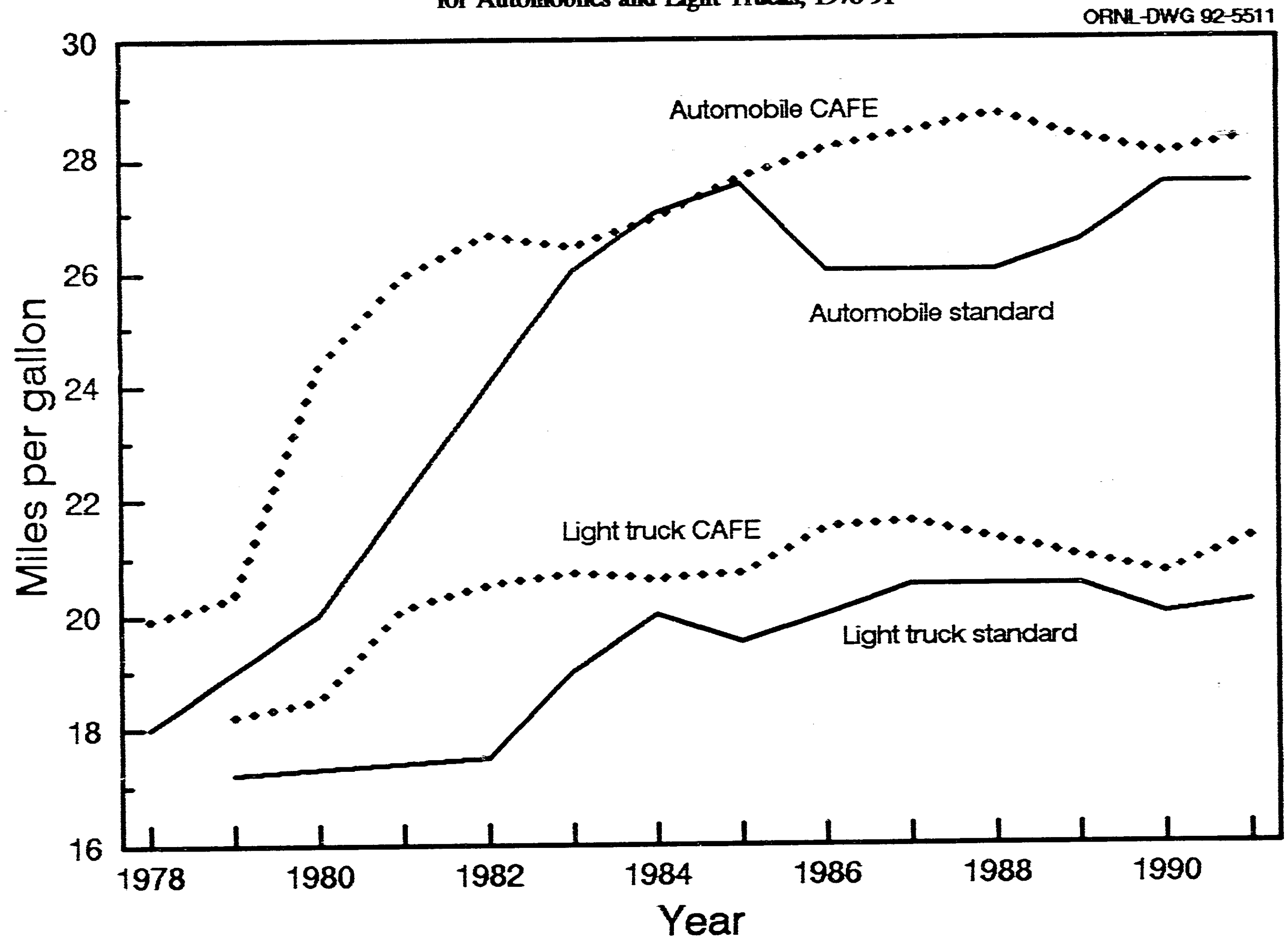
[b]Represents two- and four-wheel drive trucks combined. Gross vehicle weight of 0-6,000 pounds for model year 1979 and 0-8,500 pounds for subsequent years.

[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 3.21. Corporate Average Fuel Economy Standards and Sales-Weighted Fuel Economies for Automobiles and Light Trucks, 1978-91



Source: See Table 3.37.

Table 3.38.
Corporate Average Fuel Economy (CAFE) Fines Collected, 1983-90

Model year	Thousands: 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	30,981	35,623
1988	43,622	48,190
1989	45,828	48,309
1990	29,933	29,933

Source:
U.S. Department of Transportation, National Highway Traffic Safety Administration, Office of Vehicle Safety Compliance, Washington, DC, August 1991.

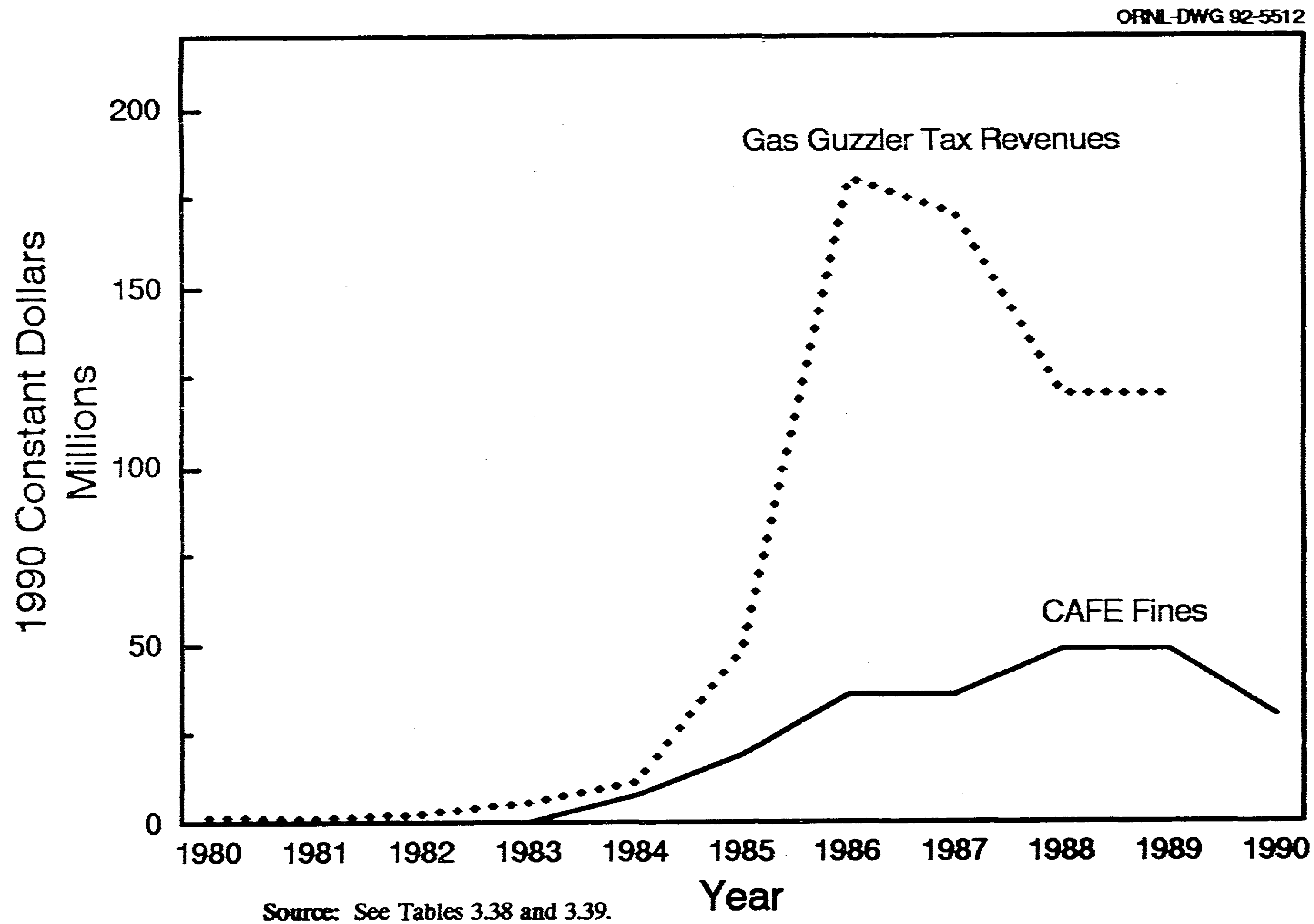
Table 3.39
Tax Receipts from the Sale of Gas Guzzlers, 1980-89

Fiscal year	Thousands: 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

Source:
Motor Vehicle Manufacturers Association, Motor Vehicle Facts and Figures '91, Detroit, MI, 1991, p. 76.

[a]Adjusted using the Consumer Price Inflation Index.

Figure 3.22. CAFE Fines and Gas Guzzler Tax Revenues, 1980-90



Source: See Tables 3.38 and 3.39.

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 3.40
The Gas Guzzler Tax on New Cars, 1980-91
(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.

Table 3.41
Model Year 1991 Cars Subject to Gas Guzzler Tax

Manufacturer Division	Model	Transmission[a]	Miles per gallon[b]	Tax (dollars)
Audi	V8	L4	19	2,100
	V8	M5	19	2,100
BMW	850I	L4	17	3,000
	M5	M5	16	3,700
	750IL	L4	17	3,000
	850I	M5	16	3,700
Cadillac	Allante	L4	20	1,700
	Brougham	L4	21	1,300
CX Automotive, Inc.	XM-V6	M5	19	2,100
Ferrari	Testarossa	M5	13	6,400
	F40	M5	16	3,700
Infiniti	Q45	L4	22	1,000
	Q45 (Full-Active Suspension)	L4	19	2,100
Jaguar	XJ-S Convertible	A3	17	3,000
	XJ-S	A3	18	2,600
Lamborghini	Countach	M5	9	7,700
	DB132/Diablo	M5	13	6,400
Mercedes-Benz	300E	A4	22	1,000
	300SE	A4	21	1,300
	300SEL	A4	21	1,300
	300SL	M5	21	1,300
	420SEL	A4	19	2,100
	500SL	A4	18	2,600
	560SEC	A4	18	2,600
	560SEL	A4	18	2,600
	SL Coupe	A5	22	1,000
Porsche	911	M5	22	1,000
	911 Carrera 4/2	M5	20	1,700
	911 Carrera 4/2	A4	21	1,300
	928 S4	A4	20	1,700
	928 S4	M5	18	2,600
Rolls-Royce	Bentley Continental	A3	13	6,400
	Bentley Eight/Mulsanne S	A3	13	6,400
	Bentley Turbo R	A3	13	6,400
	Cornich III	A3	13	6,400
	Silver Spirit II/Silver Spur	A3	13	6,400

Source:
Data compiled from information sent to ORNL on diskette by the U.S. Environmental Protection Agency, Ann Arbor, MI, June 1991.

[a]See Glossary for definition of *transmission types*.

[b]The figures shown here are the **unadjusted** fuel economies produced by the Environmental Protection Agency (EPA). These numbers will not match the numbers published in the 1990 Gas Mileage Guide. Mpg is calculated based on EPA rating of 55-percent city and 45-percent highway mileage.

Two separate studies by the Federal Highway Administration have measured the effects of speed on the 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.

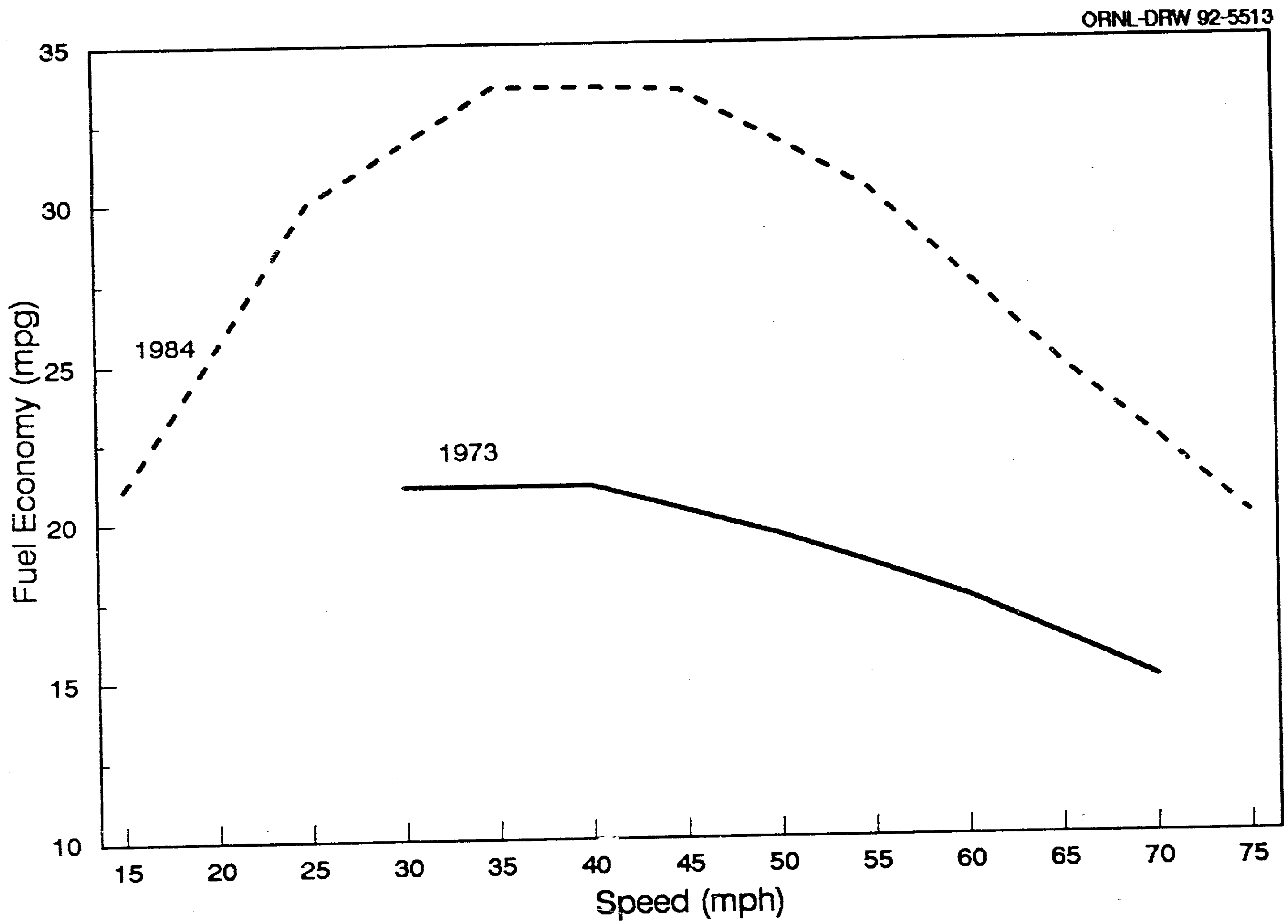
Table 3.42
Fuel Economy by Speed, 1973 and 1984
(miles per gallon)

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]Automobiles only.
[b]Automobiles and light trucks.
[c]Data are not available.

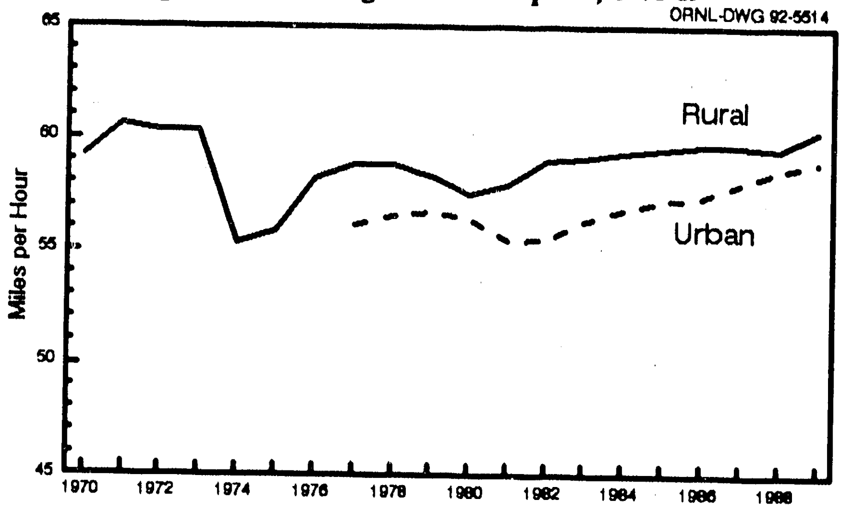
Figure 3.23. Fuel Economy by Speed, 1974 and 1983



Source: See Table 3.41.

The average rural Interstate speed in 1989 rose to 60 miles per hour for the first time since 1973.

Figure 3.24. Average Interstate Speeds, 1970-89



Source: See Table 3.43

Table 3.43
Average Urban and Rural Interstate Speeds, 1970-89[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

Source:
U.S. Department of Transportation, Federal Highway Administration, Highway Statistics 1989, Washington, DC, 1990, Table VS-1, p. 186, 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.

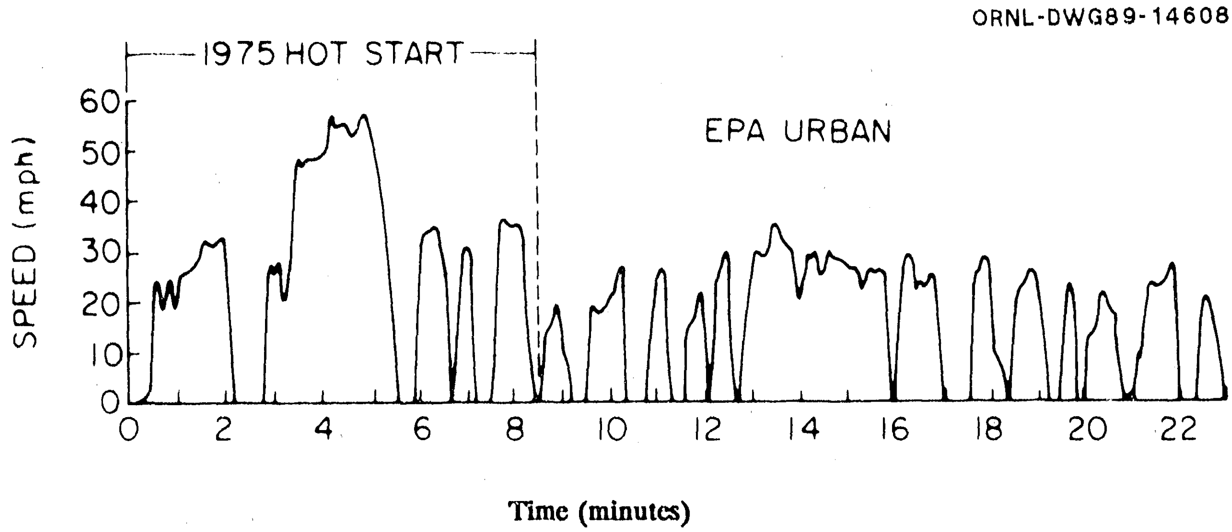


Figure 3.26. Urban Driving Cycle
Length of cycle: 1870 seconds, including idle time.
Average speed: 21.3 mph with idle; 26.5 mph without idle.

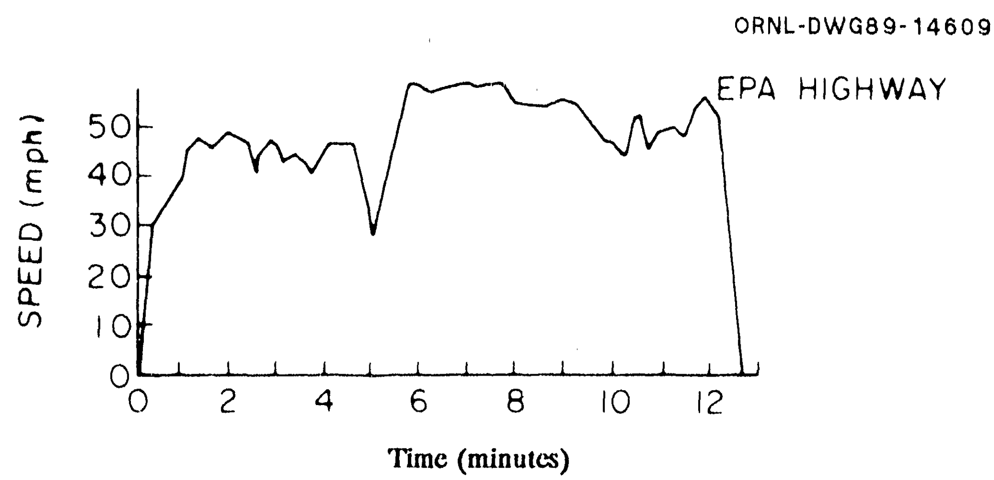


Figure 3.27. Highway Driving Cycle
Length of cycle: 765 seconds.
Average speed: 48.5 mph.

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. Vehicle Emissions

The Clean Air Act Amendment of 1990 set higher emission standards starting in 1994.

Table 3.44
Federal Emission Control Requirements for Automobiles and Light Trucks, 1976-94[a]
(grams per mile)

Model Year	Automobiles: Hydro-carbons (HC)	Automobiles: Carbon monoxide (CO)	Automobiles: Nitrogen oxides (NO_x)	Automobiles: Particulates[c]	Light trucks[b]: Hydro-carbons (HC)	Light trucks[b]: Carbon monoxide (CO)	Light trucks[b]: Nitrogen oxides (NO_x)	Light trucks[b]: 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.

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[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 set higher emission standards starting in 1994.

Table 3.45
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 set higher emission standards starting in 1994.

Table 3.46
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 3.47
Transportation's Contribution to U.S. Emissions, 1978-89

Year	Suspended Particulate		Sulfur Oxide		Carbon Monoxide		Nitrogen Oxides		Volatile Organic Compound		Lead	
	Trans.	Percent trans. of total	Trans	Percent trans. of total	Trans.	Percent trans. of total	Trans.	Percent trans. of total	Trans.	Percent trans. of total	Trans.	Percent trans. of total
1978	1.4	15.4%	0.8	3.3%	61.6	74.8%	9.8	46.4%	8.7	37.0%	0.1124	87.9%
1979	1.4	15.7%	0.9	3.6%	59.1	72.3%	10.1	46.8%	8.0	35.7%	0.0946	87.0%
1980	1.3	15.3%	0.9	3.8%	56.1	70.5%	9.8	46.9%	9.0	39.6%	0.0594	84.1%
1981	1.3	16.3%	0.9	4.0%	55.4	71.6%	10.0	47.8%	8.9	41.8%	0.0469	83.2%
1982	1.3	18.3%	0.8	3.7%	52.9	73.1%	9.4	47.0%	8.3	42.6%	0.0469	86.2%
1983	1.3	18.3%	0.8	3.9%	52.4	70.3%	8.9	46.1%	8.2	40.4%	0.0408	87.9%
1984	1.3	17.6%	0.8	3.7%	50.6	70.5%	8.8	44.4%	8.1	38.4%	0.0347	86.5%
1985	1.4	19.2%	0.9	4.3%	47.9	68.8%	8.9	44.7%	7.6	37.6%	0.0155	74.2%
1986	1.4	20.6%	0.9	4.3%	44.6	69.7%	8.3	43.5%	7.2	37.7%	0.0035	41.7%
1987	1.4	20.0%	0.9	4.3%	43.3	67.4%	8.1	41.8%	7.1	36.6%	0.0030	37.5%
1988	1.5	20.0%	0.9	4.3%	41.2	63.4%	8.1	40.5%	6.9	35.4%	0.0026	34.2%
1989	1.5	20.8%	1.0	4.7%	40.0	65.7%	7.9	39.7%	6.4	34.6%	0.0022	30.6%
					Average annual percentage change							
1978-89	0.6%		2.0%		-3.8%		-1.9%		-2.8%		-30.1%	
1982-89	2.1%		3.2%		-3.9%		-2.5%		-3.6%		-35.4%	

Emission (million metric tons/year)

Source:
United States Environmental Protection Agency, Office of Air Quality Planning and Standards, National Air Quality and Emissions Trends Report, 1989, Research Triangle Park, NC, February 1991, pp. 3-4, 3-13, 3-17, 3-22, 3-27, 3-34, and annual.

Table 3.48
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
GVRW = 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.

Almost all the New England states have chosen to adopt the California Air Resources Board standards. Many other states are currently considering using the California standards instead of the national standards.

Table 3.49
California Air Resources Board 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 3.50
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

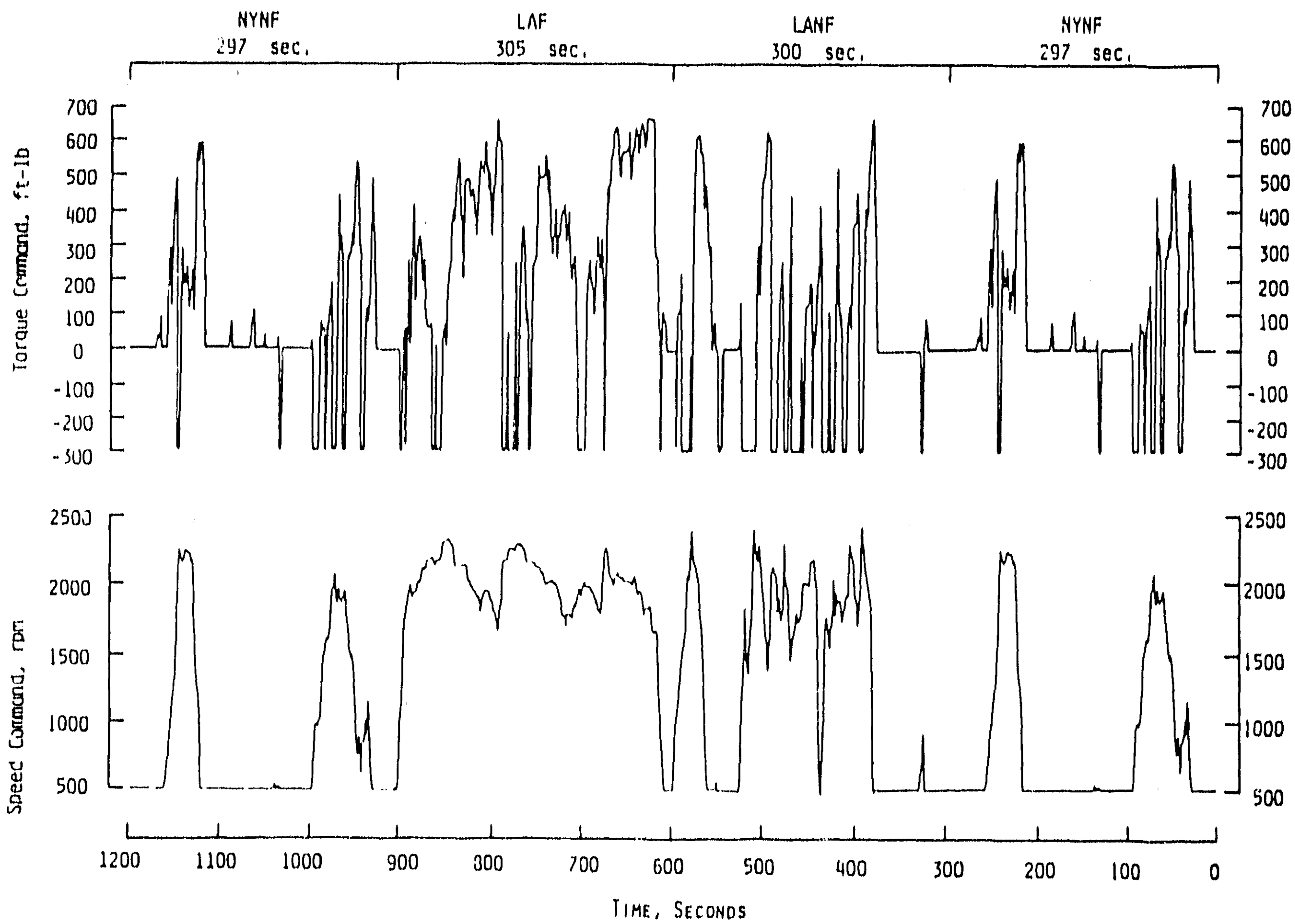
ZERO-EMISSION VEHICLES (ZEVs)

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

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

The Environmental Protection Agency (EPA) tests transient emissions from heavy-duty diesel engines using the 1984 Transient Federal Test Procedure. The engine is subjected to a cycle of varying speed and load for twenty minutes.

Figure 3.27. Torque and Speed Cycles for Transient Emissions Testing of a Typical Heavy-Duty Diesel Engine



Source: Carroll, James N., et. al., "Emission Comparison of DDC 6V-92TA on Alcohol Fuels," Truck and Bus Meeting and Exposition, Detroit, MI, 1990, p.3.

Section 3.8. High-Occupancy Vehicle Lanes

Table 3.51
Characteristics of Selected High-Occupancy Vehicle (HOV) Facilities, 1989

City	Length (miles)	Vehicles allowed to use HOV lanes[a]	Estimated peak-hour violation rate	Violators initial fine	Primary reason for HOV lane implementation[b]
Exclusive facilities, freeway right of way					
Houston, TX					
I-45N (North)	9.1	PT,PB,VP,PE	1%	$75	RV,IC
I-45S (Gulf)	6.5	PT,SB,PB,VP,CP,TX,PE	1%	$75	IC
I-10 (Katy)	11.5	PT,SB,PB,VP,CP,TX,PE	35%	$75	IC
US 290 (Northwest)	9.5	PT,SB,PB,VP,CP,TX,PE	1%	$75	RV,IC
Los Angeles, CA					
San Bernadino Fwy. Busway	12.0	PT,SB,PB,VP,CP,TX,PE	11%	$150	AQ,EN,IC,OT
Minneapolis, MN					
I-394	3.4	PT,SB,PB,VP,CP,TX,PE,MC	5%	$44	IC,OT
Washington, DC					
Shirley Highway	11.0	PT,SB,PB,VP,CP,TX,PE	2%	$50	RV,IC
I-66	10.0	PT,SB,PB,VP,CP,TX,PE	17%	$50	AQ,IC,OT
Concurrent flow facilities					
Los Angeles/Orange County, CA					
Rt. 55 (commuter lane)	11.0	PT,PB,VP,CP,TX,PE,MC	6%	$150	AQ
I-405 (commuter lane)	14.0	PT,PB,VP,CP,TX,PE,MC	5%	$150	IC
Rt. 91 (commuter lane)	8.0	PT,PB,VP,CP,TX,PE,MC	5%	$150	AQ,IC
San Francisco, CA					
Oakland Bay Bridge	2.3	PT,SB,PB,VP,CP,TX,PE,MC	2%	$100	IC
US101	7.0	PT,SB,PB,VP,CP,TX,PE	5%	$100	IC,OT
Seattle, WA					
I-90	5.8	PT,SB,PB,VP,CP,TX,PE,MC	c	$47	AQ,EN,IC,OT
SR 520	2.8	PT,SB,PB,VP,CP,TX,PE,MC	c	$47	IC
I-5	6.2NB;5.2SB	PT,SB,PB,VP,CP,TX,PE,MC	19%	$47	AQ,IC
I-405	6.0		c	$47	AQ,IC
Washington, DC/Northern VA					
I-95	6.8	PT,SB,PB,VP,CP,TX,PE	c	c	IC,OT

Source:
U.S. Department of Transportation, A Description of High-Occupancy Vehicle Facilities in North America, Washington, DC, July 1990, pp. 57-63, 67-68, 84-86.

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[a]Vehicles allowed to use High-Occupancy vehicle facilities:
PT - Public Transit Bus
SB - School Bus
PB - Private Bus
VP - Van Pool
CP - Car Pool
TX - Taxi
PE - Police & Emergency
MC - Motorcyle

[b]Primary reasons for High-Occupancy vehicles project implementation:
AQ - Air Quality
EN - Energy
RV - Reduce VMT
IC - Increase Capacity
OT - Other

[c]Data are not available.

Table 3.52
Morning Peak Direction Bus, Vanpool, and Carpool Ridership and Vehicle Volume on Selected High-Occupancy Vehicle (HOV) Facilities, 1989

City	Number of directional lanes HOV	Number of directional lanes Freeway	Peak-hour HOV Facility: Bus No. of vehicles	Bus No. of passengers	Van and Carpool No. of vehicles	Van and Carpool No. of passengers	Peak-hour Non HOV Freeway No. of vehicles	Peak-hour Non HOV Freeway No. of passengers
Exclusive facilities, freeway right of way								
Houston, TX								
I-45N (North)	1	4	75	2,810	52	416	7,897	8,566
I-45S (Gulf)	1	4	26	840	706	1,598	4,631	5,795
I-10 (Katy)	1	3	46	1,820	962	2,595	5,252	5,687
US 290 (Northwest)	1	3	17	600	1,558	3,248	6,140	6,630
Los Angeles, CA								
San Bernadino Fwy, Busway	1	4	71	2,750	1,374	4,352	8,375	9,548
Minneapolis, MN								
I-394	1	2	13	455	430	942	1,956	2,328
Washington, DC								
Shirley Highway	2	4	161	5,621	2,314	9,483	8,696	10,435
I-66	2	0	13	398	618	2,278	[a]	[a]
Concurrent flow facilities								
Los Angeles/Orange County, CA								
Rt. 55 (commuter lane)	1	3	3	50	1,295	2,687	5,284	5,656
I-405 (commuter lane)	1	4	4	120	1,625	3,705	8,322	9,154
Rt. 91 (commuter lane)	1	4	0	0	1,294	3,112	10,478	11,212
San Francisco, CA								
Oakland Bay Bridge	4	5	101	3,535	2,325	8,273	[a]	[a]
US 101	1	3	57	1,995	678	1,490	4,952	6,274
Seattle, WA								
I-90	1	3	34	1,250	127	229	5,133	5,749
SR 520	1	2	56	3,140	210	498	2,766	3,043
I-5	1	4	64	2,605	466	1,105	7,691	9,476
I-405	1	2	1	20	193	435	1,960	1,999
Washington, DC/Northern VA								
I-95	1	3	36	1,226	1,242	5,336	3,879	4,500
Total of ALL U.S. HOV Facilities	**44**	**110**	**2,165**	**104,754**	**22,064**	**62,765**	**127,156**	**146,714**

Source:
U.S. Department of Transportation, A Description of High-Occupancy Vehicle Facilities in North America, Washington, DC, July 1990, pp. 73-75.

[a]Data are not available.

CHAPTER 4
PERSONAL TRAVEL STATISTICS

The number of vehicles per household in the U.S. has almost doubled in the past forty years - from 0.99 in 1950 to 1.92 in 1990. In that time period, the average annual 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).

Each year since 1979 the U.S. Travel Data Center has conducted a monthly travel survey to provide timely and relevant information on major travel trends in the U.S. In this survey, a trip is defined as "each time one person goes to a place at least 100 miles away from home and returns." The following trips are excluded from the survey: travel as part of an operation crew on a train, airplane, truck, bus, or ship; commuting to a place of work; and, student trips to or from school. Data from the 1990 National Travel Survey are contained in Tables 4.4-4.6. According to the survey, the average trip distance in 1990 was 72 miles shorter than in 1988 due to shorter trips taken by cars, trucks, and recreational vehicles. The average trip distance by airplane, however, was longer in 1990 than in 1988 (Table 4.4). Twenty percent of all vacation trips in 1990 were less than 300 miles (Table 4.5).

The majority of data on personal travel come from the Nationwide Personal Transportation Study (NPTS). The NPTS is a national survey designed to collect data on the nature and characteristics of personal travel. Not to be confused with the National Travel Survey, 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 14 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. The data presented include information from surveys done in 1969, 1977, 1983, and 1990. Tables 4.7-4.20 and Figures 4.5-4.14 are taken directly from the U.S. Department of Transportation, Federal Highway Administration, <u>1990 Nationwide Personal Transportation Study: Summary of Travel Trends</u> which was prepared by Oak Ridge National Laboratory for the Federal Highway Administration. Since all of the NPTS surveys differ somewhat in terms of terminology, survey procedure, and target population, one should be cautious when comparing statistics from one survey to the next.

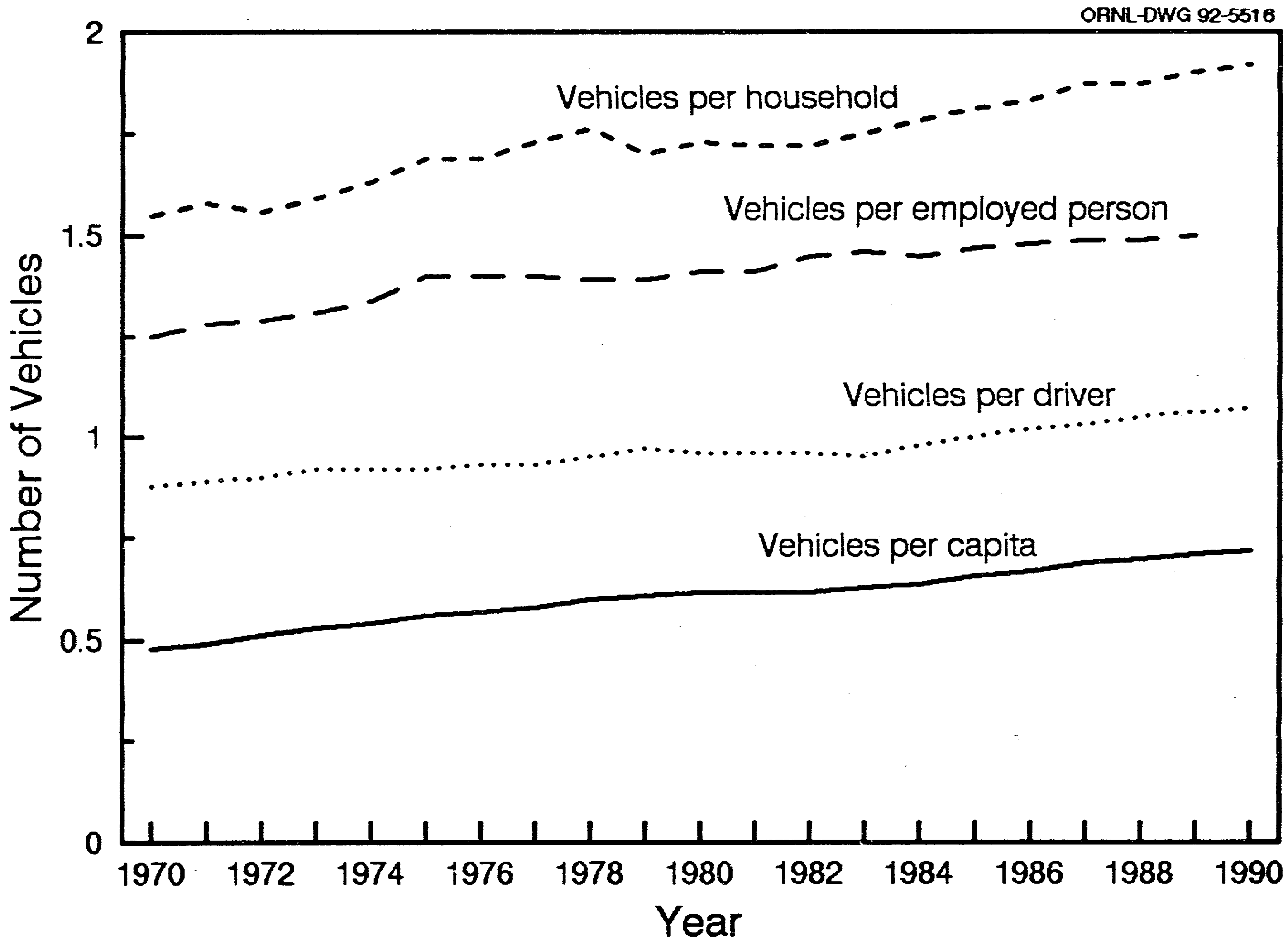
Table 4.1
Population and Vehicle Profile, 1950-90

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	Vehicles per household	Licensed drivers per household	Vehicles per licensed driver	Vehicles per civilian employed persons
1950	151,868	43,554	43,256	62,194	58,918	0.28	0.99	1.43	0.70	0.73
1955	165,069	47,874	55,804	74,686	62,170	0.34	1.17	1.56	0.75	0.90
1960	179,979	52,799	66,582	87,253	65,778	0.36	1.26	1.65	0.76	1.01
1965	193,526	57,251	82,067	98,502	71,088	0.42	1.43	1.72	0.83	1.15
1970	203,984	63,401	98,136	111,543	78,678	0.48	1.55	1.76	0.88	1.25
1975	215,465	71,120	120,054	129,791	85,846	0.56	1.69	1.82	0.92	1.40
1980	227,719	80,776	139,832	145,295	99,303	0.61	1.73	1.80	0.96	1.41
1981	229,945	82,368	141,908	147,075	100,397	0.62	1.72	1.79	0.96	1.41
1982	232,171	83,527	143,854	150,234	99,526	0.62	1.72	1.80	0.96	1.45
1983	234,296	83,918	147,104	154,389	100,834	0.63	1.75	1.83	0.95	1.46
1984	236,343	85,407	152,162	155,424	105,005	0.64	1.78	1.82	0.98	1.45
1985	238,466	86,789	157,048	156,868	107,150	0.66	1.81	1.81	1.00	1.47
1986	240,658	88,458	162,094	159,487	109,597	0.67	1.83	1.80	1.02	1.48
1987	242,820	89,479	167,193	161,975	112,440	0.69	1.87	1.81	1.03	1.49
1988	245,051	91,061	171,741	162,853	114,968	0.70	1.87	1.79	1.05	1.49
1989	247,350	92,830	175,960	165,555	117,342	0.71	1.90	1.78	1.06	1.50
1990	249,975	93,347	179,299	167,015	[b]	0.72	1.92	1.79	1.07	[b]
				Average annual percentage change						
1950-90	1.3%	1.9%	3.6%	2.5%	1.8%[c]	2.4%	1.7%	0.6%	1.1%	1.9%[c]
1970-90	1.0%	2.0%	3.1%	2.0%	2.1%[c]	2.0%	1.1%	0.1%	1.0%	1.0%[c]
1982-90	0.9%	1.4%	2.8%	1.3%	2.4%[c]	1.9%	1.4%	-0.1%	1.4%	0.5%[c]

Sources:
Resident population, total households, and civilian employed persons - U.S. Department of Commerce, Bureau of the Census, Statistical Abstract of the United States, 111th edition, 1991, Washington, DC, pp. 7, 45, 395, and annual.
Vehicles in operation - R. L. Polk and Company. **FURTHER REPRODUCTION PROHIBITED.**
Licensed drivers - U.S. Department of Transportation, Federal Highway Administration, Highway Statistics 1990, Table DL-1, p. 30, and annual.

[a]Estimates as of July 1. Includes Armed Forces stationed in the United States.
[b]Data are not available.
[c]Average annual percentage changes are for years 1950-89, 1970-89 and 1982-89.

Figure 4.1. Population and Vehicle Profile, 1970-90



Source: See Table 4.1.

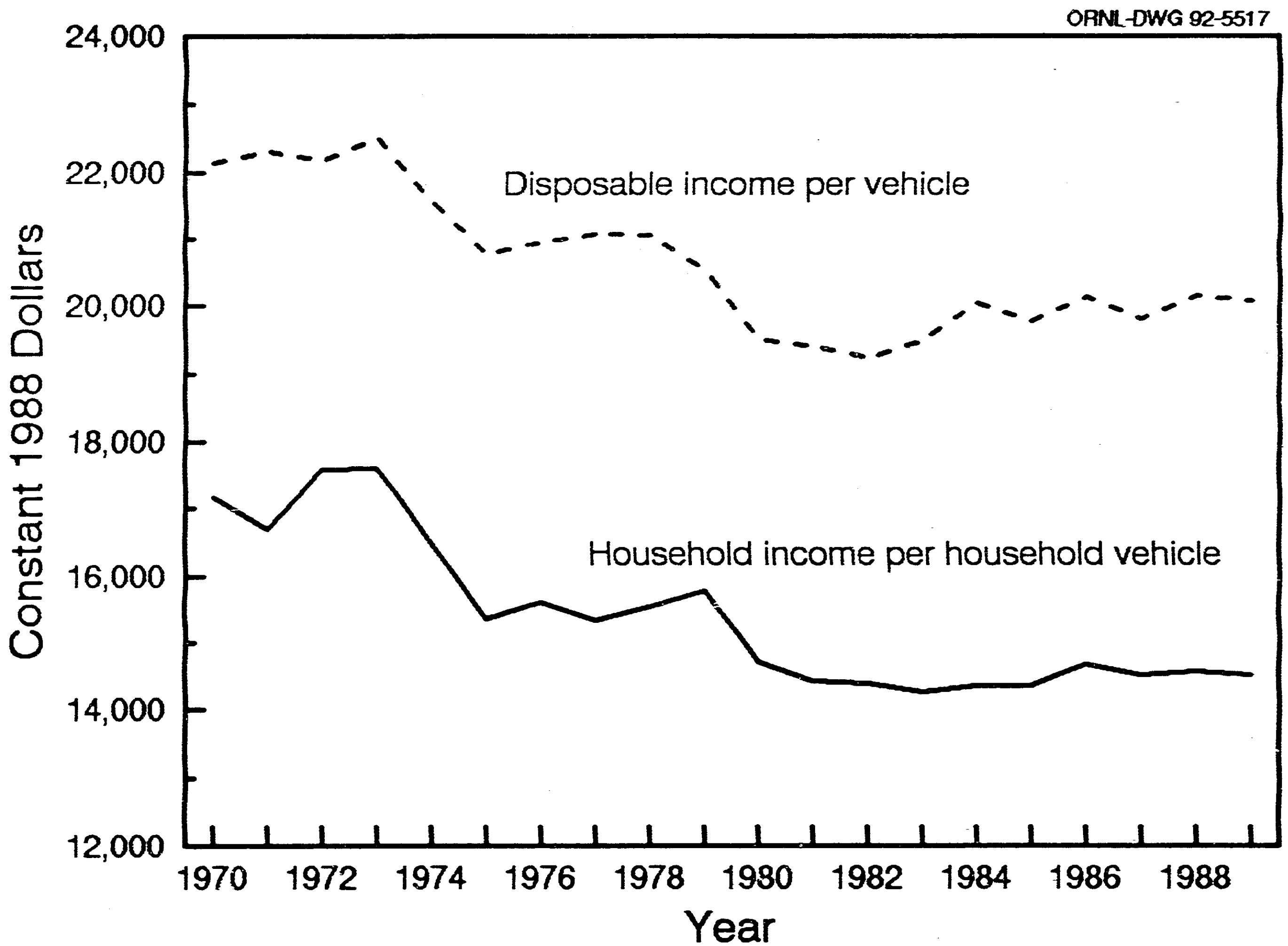
Table 4.2
Financial Profile of the Population, 1970-89

	Median household income			Household income per household vehicle[a]	Disposable income per capita			Disposable income per vehicle[b]
Year	Current dollars	Constant 1988 dollars[c]	Vehicles per household	Constant 1988 dollars[c]	Current dollars	Constant 1988 dollars[c]	Vehicles per capita	Constant 1988 dollars[c]
1970	8,734	26,604	1.55	17,164	3,489	10,627	0.48	22,141
1971	9,028	26,371	1.58	16,690	3,740	10,925	0.49	22,295
1972	9,697	27,423	1.56	17,579	4,000	11,312	0.51	22,180
1973	10,512	27,983	1.59	17,599	4,481	11,928	0.53	22,506
1974	11,197	26,862	1.63	16,480	4,855	11,647	0.54	21,569
1975	11,800	25,936	1.69	15,347	5,291	11,630	0.56	20,767
1976	12,686	26,362	1.69	15,599	5,744	11,936	0.57	20,940
1977	13,572	26,493	1.73	15,314	6,262	12,223	0.58	21,075
1978	15,064	27,311	1.76	15,518	6,968	12,633	0.60	21,055
1979	16,461	26,831	1.70	15,783	7,682	12,522	0.61	20,527
1980	17,710	25,432	1.73	14,700	8,421	12,093	0.61	19,504
1981	19,074	24,815	1.72	14,427	9,243	12,025	0.62	19,395
1982	20,171	24,730	1.72	14,378	9,724	11,922	0.62	19,228
1983	21,018	24,948	1.75	14,256	10,340	12,274	0.63	19,482
1984	22,415	25,531	1.78	14,343	11,257	12,822	0.64	20,034
1985	23,618	25,980	1.81	14,353	11,863	13,049	0.66	19,772
1986	24,897	26,864	1.83	14,680	12,496	13,483	0.67	20,124
1987	26,061	27,130	1.87	14,508	13,128	13,666	0.69	19,806
1988	27,225	27,225	1.87	14,559	14,107	14,107	0.70	20,153
1989	28,906	27,576	1.90	14,514	14,948	14,260	0.71	20,085
				Average annual percentage change				
1970-89	6.5%	0.2%	1.1%	-0.9%	8.0%	1.6%	2.1%	-0.5%
1982-89	5.3%	1.6%	1.4%	0.1%	6.3%	2.6%	2.0%	0.6%

Sources:
Median household income and disposable income per capita - U.S. Department of Commerce, Bureau of the Census, Statistical Abstract of the United States, 111th ed., Washington, DC, 1991, pp. 440, 450, and annual.
Vehicles per household and vehicles per capita - See Table 4.1.

[a]Median household income divided by the number of vehicles per household equals the household income per household vehicle.
[b]Disposable income per capita divided by the number of vehicles per capita equals disposable income per vehicle.
[c]Adjusted by the Consumer Price Inflation Index.

Figure 4.2. Financial Profile, 1970-89



Source: See Table 4.2.

An average household spent 19.3% of income on transportation in 1989. Households with an income of $30,000 to $39,000 spent a greater share of income on transportation (22.6%) than any other income group, while households with an income of $5,000 to $9,999 spent the least (15.3%).

Table 4.3
Average Annual Expenditures of Households by Income, 1989[a]

	All households	Income[b] Less than $5,000	$5,000 to $9,999	$10,000 to $14,999	$15,000 to $19,999	$20,000 to $29,999	$30,000 to $39,999	$40,000 to $49,999	$50,000 and over
Total expenditures	$27,042	$11,468	$12,017	$667	$19,018	$658	$424	$35,841	53,193
					Percentage of total expenditures[c]				
Food[d]	16.5	21.4	21.9	20.1	18.7	17.9	16.0	15.8	13.9
Housing	29.9	32.7	34.9	33.0	30.8	29.6	28.2	29.0	29.2
Apparel and services	4.9	4.9	4.3	4.2	4.4	4.6	4.8	5.2	5.4
Transportation	19.3	18.7	15.3	18.2	19.8	20.1	22.6	20.4	18.0
Cars and trucks, new	4.6	3.9	1.6	2.7	3.2	4.5	5.4	4.9	5.4
Cars and trucks, used	4.0	4.5	4.0	4.9	5.4	4.1	5.4	4.7	2.6
Other vehicles	0.1	0.1	0.1	0.1	0.0	0.1	0.1	0.1	0.1
Vehicle finance charges	1.1	0.6	0.6	0.8	1.1	1.2	1.5	1.4	1.1
Gasoline & motor oil	3.6	4.4	3.7	4.3	4.4	4.2	3.9	3.7	3.0
Maintenance and repairs	2.0	2.0	2.0	1.9	2.2	2.1	2.2	2.0	1.8
Vehicle insurance	2.1	1.7	1.7	2.1	2.3	2.4	2.3	2.2	2.0
Public transportation	1.0	1.1	1.1	1.0	0.8	0.9	1.0	0.7	1.3
Vehicle rental, licenses and other charges	0.7	0.5	0.4	0.5	0.5	0.6	0.8	0.7	0.8
Health care	4.9	4.8	8.0	7.9	6.9	5.5	4.2	4.1	3.6
Entertainment	5.0	4.9	3.4	3.5	3.9	4.4	5.0	4.9	6.0
Personal insurance and pensions	10.2	2.6	2.8	4.7	6.5	8.7	10.7	12.3	13.7
Others[e]	9.3	10.1	9.5	8.3	9.0	9.2	8.6	8.4	10.2

Source:
U.S. Department of Labor, Bureau of Labor Statistics, Consumer Expenditure Survey: Interview Survey, 1989, press release, Washington, DC, April 1990; and detailed computer printouts from the Bureau of Labor Statistics.

[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]Income before taxes.
[c]Percentages may not sum to totals due to rounding.
[d]Includes alcoholic beverages.
[e]Includes personal care, reading, education, tobacco and smoking supplies, cash contributions, and miscellaneous items.

Table 4.4
Demographic Characteristics of Auto/Truck/Recreational Vehicle (RV) and Air Travelers 1988-90[a] (percentage)

	Total travelers		Auto/truck/RV travelers		Air travelers	
	1988	1990	1988	1990	1988	1990
Sex						
Male	57	54	56	54	60	57
Female	43	46	44	46	40	43
Age						
18-24 years	15	13	16	14	14	11
25-34 years	27	27	25	27	28	27
35-44 years	23	22	24	22	23	23
45-54 years	15	15	15	15	18	15
55-64 years	10	12	11	13	9	10
65 years and over	11	11	11	10	9	12
Household size						
One person	20	20	18	18	24	24
Two people	32	35	32	34	32	36
Three people	19	18	20	19	17	14
Four people	17	17	18	18	17	14
Five or more people	12	11	12	11	10	11
Family income						
Less than $10,000	6	10[b]	7	10[b]	4	6[b]
$10,000 - $19,999	16	9[c]	17	9[c]	11	6[c]
$20,000 - $29,999	21	22	23	24	15	14
$30,000 - $39,999	20	17	21	18	16	15
$40,000 - $49,999	13	13	13	13	14	14
$50,000 - $74,999	14	17	13	16	21	21
$75,000 - $99,999	4	6	4	5	7	9
$100,000 or more	5	6	3	4	13	13
Region of origin of trip						
New England	5	5	4	5	6	6
Mid-Atlantic	13	13	12	11	13	17
South Atlantic	16	17	17	17	16	17
East South Central	6	6	6	7	5	5
East North Central	16	18	18	18	12	15
West South Central	13	12	13	12	11	13
West North Central	8	8	8	9	8	7
Mountain	7	7	6	8	10	7
Pacific	16	13	15	13	19	14
Round trip distance						
200-299 miles	22	22	28	29	3	2
300-399 miles	16	15	20	19	4	1
400-499 miles	10	11	12	13	5	4
500-599 miles	6	7	7	8	4	4
600-999 miles	13	14	13	15	14	11
1000-1999 miles	15	14	11	9	25	30
2000 or more miles	12	11	5	4	35	34
Outside U.S.	6	6	4	3	13	13
Average trip distance (miles)[d]	970	898	680	596	1980	2014
Total miles (billions)[e]	636	594	321	288	306	292
Total trips (millions)	656.1[f]	661.1[f]	472.6	483.9	154.6	144.9

Sources:
U.S. Travel Data Center, 1988 Travel Market Close-Up, Washington, DC, 1989, pp. 1, 29, 81, 89, and 93.
U.S. Travel Data Center, 1990 Travel Market Report, Washington, DC, 1991, Appendix F, pp. 1, 29, 81, 89, and 93.

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[a]The sum of the components may not equal 100 percent due to rounding. A trip is defined as "each time a person goes to a place at least 100 miles from home and returns."

[b]Less than $15,000

[c]$15,000-$19,999.

[d]Based on total trips taken in category, not total travelers.

[e]Total number of trips multiplied by average trip distance.

[f]The total exceeds the sum of automobile and air travel because some trips are made by bus and rail.

While the total number of trips has more than doubled from 1974 to 1990, the number of vacation trips has more than triped in this period. Half of all trips taken were less than 600 miles, while two-thirds of all weekend trips were less than 600 miles. The average distance of a business trip was the same in 1990 as in 1983. Trips for pleasure were the only trip type to have a decline in average distance from 1983 to 1990.

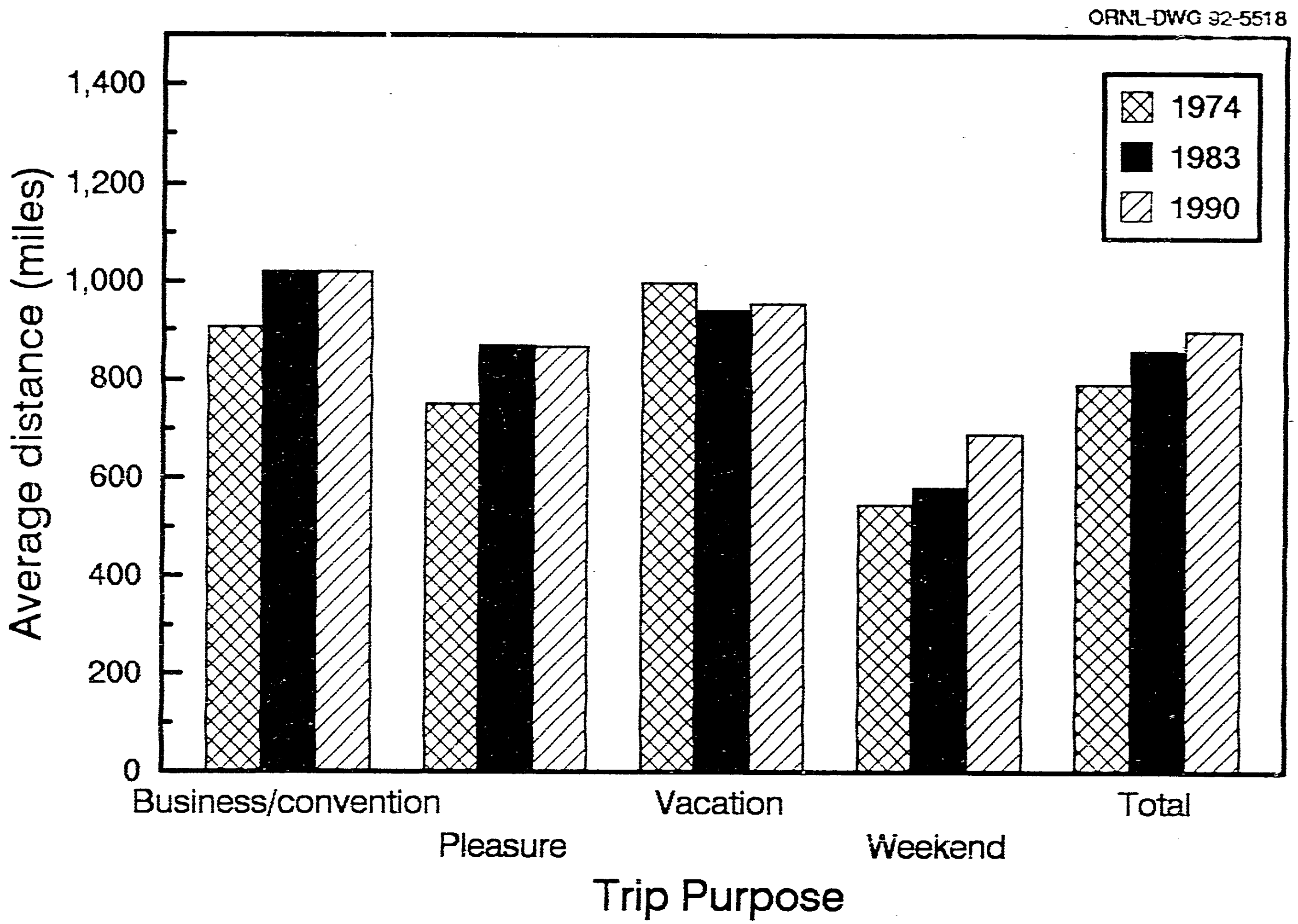
Table 4.5
Distribution of Trips for All Modes by Trip Purpose and Round-Trip Distance, 1974, 1983, and 1990[a]
(percentage)

Round-trip distance (miles)	Business/convention			Pleasure			Vacation			Weekend			Total		
	1974[b]	1983	1990	1974[b]	1983	1990	1974[b]	1983	1990	1974[b]	1983	1990	1974[b]	1983	1990
200-299	16	16	21	21	21	22	14	18	20	22	30	26	20	22	22
300-399	16	11	12	18	16	16	13	15	14	21	21	17	18	15	15
400-599	20	20	19	20	16	19	18	14	18	25	20	23	20	17	18
600-999	18	15	13	16	13	15	18	14	15	18	14	15	16	14	14
1,000-1,999	17	20	18	11	13	13	16	15	14	8	8	10	13	14	14
2,000 or more	11	12	13	9	10	10	15	12	12	3	4	6	9	10	11
Outside U.S.	2	6	5	5	9	7	8	10	8	2	3	4	4	8	6
Total[c]	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Average distance[d]	905	1,020	1,020	751	870	867	998	940	953	546	580	689	791	860	898
Total trips (millions)	**67.8**	**103.6**	**155.6**	**163.9**	**371.5**	**460.9**	**113.9**	**307.8**	**422.3**	**109.4**	**225.5**	**280.0**	**280.7**	**540.9**	**661.1**

Sources:
1974 data - U.S. Travel Data Center, 1974 National Travel Survey, Full Year Report, Washington, DC, 1975, pp. 34, 50, 58, 62, 66.
1983 data - U.S. Travel Data Center, 1983 National Travel Survey, Full Year Report, Washington, DC, 1984, pp. A3, A30, A39, A48, A57.
1990 data - U.S. Travel Data Center, 1990 Travel Market Report, Washington, DC, 1991, Appendix F, p. 1.

[a]A trip is defined as "each time a person goes to a place at least 100 miles from home and returns." Trip types are not mutually exclusive.
[b]Data from 1974 are not comparable with data past 1981 because of a change in survey methodology.
[c]Totals may not equal the sum of the components due to rounding.
[d]Round trip straight-line distance for domestic travel only.

Figure 4.3. Average Distance of Trips by Trip Purpose, 1974, 1983, and 1990



Source: See Table 4.5.

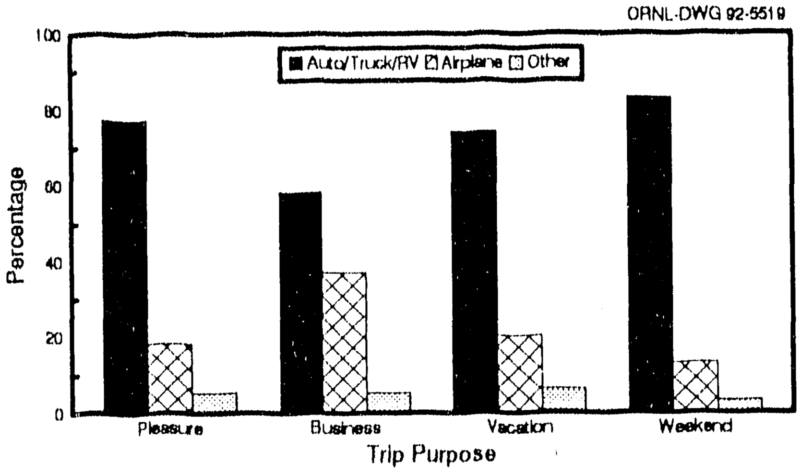
Regardless of the trip purposes, the majority of trips in 1990 were taken using auto/truck/RV. Of the four trip purposes, business trips had the highest percentage of trips by airplane (37%), while weekend trips had the lowest percentage (13%). Because trips taken by airplane are, on average, longer than other modes, business trips have the longest average trip length in 1990 (1,020 miles) and weekend trips, the shortest (689 miles).

Table 4.6
Mode of Travel by Trip Purpose, 1990[a]

Mode	Pleasure	Business	Vacation	Weekend	Total
	(percentage)				
Auto/truck/RV[b]	77	58	74	83	73
Airplane	18	37	20	13	22
Bus	3	2	3	2	3
Train	1	[c]	1	1	1
Other	1	2	1	1	2
Total number of trips (millions)	460.9	155.6	422.3	280.2	661.1
Average trip distance (miles)	867.0	1020.0	953.0	689.0	898.0

Source:
U.S. Travel Data Center, 1990 Travel Market Report, Washington, D.C., 1991, Appendix F, pp. 1, 5.

Figure 4.4. Mode of Travel by Trip Purpose, 1990



Source: See Table 4.6.

[a]The sum of the components may not equal 100 percent due to rounding. A trip is defined as "each time a person goes to a place at least 100 miles from home and returns."
[b]This category also includes rental cars. RV = recreational vehicle.
[c]Less than 1 percent.

Table 4.7
Summary Statistics on Demographic Characteristics
and Total Travel
1969, 1977, 1983, and 1990 Series of the NPTS

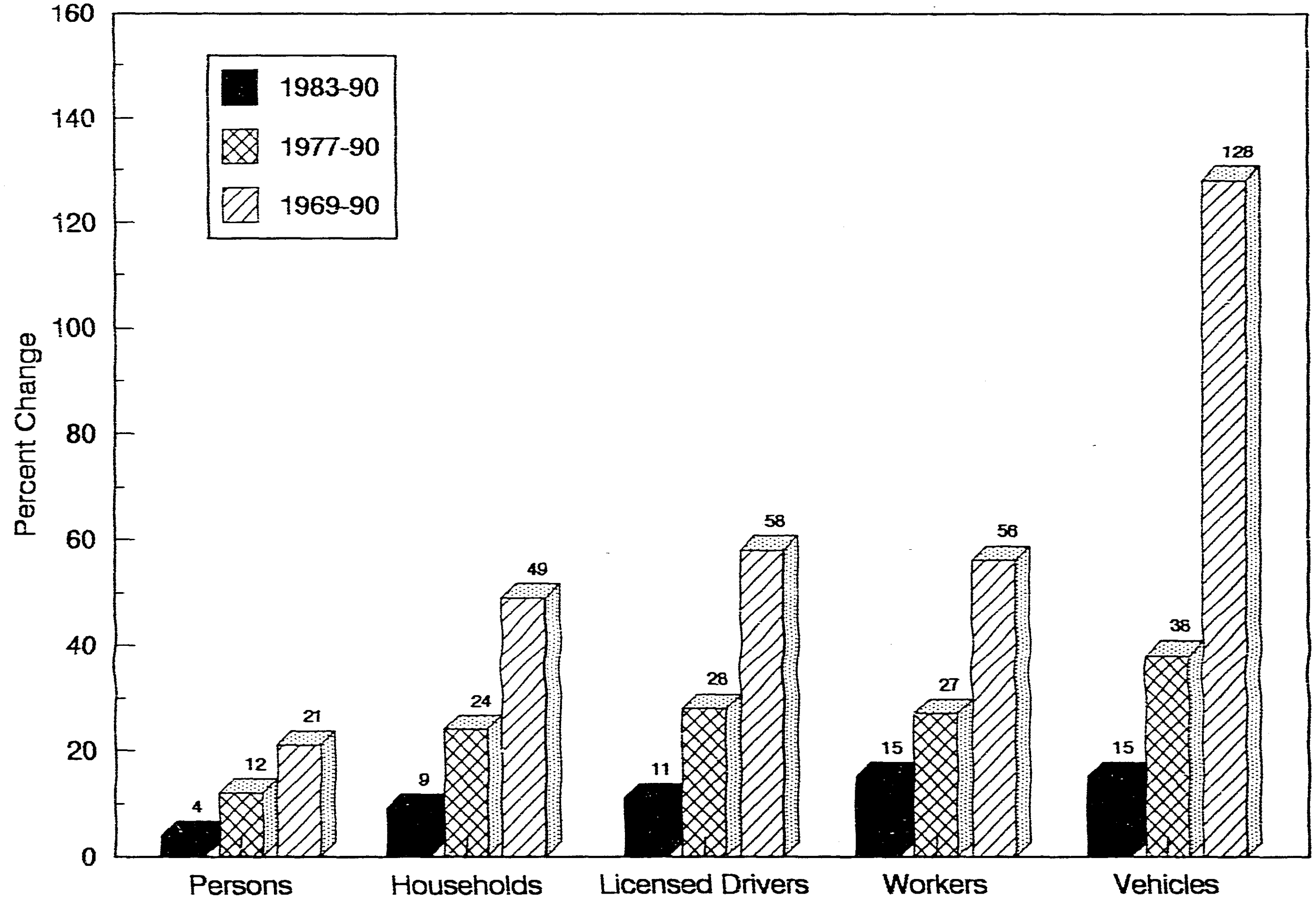
	1969	1977	1983	1990	Change 69-90[a]	Change 69-90[b]
HOUSEHOLDS (000)						
All	62,504	75,412	85,371	93,347	1.9	49
1 person	10,980	16,214	19,354	22,999	3.6	109
2 persons	18,448	22,925	27,169	30,114	2.4	63
3 persons	10,746	13,046	14,756	16,128	2.0	50
4+ persons	22,330	23,227	24,092	24,106	0.4	8
PERSONS (000)						
All	197,213	213,141	229,453	239,416[c]	0.9	21
Under 16	60,100	54,958	53,682	54,303	-0.5	-10
16-19	14,598	16,552	15,268	13,851	-0.2	-5
20-34	40,060	52,252	60,788	59,517	1.9	49
35-64	62,982	66,988	75,353	82,480	1.3	31
65+	19,473	22,391	24,362	26,955	1.6	38
All Male	94,465	102,521	111,514	114,441	0.8	21
All Male - 16 and older	66,652	74,542	83,645	86,432	1.1	30
All Female	102,748	110,620	117,939	124,975	0.8	22
All Female - 16 and older	73,526	83,721	92,080	96,371	1.1	31
All - 5 and older	NA	198,434	212,932	222,101	0.9[d]	12[4]
LICENSED DRIVERS (000)						
All	102,986	127,552	147,015	163,025[3]	2.2	58
Male	57,981	66,199	75,639	80,289	1.6	38
Female	45,005	61,353	71,376	82,707	2.9	84
WORKERS (000)						
All	75,758	93,019	103,244	118,343[3]	2.1	56
Male	48,487	55,625	58,849	63,996	1.3	32
Female	27,271	37,394	44,395	54,334	3.3	99
HOUSEHOLD VEHICLES[e] (000)	72,500	120,098	143,714	165,221	4.0	128
HOUSEHOLD VEHICLE TRIPS (000,000)	87,284	108,826	126,874	158,927	2.9	82
HOUSEHOLD VMT (000,000)	775,940	907,603	1,002,139	1,409,600	2.9	82
PERSON TRIPS[f] (000,000)	145,146	211,778	224,385	249,562	2.6	72
PERSON MILES OF TRAVEL[e] (000,000)	1,404,137	1,879,215	1,946,662	2,315,300	2.4	65

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

[a]Compounded annual percentage change rate.
[b]Percentage change rate.
[c]Includes "don't know" and "refusals."
[d]For years 1977-1990.
[e]1969 survey includes only automobiles, station wagons, and vanbuses/minibuses as household vehicles.
[f]1969 survey does not include walk and bicycle trips.

Figure 4.5. Percent Change in Numbers of Individuals, Households, Drivers, Workers, and Vehicles 1969, 1977, 1983, and 1990 Series of the NPTS

ORNL-DWG92-6434



Source: See Table 4.7.

The percentage of households without a vehicle dropped from 20.6% in 1969 to 9.2% in 1990, while the percentage of households that has three or more vehicles quadrupled. Over the 1969 to 1990 period, the total number of households increased by 49% while the number of household vehicles increased by 128%.

Table 4.8
Number of Households by Vehicles Available
1969, 1977, 1983, and 1990 Series of the NPTS
(thousands)

Number of Vehicles Owned	1969[a]	1977	1983	1990	Change 69-90[b]	Change 69-90[c]
No Vehicle	12,876 (20.6%)	11,538 (15.3%)	11,548 (13.5%)	8,573 (9.2%)	-1.9	-33
1 Vehicle	30,252 (48.4%)	26,092 (34.6%)	28,780 (33.7%)	30,654 (32.8%)	0.1	1
2 Vehicles	16,501 (26.4%)	25,942 (34.4%)	28,632 (33.5%)	35,872 (38.4%)	3.8	117
3+ Vehicles	2,875 (4.6%)	11,840 (15.7%)	16,411 (19.2%)	18,248 (19.5%)	9.2	535
ALL HOUSEHOLDS	**62,504**	**75,412**	**85,371**	**93,347**	**1.9**	**49**
ALL HOUSEHOLD VEHICLES	**72,500**	**120,098**	**143,714**	**165,221**	**4.0**	**128**
VEHICLES PER HOUSEHOLD	**1.15**	**1.59**	**1.68**	**1.76**	**2.0**	**53**

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

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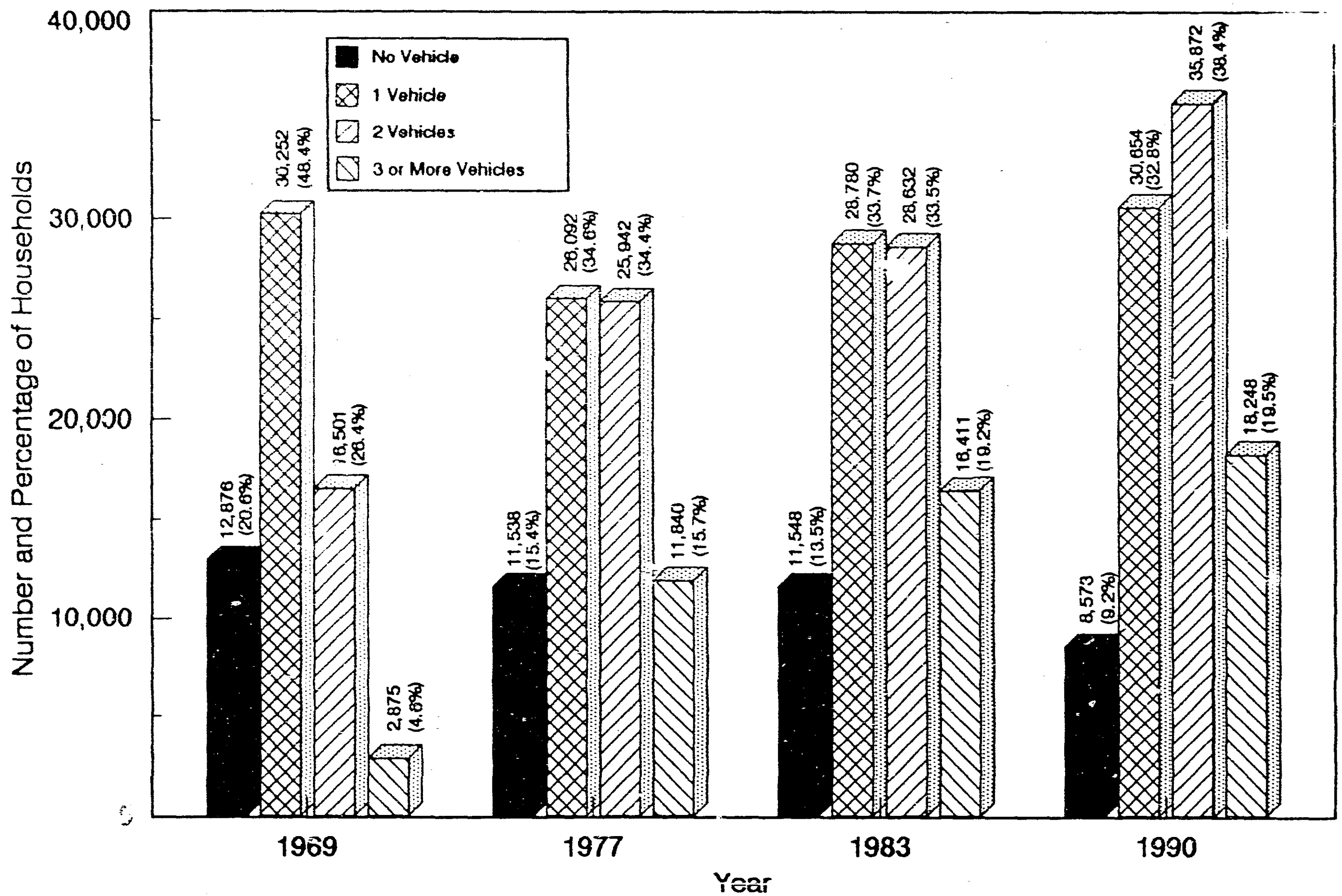
[a]The 1969 survey does not include pickups or other light trucks as household vehicles.
[b]Compounded annual percentage change rate.
[c]Percentage change rate.

Figure 4.6. Number and Percentage of Households by Number of Vehicles Available 1969, 1977, 1983, and 1990 Series of the NPTS

ORNL-DWG92-6436



Source: See Table 4.8.

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 4.9
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**	**15,099**	**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 Study: Summary of Travel Trends, Washington, DC, March 1992.

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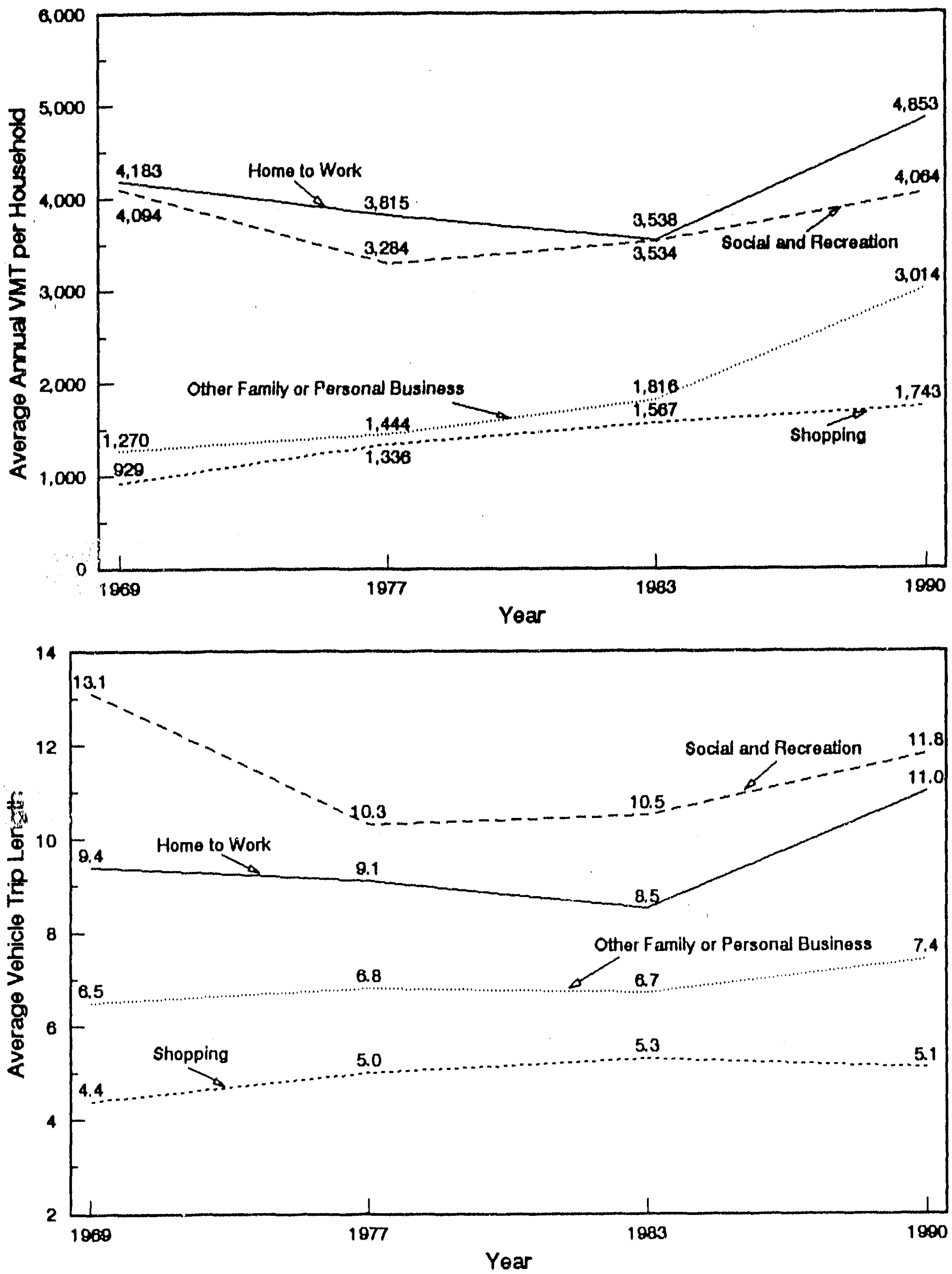
[a]Includes trip purposes not shown above.

Figure 4.7. Household Vehicle Travel for Selected Trip Purposes 1969, 1977, 1983, and 1990 Series of NPTS

ORNL-DWG92-6438



Source: See Table 4.9.

The average vehicle occupancy, calculated as person miles per vehicle mile, was at its lowest level since 1977 in 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.

Table 4.10
Average Vehicle Occupancy for Selected Trip Purposes
1977, 1983, and 1990 Series of the NPTS
(person miles per vehicle mile)

Trip Purpose	1977	1983	1990	Change 77-90[a]	Change 77-90[b]
Home to Work	1.3	1.3	1.2	-0.6	-8
Shopping	2.1	1.8	1.5	-2.6	-29
Other Family or Personal Business	2.0	1.8	1.6	-1.7	-20
Social and Recreation	2.4	2.1	2.1	-1.0	-13
All Purposes[c]	**1.9**	**1.7**	**1.6**	**-1.3**	**-16**

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

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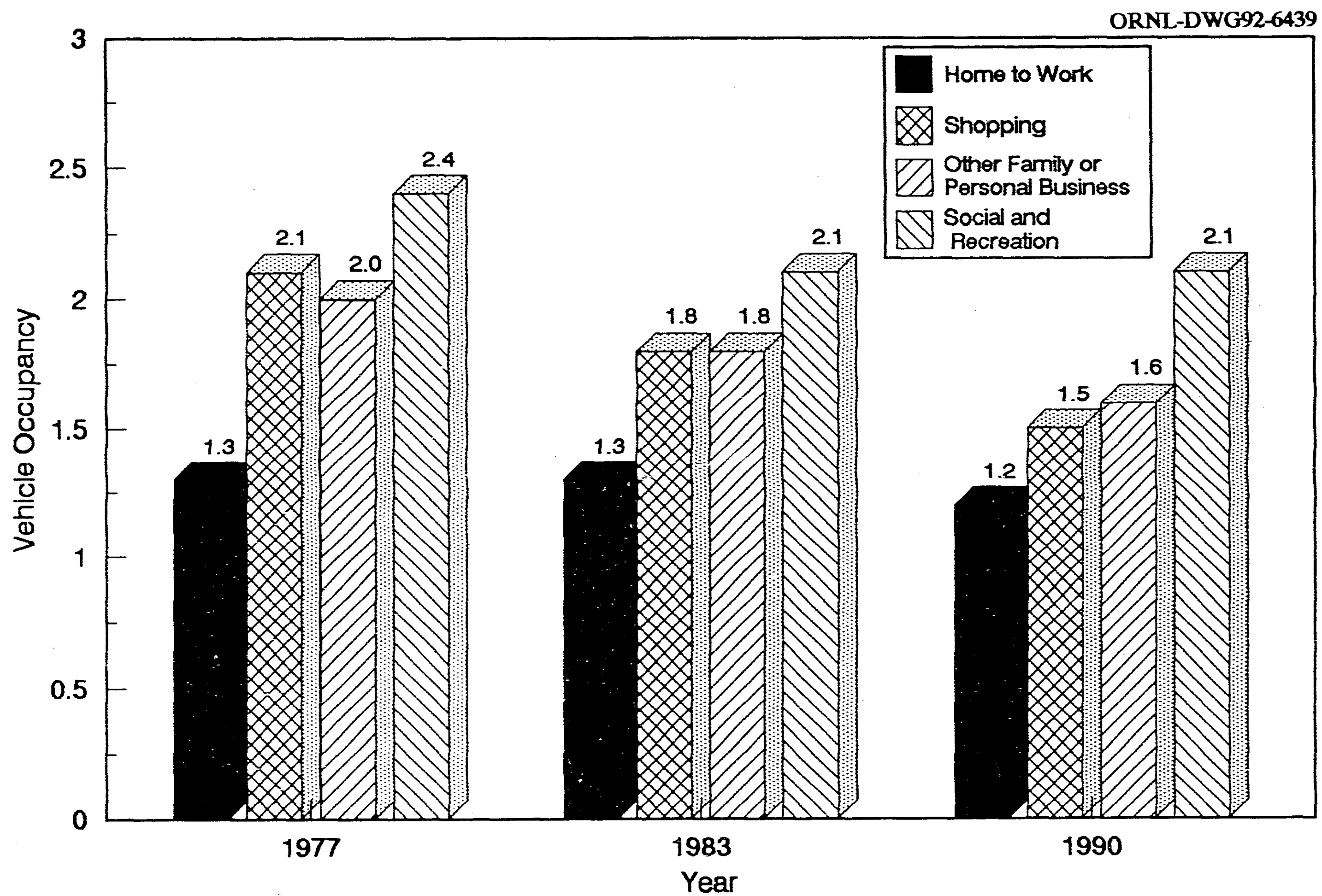
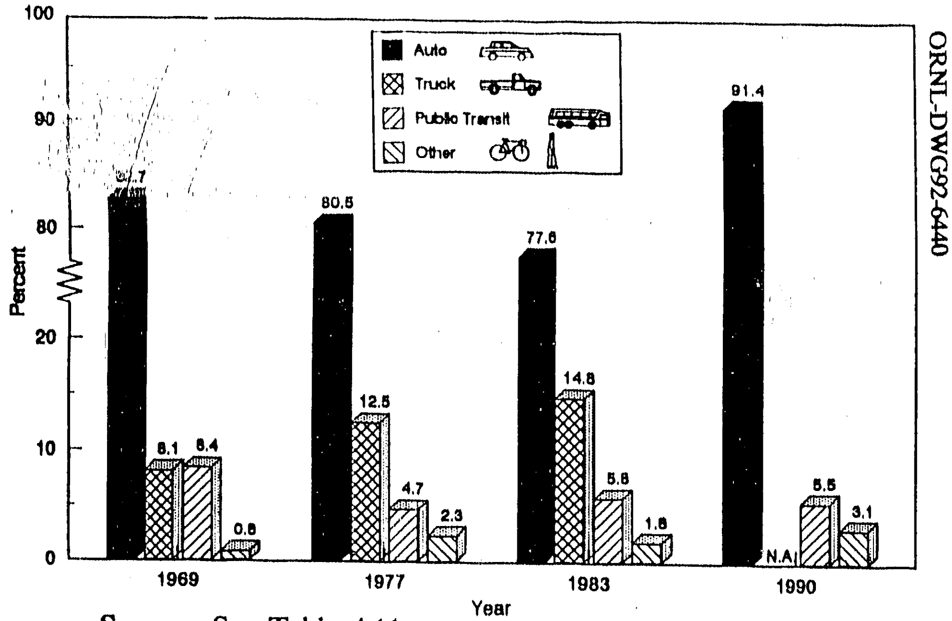
[a]Compounded annual percentage change rate.
[b]Percentage change rate.
[c]Includes other purposes not shown above such as trips to school, church, doctor, dentist, and work-related business trips.

Figure 4.8. Average Vehicle Occupancy (persons per vehicle mile)



Source: See Table 4.10.

Figure 4.9. Distribution of Journey-to-Work Trips by Usual Mode[a]



Source: See Table 4.11.

Table 4.11
Distribution of Journey-to-Work Trips by Usual Mode[a]
1969, 1977, 1983, and 1990 Series of the NPTS
(percentage)

Mode	1969	1977	1983	1990
Auto	82.7	80.5	77.6	91.4[b]
Truck[c]	8.1	12.5	14.8	-
Public Transit	8.4	4.7	5.8	5.5
Other	0.8[d]	2.3	1.8	3.1
Total	**100.0**	**100.0**	**100.0**	**100.0**

Source: U.S. Department of Transportation, Federal Highway Administration, <u>1990 Nationwide Personal Transportation Study: Summary of Travel Trends</u>, Washington, DC, March 1992.

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[a]Usual mode is defined as the main means of transportation to work during the week preceding the interview.

[b]1990 survey combines automobile and truck as a single mode.

[c]Household-based trucks, primarily pickups.

[d]Excludes walk trips.

The average commute trip length increased by 7% from 1983 to 1990, from 9.9 miles to 10.6 miles. Yet the commute time declined by 3% during the same period. This observation might be partially due to the fact that a greater number of suburban and exurban residential areas and employment centers were developed. The resulting commutes are longer but are travelled at faster speeds. The decline in travel time is also influenced by changes in commuting modes, with a decrease in transit and carpooling and an increase in driving alone.

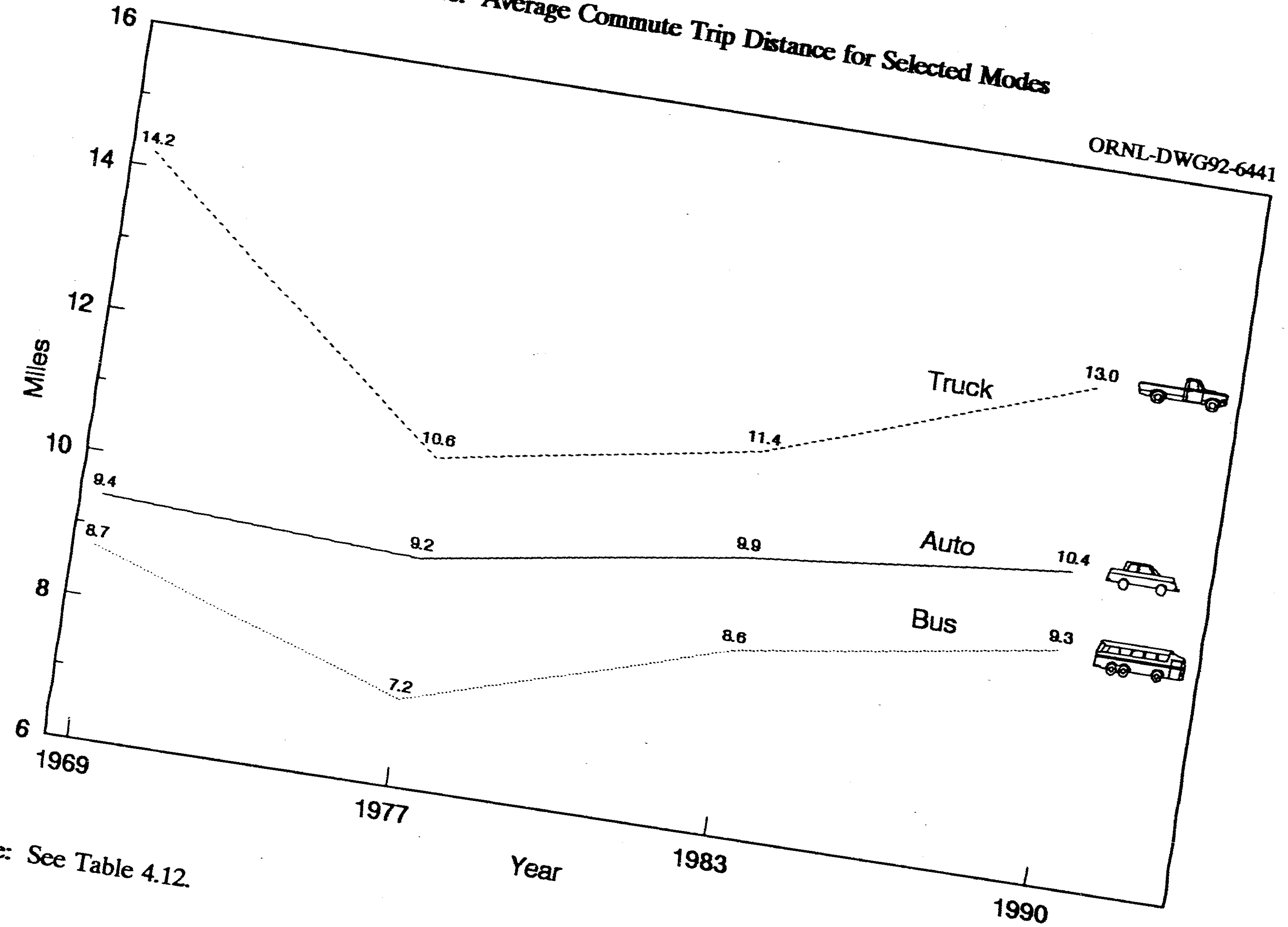
Table 4.12
Commuting Patterns of Journey-to-Work Trips by Mode
1969, 1977, 1983, and 1990 Series of the NPTS

					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**
Average Commute Travel Time (Minutes)						
ALL	**22**	**20.4**	**20.4**	**19.7**	**-0.5**	**-10**

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

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

Figure 4.10. Average Commute Trip Distance for Selected Modes



Source: See Table 4.12.

Table 4.13
Distribution of Journey-to-Work Trips by Household Income and Mode, 1990
(percentage)

Income (thousands)	Automobile	Truck	Van	Bus	Train[a]	Walk	Other[b]	Total
Under $10	65.4	11.8	4.9	5.0	0.8	10.6	1.5	100
$10-19.9	70.5	14.8	2.9	3.9	1.2	5.1	1.6	100
$20-29.9	68.2	18.1	4.5	2.4	1.7	4.4	0.8	100
$30-39.9	67.9	19.4	4.6	2.1	1.3	4.0	0.8	100
$40 and over	73.1	15.8	4.6	1.3	2.0	2.5	0.7	100
Total	70.5	16.6	4.4	2.2	1.6	3.9	0.9	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 4.14
Distribution of Journey-To-Work Trips by Age and Mode, 1990
(percentage)

Age (years)	Au..mbile	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 4.15
Distribution of Journey-To-Work Trips by Distance and Mode, 1990
(percentage)

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

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

While 41.8% of household automobiles in 1969 were less than two years old, this percentage decreased to 15.6% in 1990. The trend continued that American households keep their vehicles for a longer period of time, both for cars and trucks. The percent of household automobiles that were 10 or more years old increased from 6.2 in 1969 to 29.9 by 1990.

Table 4.16
Distribution of Vehicles by Age
1969, 1977, 1983, and 1990 Series of the NPTS
(percentage)

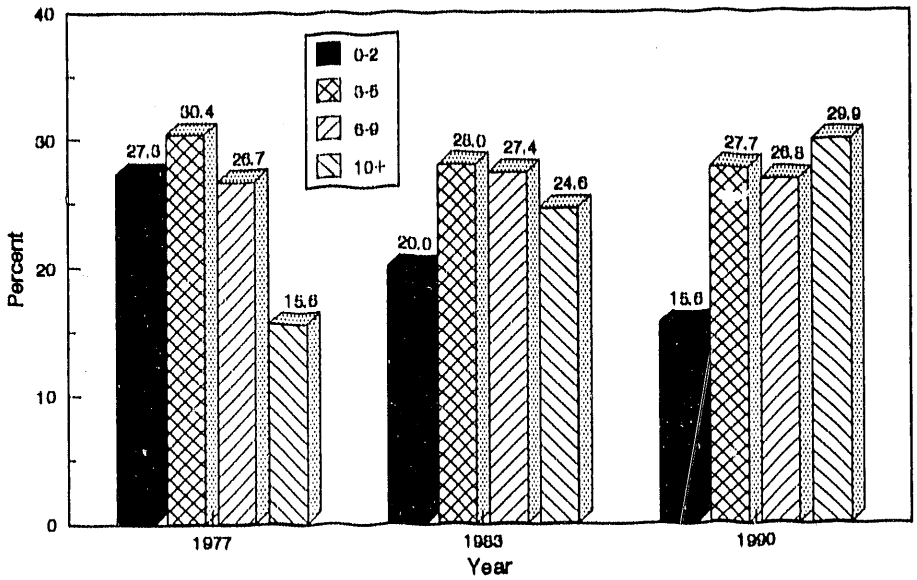
Vehicle Age (Years)	1969[a]	1977			1983			1990		
		Auto	Truck/ Van	All	Auto	Truck/ Van	All	Auto	Truck/ Van	All
0-2	41.8	27.3	29.9	27.8	20.0	16.6	19.2	15.6	19.7	16.6
3-5	31.9	30.4	25.6	29.6	28.0	26.6	27.6	27.7	27.2	27.5
6-9	20.1	26.7	21.1	25.7	27.4	25.0	26.9	26.8	20.9	25.3
10 or more	6.2	15.6	23.4	16.9	24.6	31.8	26.3	29.9	32.2	30.6
TOTAL	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Average Age (Years)	5.1	5.5	6.4	5.6	6.7	7.8	6.9	7.6	8.0	7.7

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

[a]1969 survey includes automobiles and vanbus/minibus only.

Figure 4.11. Distribution of Automobiles by Vehicle Age 1977, 1983, and 1990 Series of the NPTS

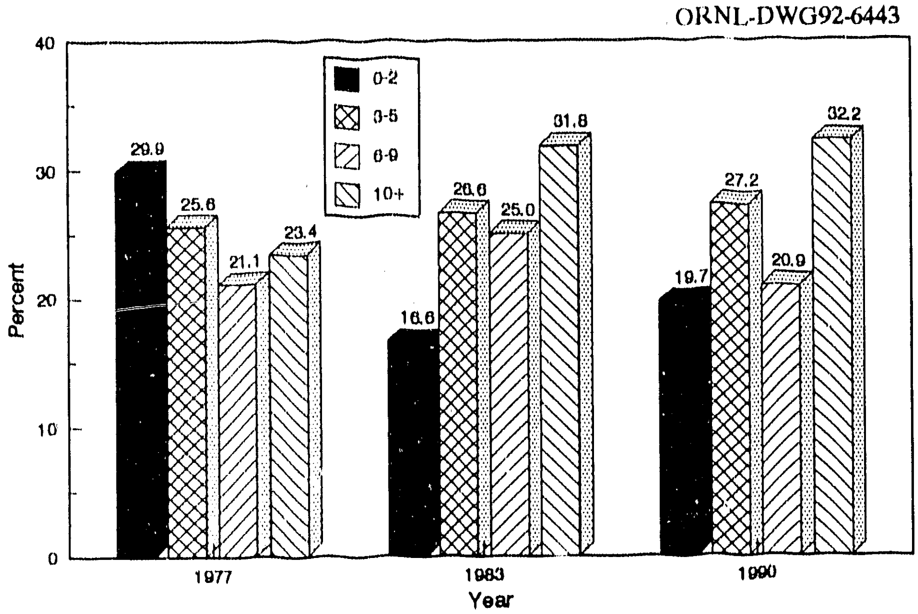
ORNL-DWG92-6442



Source: See Table 4.16.

Figure 4.12. Distribution of Household-Based Trucks by Vehicle Age 1977, 1983, and 1990 Series of the NPTS

ORNL-DWG92-6443



Source: See Table 4.16.

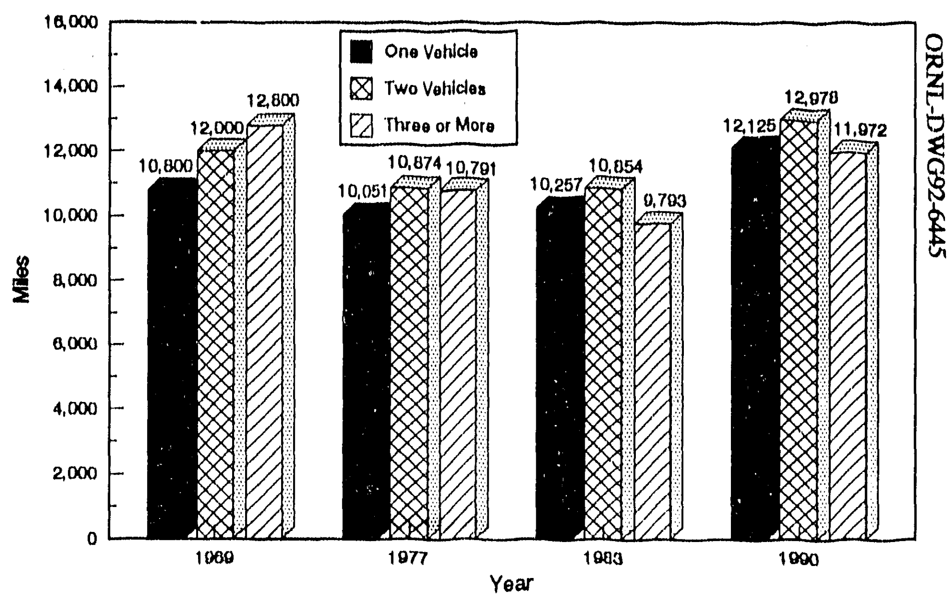
Table 4.17
Average Annual Miles per Vehicle by Number of Vehicles Owned
1969, 1977, 1983, and 1990 Series of the NPTS

Number of Vehicles	1969[a]	1977	1983	1990	Change 69-90[b]	Change 69-90[c]
One	10,800	10,051	10,257	12,125	0.6	12
Two	12,000	10,874	10,854	12,978	0.4	8
Three or more	12,800	10,791	9,793	11,972	-0.3	-6
TOTAL	11,600	10,679	10,315	12,458	0.3	7

[a]1969 survey includes autos, vanbus/minibus only.
[b]Compounded annual percentage change rate.
[c]Percentage change rate.

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

Figure 4.13. Average Annual Miles Per Vehicle by Number of Vehicles Owned 1969, 1977, 1983, and 1990 Series of the NPTS



Source: See Table 4.17.

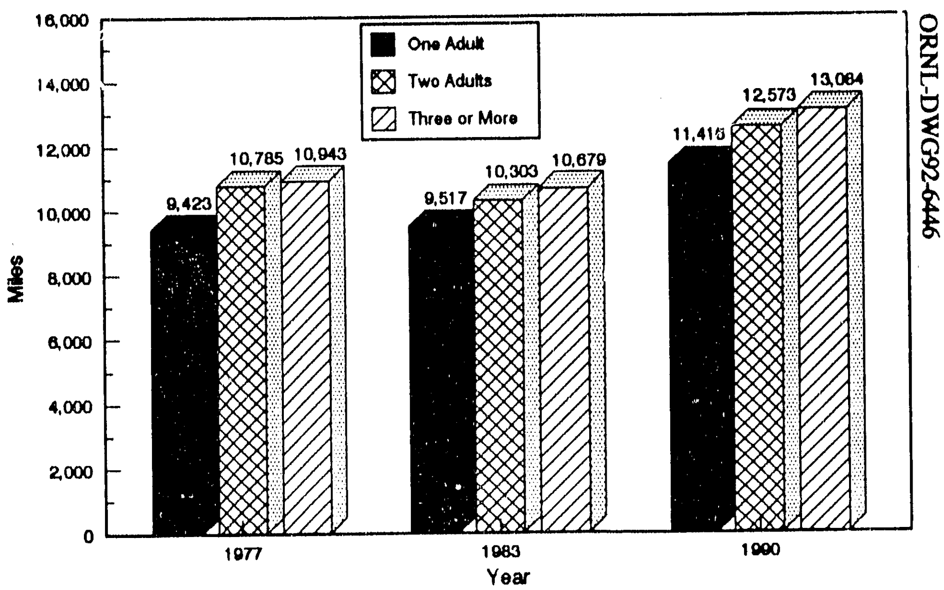
Table 4.18
Average Annual Miles Per Vehicle by Number of Adults in Household
1977, 1983, and 1990 Series of the NPTS

Number of Adults	1977	1983	1990	Change 77-90[a]	Change 77-90[b]
One	9,423	9,517	11,416	1.5	21
Two	10,785	10,303	12,573	1.2	17
Three or more	10,943	10,679	13,084	1.4	20
ALL	10,679	10,315	12,458	1.2	17

[a]Compounded annual percentage change rate.
[b]Percentage change rate.

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

Figure 4.14. Average Annual Miles Per Vehicle by Number of Adults in Household 1977, 1983, and 1990 Series of the NPTS



Source: See Table 4.18.

Although travel by males still accounts for a majority of the total travel, travel by females continues to increase. A significant jump in the share of travel by females was observed in the past 20 years - from 26.8% in 1969 to 35.4% in 1990. From 1983 to 1990, the share of travel by males, regardless of the age group, either remained relatively constant or decreased. In constrast, travel by females increased across all age groups, except for the 55 to 64 age group.

Table 4.19
Distribution of Annual Miles by Driver Age and Sex
1969, 1977, 1983, and 1990 Series of the NPTS
(percentage)

Age	1969	1977	1983	1990
		MALE		
16-19	3.1	3.2	2.0	2.0
20-34	27.0	29.7	28.6	24.3
35-54	30.1	27.2	27.0	27.1
55-64	9.3	8.5	9.3	6.8
65+	3.7	3.7	3.8	4.4
TOTAL	73.2	72.3	70.7	64.6
		FEMALE		
16-19	1.5	1.6	1.1	1.5
20-34	9.9	11.9	12.4	14.6
35-54	11.3	10.1	10.9	14.3
55-64	2.9	2.8	3.4	2.9
65+	1.2	1.3	1.5	2.1
TOTAL	26.8	27.7	29.3	35.4

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

As households owned more vehicles, the average annual miles for the most frequently driven vehicle increased. For example, the most frequently driven vehicle in five-vehicle households was driven 31% more per year than the one in two-vehicle households (20,300 miles vs. 15,500 miles).

Table 4.20
Average Annual Miles per Vehicle by Household Vehicle Ownership, 1990

Total number of vehicles owned by household	Vehicle[a]					All vehicles
	#1	#2	#3	#4	#5	
1	11,500	-	-	-	-	11,500
2	15,500	8,400	-	-	-	12,200
3	17,500	9,900	4,900	-	-	11,200
4	18,800	11,600	7,100	3,800	-	10,900
5	20,300	12,800	8,900	5,100	2,900	10,600

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

[a]Vehicles are ranked by descending annual miles driven.

CHAPTER 5

ALTERNATIVE FUELS STATISTICS

In 1990, the transportation sector alone consumed 21.4 quads of petroleum fuels, which accounted for 63.6% of total petroleum consumed in the United States. With the decrease in domestic oil production, the amount of imported crude oil and petroleum products has increased at an average rate of 9.4% per year since 1985. In 1990, 47% of the U.S. petroleum consumed was imported. With the transportation sector being the largest petroleum end-use sector, the nation's dependence on petroleum will have to be addressed by reducing the dependence of the transportation sector on petroleum fuels.

Conventional petroleum fuels in motor vehicles are among the major contributors to environmental pollution around the world. Typically, motor vehicles emissions account for 30-50% of urban hydrocarbon, 80-90% of carbon monoxide and 40-60% of nitrogen oxide emissions. Alternative fuels may offer the potential to reduce these pollutants significantly.

Because of increasing concerns about environmental pollution and the growing U.S. dependence on petroleum, the policy-makers began to search for ways of diversifying energy sources by switching from conventional to alternative fuels[a]. In 1988 the Alternative Motor Fuels Act (AMFA) was established to encourage the use of alternative fuels in the U.S. transportation sector. A synopsis of the AMFA follows, as well as information about the Alternative Fuels Data Center and the U.S. Advanced Battery Consortium. Also presented in this chapter are the characteristics of selected alternative fuels and statistics on the use of gasohol, a blend of gasoline and ethanol.

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[a]Information about the California emission standards is contained in Chapter 3, Section 3.7 **Vehicle Emissions.**

THE ALTERNATIVE MOTOR FUELS ACT OF 1988
PUBLIC LAW 100-494

The Alternative Motor Fuels Act (AMFA) is intended to:

- encourage the development and widespread use of methanol, ethanol, and natural gas as transportation fuels by consumers, and

- encourage the production of methanol, ethanol, and natural-gas-powered motor vehicles.

To meet its objectives, AMFA provides vehicle manufacturers with incentives to produce alternative fuel vehicles. The law also requires the demonstration and testing of alternative fuels in a variety of vehicles and calls for several studies to further understand alternative fuels. Government agencies participating in the program are: the U.S. Department of Energy (DOE), the General Services Administration (GSA), the U.S. Department of Transportation (DOT), and the U.S. Environmental Protection Agency (EPA), as well as other federal agencies, state and local governments, and industry.

Beginning in model year 1993, automotive manufacturers will have Corporate Average Fuel Economy (CAFE) incentives to produce alternative fuel vehicles. By assigning a high fuel economy value to alternative fuel vehicles, the manufacturers producing these vehicles will be provided with defined credits that will make it easier to meet CAFE standards. Incentives for federal agencies to acquire these vehicles through the GSA include allowing an agency to count only half the number of its alternative fuel vehicles against its total vehicle allocation.

The Department of Energy (DOE) is managing three demonstration and testing projects required by AMFA, including the following:

- a cooperative project with the GSA to procure alternative fuel passenger automobiles and light-duty trucks and place them into service in federal fleets;

- a heavy-duty truck project that will be conducted with commercial fleets; and

- testing of alternative fuel transit buses in support of the DOT Federal Transit Administration's Alternative Fuel Initiative program, and alternative fuel transit buses operated by state and local agencies.

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 objectives of the Center include:

- designing, implementing, and operating a computerized system for collection, storage, retrieval, and analysis of available data on alternative fuels utilization;

- establishing and disseminating a uniform data collection protocol for future fleet tests and demonstrations of alternative fuels;

- publishing reliable, unbiased, and accurate reports and data summaries

- providing easy access to data for external users in the scientific, industrial, and governmental communities; and

- expanding the scope of the data base to include other transportation fuel alternatives, such as a biofuels production database.

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. Many categories of data are collected, including;

- vehicle weekly log (mileage, driveability, startability, fuel consumption)
- emissions test data
- lubrication oil analysis
- fuel analysis reports (alcohol, gasoline, diesel, propane, natural gas)
- chassis dynamometer performance
- meteorological data
- maintenance reports
- environmental health and safety issues
- route characterization
- basic vehicle data
- basic powertrain data

Future editions of the Transportation Energy Data Book will present statistics generated by the AFDC.

U.S. ADVANCED BATTERY CONSORTIUM

Electric vehicles are being studied as one type of alternative fuel vehicle. One of the greatest advantages in using electric vehicles is that there are no vehicle emissions. The U.S. Advanced Battery Consortium (USABC) has been established to concentrate efforts on battery development for future electric vehicles.

The USABC consists of:

- Big Three U.S. Auto Manufacturers - Chrysler, Ford, General Motors
- Electric Power Research Institute
- Electric Utility Industry
- U.S. Department of Energy

The objectives of the consortium are:

- to develop the mid-term battery with production targeted for 1994; and
- to demonstrate design feasibility for the long-term battery in 1994

Key concepts:

- The formation of complete integrated teams, which might consist of the battery manufacturer and all key suppliers for each battery technology. Larger groups might also be established with a key developer coordinating the efforts of several manufacturers and their suppliers.

- Highly interactive technical coordination of each project by the assigned USABC Work Group. Frequent, informal interaction and discussion would be the normal mode of operation. Work Groups will be organized according to a specific battery technology or related technology. Membership will include technical personnel from Chrysler, Ford, General Motors, and participating electric utilities with advisors from the Department of Energy.

- Frequent and thorough evaluation of deliverable hardware to verify program progress and to ensure that problems are satisfactorily resolved as the program proceeds.

Table 5.1
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 W/kg (80% DoD/30 sec)	150 (200 desired)	400
Energy density Wh/L (C/3 discharge rate)	135	300
Specific energy Wh/kg (C/3 discharge rate)	80 (100 desired)	200
Life (years)	5	10
Cycle life (cycles) (80% DoD)	600	1000
Power and capacity degradation (% of rated spec)	20%	20%
Ultimate cost ($/kWh) (10,000 units @ 40 kWh)	<$150	<$100
Operating environment	-30 to 65° C	-40 to 85° C
Recharge time	<6 hours	3 to 6 hours
Continuous discharge in 1 hour (no failure) energy	75% (of rated energy capacity)	75% (of rated capacity)

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 5.2
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 5.3.
Reid Vapor Pressure of Various Alcohol/Ether/Gasoline Blends

% of Gasoline	% of Alcohol/Ether	Blending Agent			
		Ethanol	ETBE[a]	Methanol	MTBE[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, 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, p. 4-i.

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

Table 5.4.
Production of Methanol and Ethanol, 1978-1990
(million gallons)

Year	Ethanol	Methanol
1978	20	[a]
1979	40	1,111
1980	80	1,079
1981	85	1,294
1982	234	1,139
1983	443	1,204
1984	567	1,239
1985	793	760
1986	798	1,110
1987	825	1,108
1988	800	1,237
1989	750	1,085
1990	756	1,214
Average annual percentage change		
1978-90	35.3%	0.8%[b]
1982-90	15.8%	0.8%

Sources:
Ethanol - Information Resources, Inc., Washington, DC, 1991.
Methanol - EA-Mueller,Inc., Baltimore, MD, 1992.

[a]Data are not available
[b]Average annual percentage change is for years 1979-90.

As of April 1991, 11 states offered tax exemptions to encourage the use of gasohol for transportation purposes. Alaska offered the greatest exemption of eight cents per gallon, while Iowa and Connecticut both had the lowest exemption of one cent per gallon. Some states, such as Maine, Tennessee, Texas, and North Dakota, have discontinued the exemption of gasohol in recent years.

Table 5.5.
State Tax Exemptions for Gasohol
April 1991

State	Exemption (cents/gallon of gasohol)
Alaska	8.0
Connecticut	1.0
Idaho	4.0
Iowa	1.0
Minnesota	2.0
Nebraska	2.0
New Jersey	4.0
New Mexico	2.0
South Dakota	2.0
Washington	3.7
Wyoming	4.0

Source:
U.S. Department of Transportation, Federal Highway Administration, "Monthly Motor Fuel Reported by the States, March 1991," June 1991, Washington, DC, Table MF-121T.

Table 5.6
Gasohol Consumption by Reporting States, 1980-90[a]
(thousands of gallons)

	1980	1982	1984	1986	1987	1988	1989	1990[b]
Alabama		11,522	34,899	261,286	466,255	416,308	195,725	197,856
Alaska				171	381	215	12	
Arizona	2,798	5,096						
Arkansas	8,250	8,462	28,871					
California	147,795	464,004	401,837	189,046	252,702	489,235	369,185	479,716
Colorado	3	23,990	82,233	70,462	21,400	50,707	70,522	97,263
Connecticut	15,849	4,461	5,421	5,323				
Delaware	1,512							
DC	124	34	84	205	328	446	333	
Florida	14,359	103,053	508,751	334,041	139,616	76,312	77,657	77,558
Georgia	11,063	148	18			6,291	30,265	88,672
Hawaii	1,095	368						
Idaho		2,464	8,067	22,016	24,207	45,012	64,830	70,199
Illinois	15,088	251,200	562,036	1,286,828	1,341,009	1,406,620	1,278,517	1,341,148
Indiana		120,569	587,396	668,638	685,814	651,544	610,320	
Iowa	155,947	498,636	457,125	385,130	397,029	402,844	385,991	374,897
Kansas	37,786	7,448	273,077	232,604	139,831	120,763	98,844	73,971
Kentucky	4,763	18,872	328,238	736,349	757,390	656,845	403,859	355,987
Louisiana			24,424	336,187	252,975	79,635	52,698	38,760
Maine	2,634							
Maryland	18,549	107	82	501				
Massachusetts	16,209	290						
Michigan	29,924	206,794	577,723	382,010	482,896	499,565	402,714	510,447
Minnesota	11,776	4,653	2,707	374,032	214,005	171,929	170,499	244,336
Missouri		9,000	13,860	14,316	21,912	134,832	157,056	245,436
Montana	158	10,170	10,181	3,454	2,451	257	80	1,423
Nebraska	30,067	89,698	208,455	216,356	241,984	258,073	271,082	300,632
Nevada	641	964		18,650	58,877	56,716	37,342	49,167
New Hampshire	3,642							
New Jersey	6,567							
New Mexico		1,082	63,756	58,752	99,310	147,656	171,297	156,935
N. Carolina	10,688	7,456	34,037					
N. Dakota	13,491	6,499	5,469	65,327	62,726	44,317	37,966	35,821
Ohio	16,726	91,679	495,595	814,579	891,110	981,874	929,379	1,045,418
Oklahoma	28,910	155,053	23,620	26,994	56,524			
Oregon		2,073	296					
Rhode Island	1,763	22						
S. Carolina	11,608	59,688	154	15,550	37,647	102,333	82,454	62,549
S. Dakota	10,507	13,808	41,343	63,484	59,157	58,150	56,524	60,000
Tennessee			264,167	394,469	524,300	580,227	373,391	246,713
Texas		38,142	207,152	362,243	454,502	341,682	216,607	247,384
Utah		500	26,358	2,409	226	358	427	485
Virginia	1,991	30,834	131,618	423,709	310,274	282,181	251,793	161,202
Washington	14,063	7,230	9,143	26,797	53,840	54,519	64,169	86,847
W. Virginia	692							
Wisconsin		2,718	1,962	15,312	10,238	20,175	47,620	82,961
Wyoming	611	259	309	55	50	62	2,668	2,899
Total	**497,222**	**2,259,046**	**5,420,464**	**7,807,285**	**8,004,442**	**8,137,683**	**6,911,871**	**6,736,682 [b]**

Sources:

1980-1989: U.S. Department of Transportation, Federal Highway Administration, Highway Statistics 1989, Washington, DC, 1989, Table MF-33GLA, p. 11, and annual.

1990: U.S. Department of Transportation, Federal Highway Administration, "Monthly Motor Fuel Reported by States, May 1991," Washington, DC, August 1991, Table MF-33GLA.

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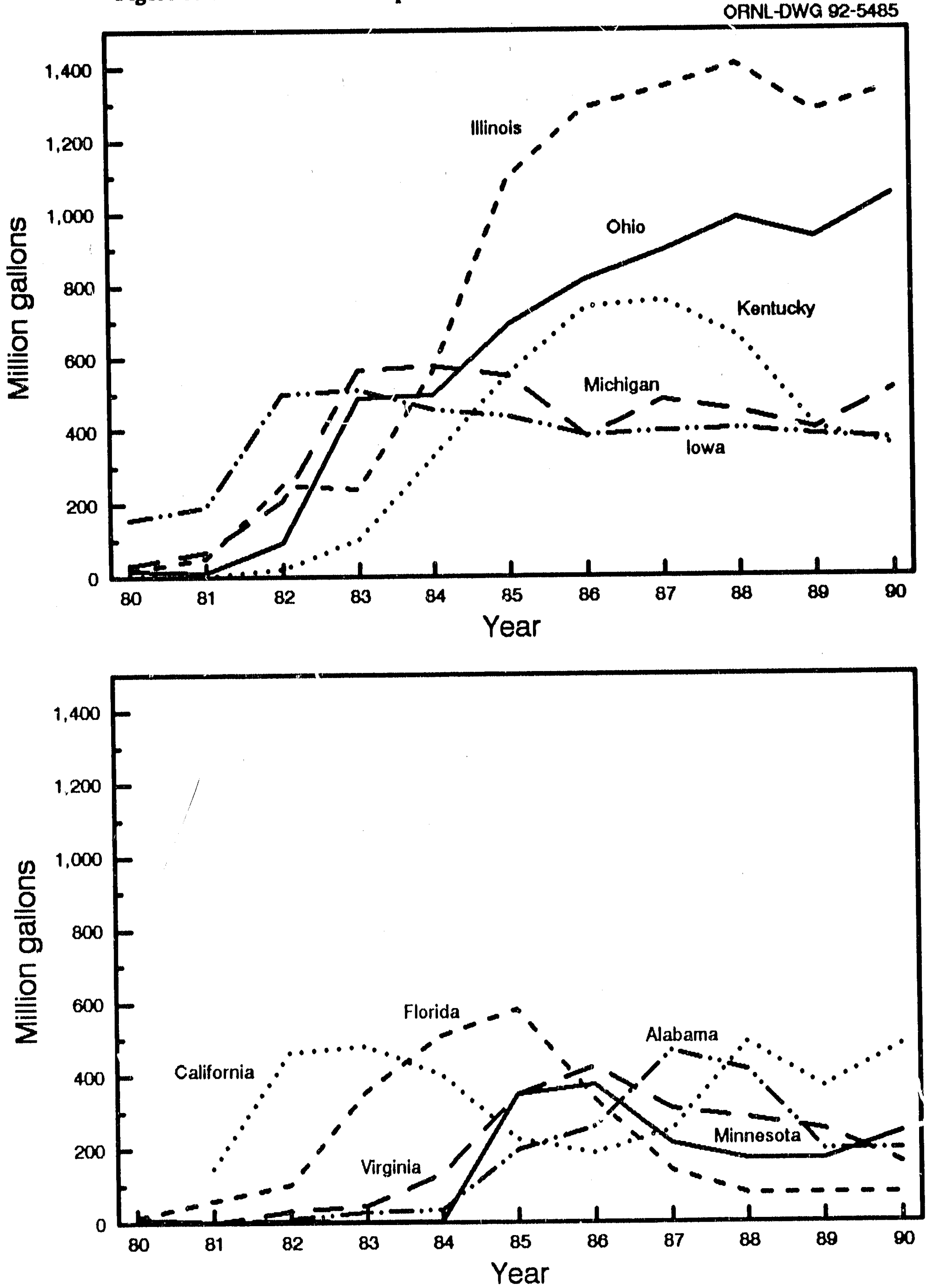
[a]The data reflect gallons of gasohol reported by the distributors in each of the selected states. Blanks indicate data were not reported for the state that year.

[b]Preliminary data.

Figure 5.1. Gasohol Consumption of Selected States, 1980-90



Source: See Table 5.6.

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 1989 (Table 6.1). Air transportation still accounted for the largest share (42%) 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; pipeline data in Section 6.3; and rail data in Section 6.4.

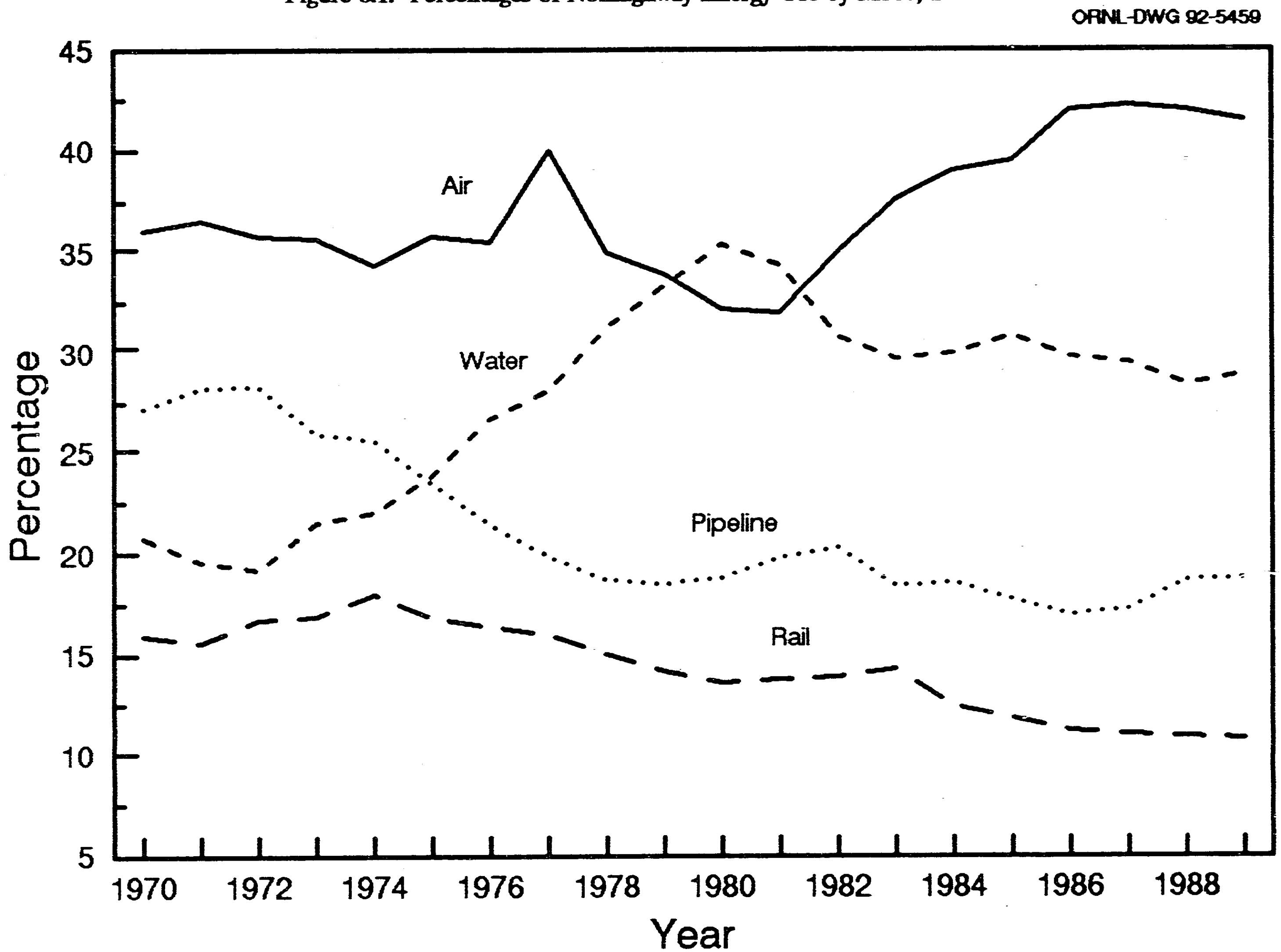
Table 6.1
Nonhighway Energy Use by Mode, 1970-89[a]
(trillion Btu)

Year	Air	Water	Pipeline	Rail	Nonhighway energy use	Transportation energy use[b]
1970	1,307 (8.5%)	753 (4.9%)	985 (6.4%)	575 (3.8%)	3,620 (23.7%)	15,305
1971	1,304 (8.2%)	698 (4.4%)	1,007 (6.3%)	556 (3.5%)	3,565 (22.4%)	15,907
1972	1,314 (7.8%)	703 (4.1%)	1,039 (6.1%)	614 (3.6%)	3,670 (21.7%)	16,949
1973	1,377 (7.7%)	827 (4.6%)	996 (5.6%)	652 (3.7%)	3,852 (21.6%)	17,813
1974	1,254 (7.3%)	804 (4.7%)	932 (5.5%)	657 (3.8%)	3,647 (21.3%)	17,088
1975	1,274 (7.4%)	851 (4.9%)	835 (4.8%)	596 (3.4%)	3,556 (20.5%)	17,329
1976	1,333 (7.2%)	1,001 (5.4%)	803 (4.4%)	617 (3.4%)	3,754 (20.4%)	18,389
1977	1,411 (7.4%)	1,103 (5.8%)	781 (4.1%)	627 (3.3%)	3,922 (20.6%)	19,071
1978	1,467 (7.3%)	1,311 (6.5%)	781 (3.9%)	628 (3.1%)	4,187 (20.9%)	20,035
1979	1,568 (7.8%)	1,539 (7.7%)	856 (4.3%)	656 (3.3%)	4,619 (23.0%)	20,101
1980	1,528 (7.9%)	1,677 (8.7%)	889 (4.6%)	645 (3.3%)	4,739 (24.5%)	19,317
1981	1,455 (7.6%)	1,562 (8.2%)	899 (4.7%)	627 (3.3%)	4,543 (23.8%)	19,065
1982	1,468 (7.9%)	1,290 (6.9%)	853 (4.6%)	581 (3.1%)	4,192 (22.6%)	18,589
1983	1,505 (8.0%)	1,187 (6.3%)	738 (3.9%)	574 (3.1%)	4,004 (21.4%)	18,728
1984	1,633 (8.5%)	1,252 (6.5%)	780 (4.0%)	520 (2.7%)	4,185 (21.7%)	19,310
1985	1,678 (8.5%)	1,311 (6.7%)	758 (3.9%)	501 (2.5%)	4,248 (21.6%)	19,659
1986	1,823 (9.0%)	1,295 (6.4%)	738 (3.6%)	487 (2.4%)	4,343 (21.5%)	20,229
1987	1,894 (9.2%)	1,326 (6.4%)	775 (3.7%)	496 (2.4%)	4,491 (21.7%)	20,704
1988	1,978 (9.3%)	1,338 (6.3%)	878 (4.1%)	512 (2.4%)	4,706 (22.1%)	21,278
1989	1,981 (9.2%)	1,376 (6.4%)	895 (4.1%)	516 (2.4%)	4,768 (22.1%)	21,598

Source:
See Appendix A for Table 2.10.

[a]Numbers in parentheses are percentages of transportation energy use.
[b]Does not include off-highway and military transportation energy use.

Figure 6.1. Percentages of Nonhighway Energy Use by Mode, 1970-89



Source: See Table 6.1.

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 the one by the air carrier fleet, 6.8% and 93.2%, respectively (Tables 6.2 and 6.4).

More passengers and cargo traveled by certificated route air carrier in 1989 than ever before. While aircraft miles increased by 2% from 1988 to 1989, revenue passenger-miles and revenue cargo ton-miles increased by 2.2% and 11.6%, respectively. The movement of cargo by air carriers has been rapidly growing, evidenced by the average annual increase of 11.1% from 1982 to 1989. The passenger load factor increased to a high of 63.3% in 1989, which was in part due to a decline in the number of available seats per aircraft. The average passenger trip length for scheduled domestic services continued to grow in 1989 to 792 miles (Table 6.2).

Air carriers are classified based on operating revenues for the purposes of statistical and financial reporting and analysis. The classifications, which were updated in January 1984, are:

Carrier Group	**Operating Revenue (millions of dollars)**
Major	Over $1,000
National	$100 - 1,000
Large regional	$10 - 99.9
Medium regional	$0 - 9.99

International[a] certificated route air carriers have more than doubled their revenue aircraft miles, revenue passenger-miles, available seat miles, and revenue cargo ton-miles from 1982 to 1989. The energy use for international air carriers has not quite doubled in this time period due to increased aircraft efficiency. The domestic carriers also experienced an increase in all types of activity from 1982 to 1989, but not as great an increase as the international air carriers (Table 6.3).

Due to the increased efficiency of general aviation aircraft, their energy use declined in 1989 (9.8%) even though the number of aircraft and the hours flown increased 4.5% and 4.2%, respectively, from 1988 to 1989 (Table 6.4).

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[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), 1970-89[a]

Year	Number of aircraft	Revenue aircraft miles (millions)	Average passenger trip length[b] (miles)	Revenue passenger-miles (millions)	Available seat-miles (millions)	Available seats per aircraft[c]	Passenger load factor (percentage)[d]	Revenue cargo ton-miles (millions)	Energy use (trillion Btu)[e]
1970	2,437	2,383	678	131,719[f]	264,904[f]	111	49.7[f]	4,994	1,363.4
1971	2,389	2,344	681	135,658[f]	279,823[f]	119	48.5[f]	5,120	1,370.5
1972	2,361	2,337	685	152,406[f]	287,411[f]	122	53.0[f]	5,506	1,374.3
1973	2,361	2,402	689	174,352	322,992	129	54.0	6,046	1,444.5
1974	2,237	2,351	684	174,052	310,130	126	56.1	6,133	1,289.8
1975	2,261	2,241	698	173,324	315,823	135	54.9	5,944	1,283.4
1976	2,261	2,320	704	191,823	338,349	139	56.7	6,222	1,324.1
1977	2,254	2,418	704	206,082	361,172	143	57.1	6,587	1,386.2
1978	2,346	2,608	719	236,998	381,113	147	62.2	7,395	1,436.3
1979	2,466	2,859	714	269,719	425,411	146	63.4	7,580	1,534.8
1980	2,425	2,924	736	267,722	448,479	148	59.7	7,515	1,489.6
1981	2,523	2,703	749	260,063	438,778	157	59.3	7,917	1,429.3
1982	2,468	2,804	766	272,435	455,938	157	59.8	7,807	1,406.6
1983	2,618	2,923	765	295,144	480,977	159	61.4	8,497	1,439.2
1984	2,692	3,264	759	319,504	534,104	164	59.8	9,328	1,607.4
1985	2,860	3,462	758	351,073	565,677	163	62.1	9,048	1,701.5
1986	g	3,873	767	378,923	623,073	161	60.8	10,987	1,847.1
1987	g	4,182	779	417,830	670,871	160	62.3	13,130	1,945.4
1988	g	4,355	786	437,649	696,337	160	62.9	14,633	2,049.4
1989	g	4,441	792	447,403	703,788	158	63.6	16,333	2,087.4
				Average annual percentage change					
1970-89	1.1%[h]	3.3%	0.8%	6.6%	5.3%	1.9%		6.4%	2.3%
1982-89	5.0%[h]	6.8%	0.5%	7.3%	6.4%	0.1%		11.1%	5.8%

Sources:

U.S. Department of Transportation, Federal Aviation Administration, FAA Statistical Handbook of Aviation, 1989 Edition, Washington, DC, 1991, pp. 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.

1982-89 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]These figures differ slightly from the 1989 figures on Table 6.3 as a result of different sources for data.

[b]Scheduled services of domestic operations only. The average passenger trip length for international operations is approximately three times longer than for domestic operations.

[c]Available seats per aircraft is calculated as the ratio of available seat-miles to revenue aircraft miles.

[d]Passenger load factor is calculated as the ratio of revenue passenger miles to available seat miles for scheduled and nonscheduled services.

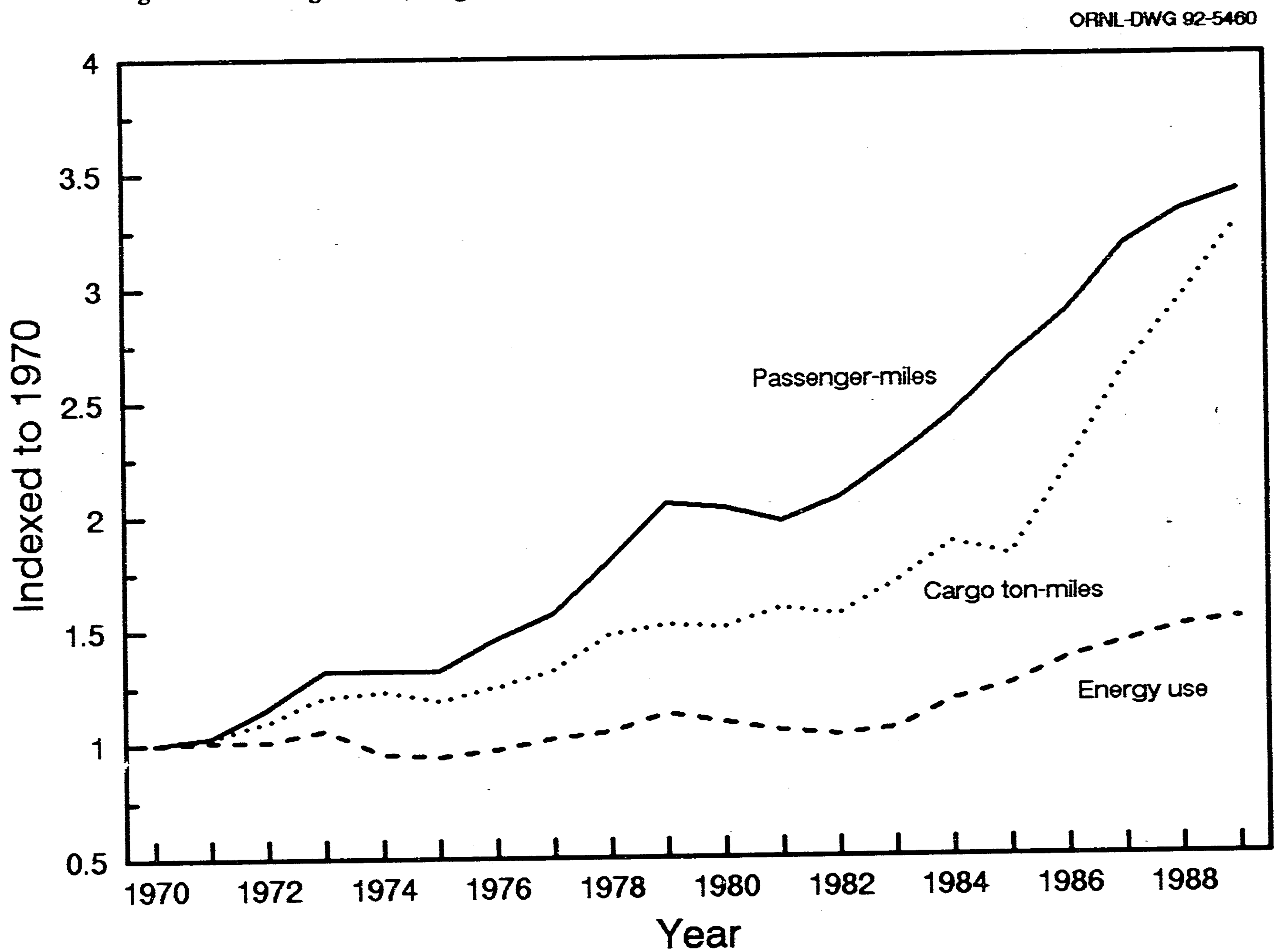
[e]Energy use includes fuel purchased abroad for international flights.

[f]Scheduled services only.

[g]The Federal Aviation Administration has discontinued the publication of these estimates. No comparable data are available.

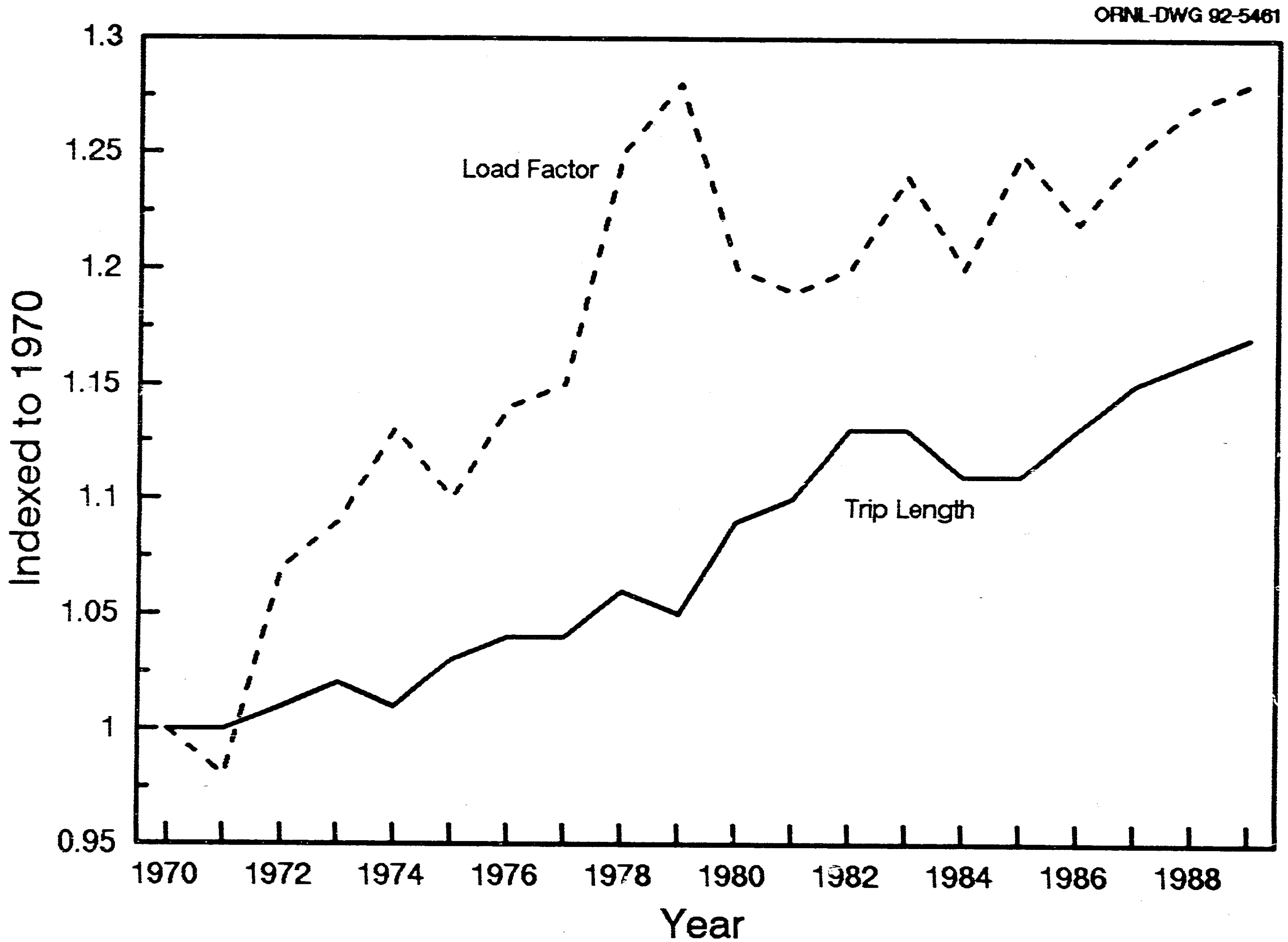
[h]Average annual percentage change is for year 1970-85 and 1982-85.

Figure 6.2. Passenger-Miles, Cargo Ton-Miles, and Energy Use for Certificated Route Air Carriers, 1970-89



Source: See Table 6.2.

Figure 6.3. Average Trip Length and Load Factor for Certificated Route Air Carriers, 1970-89



Source: See Table 6.2.

While the revenue passenger-miles for major air carriers increased by 96% from 1982 to 1989, the national and regional air carriers experienced declines in passenger-miles of 37% and 50%, respectively. However, revenue cargo ton-miles for regionals in 1989 was more than five times the 1982 figure.

Table 6.3
Traffic Data for Large Certificated Route Air Carriers By Carrier Group, Scheduled and Nonscheduled Services, 1982 and 1990[a]

	Revenue aircraft miles[b] (millions)		Revenue passenger-miles (millions)		Available seat miles[b] (millions)		Revenue passenger load factor[c] (percentage)		Revenue cargo ton-miles[d] (millions)		Energy use (trillion Btu)	
	1982	1990	1982	1990	1982	1990	1982	1990	1982	1990	1982	1990
Carrier Group[e]												
Majors	2,183	4,214	227,379	445,376	384,279	710,048	59.2	62.6	4,983	12,382	1,167.6	f
Nationals	448	386	36,582	22,986	57,845	37,446	63.2	58.0	2,480	2,402	198.6	f
Regionals[g]	158	125	7,532	3,793	12,181	5,619	63.0[h]	55.3[h]	303	1,711	37.8	f
Total Air Carriers	**2,789**	**4,725**	**271,493**	**472,155**	**454,305**	**753,112**	**59.0**	**62.4**	**7,766**	**16,495**	**1,404.0**	**2,191.3**
Domestic	2,430	3,964	213,003	345,763	363,106	570,387	51.7	60.4	4,459	9,129	1,138.4	1663.6
International	359	761	58.490	126,392	91,199	182,724	61.4	69.1	3,307	7,366	265.6	527.7

Sources:
1982 - Civil Aeronautics Board, Air Carrier Traffic Statistics, Washington, D.C., December 1982.
1990 - U.S. Department of Transportation, Transportation Systems Center, Air Carrier Traffic Statistics Monthly, December 1989/90 and Twelve Months Ending December 31, Cambridge, MA, 1991, pp.1, 2, 3, 60, 98, 165.
Energy Use - 1982: Fuel Cost and Consumption, Twelve Months Ended December 31, 1982 and 1981, Washington, D.C., 1983.
1990 - 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]The data presented in this table represent all international carrier operations, and domestic air carriers that hold a Section 401 certificate and operate aircraft designed to have a maximum passenger capacity of more than 60 or a maximum payload capacity of more than 18,000 pounds.

[b]Calculated as the sum of scheduled and nonscheduled services.

[c]Load factor applies to scheduled services only.

[d]Cargo includes freight, express, and mail shipments.

[e]Large certificated air carriers are classified according to their total annual operating revenue as listed:
Majors - $1,000,000,000 and up; Nationals - $100,000,000 to $999,999,999; Large Regionals - $10,000,000 to $99,999,999; Medium Regionals - $0 to $9,999,999.

[f]Data are not available.

[g]Calculated as the sum of Large Regionals and Medium Regionals.

[h]Load factor was calculated as the sum of Large and Medium Regionals' scheduled revenue passenger miles divided by the sum of Large and Medium Regionals' scheduled available seat miles.

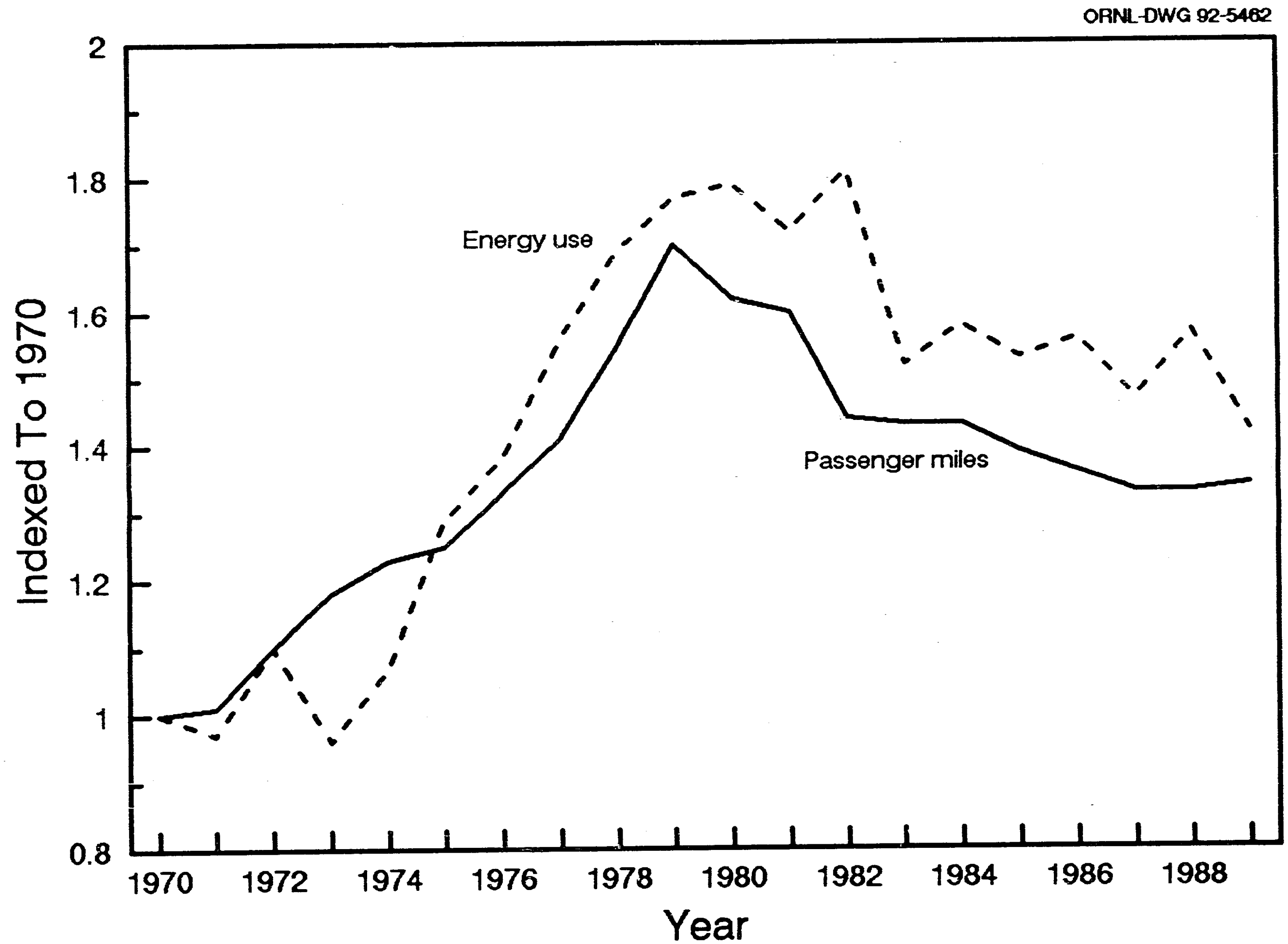
Table 6.4
Summary Statistics for General Aviation, 1970-89

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	12.1	148.6
1989	88.2	2.9	2.0	3.4	3.5	219,737	35,012	12.2	134.0
						Average Annual Percentage Change			
1970-89						2.7%	1.6%	1.6%	1.9%
1982-89						0.7%	-0.6%	-1.0%	-3.4%

Sources:
Aircraft and hours flown - U.S. Department of Transportation, Federal Aviation Administration, FAA Statistical Handbook of Aviation, Calendar Year 1989, Washington, DC, 1991, pp. 8-4, 8-6, and annual.
Intercity passenger miles - Eno Foundation for Transportation, Transportation in America, 8th edition, Washington, DC, December 1990 Supplement, p.7.
Energy use - U.S. Department of Transportation, Federal Aviation Administration, General Aviation Activity and Avionics Survey: Calendar Year 1989, Table 5.1, p. 5-6.

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

Figure 6.4. Passenger-Miles and Energy Use in General Aviation, 1970-89



Source: See Table 6.4.

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 since 1986, domestic traffic still accounted for more than half of the total tons shipped in waterborne commerce. The combined foreign and domestic tonnage in 1989 reached a record high of 2,140 million tons (Table 6.5).

The average length of haul for domestic waterborne commerce dropped in 1989 to its lowest point since 1977. This decline in average length of haul, together with a decline in tons shipped in 1989, resulted in a 8.3% decline in ton-miles. Despite these declines, energy use for domestic waterborne commerce rose 2.3% from 1988 to 1989 (Table 6.6).

The commodities most often moved by domestic commerce in 1989 were petroleum and products (41.8%) and coal and coke (19.2%). The longest average haul per ton for total domestic commerce in 1989 was grain, which had an average of 1,072 miles (Table 6.7).

Over 1 billion tons were shipped in international waterborne commerce in 1989. Domestic commerce accounted for 51.5% of total tonnage, which is only 0.5% above the lowest domestic share in 1977.

Table 6.5
Tonnage Statistics for Domestic and International Waterborne Commerce, 1970-89
(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	1,513	566	947	62.6%
1972	1,617	630	987	61.0%
1973	1,761	767	994	56.4%
1974	1,747	764	983	56.3%
1975	1,695	749	946	55.8%
1976	1,835	856	979	53.4%
1977	1,908	935	973	51.0%
1978	2,021	946	1,075	53.2%
1979	2,073	993	1,080	52.1%
1980	1,999	921	1,078	53.9%
1981	1,942	887	1,055	54.3%
1982	1,777	820	957	53.9%
1983	1,708	751	957	56.0%
1984	1,836	803	1,033	56.3%
1985	1,788	774	1,014	56.7%
1986	1,874	837	1,037	55.3%
1987	1,967	891	1,076	54.7%
1988	2,088	976	1,112	53.3%
1989	2,140	1,038	1,103	51.5%
	Average annual percentage change			
1970-89	1.8%	3.1%	0.8%	
1982-89	2.7%	3.4%	2.0%	

Source:
U.S. Department of the Army, Corps of Engineers, Waterborne Commerce of the United States, Calendar Year 1989, Part 5: National Summaries, New Orleans, LA, 1991, p. 5.

[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 dropped in 1989 to its lowest point since 1977. Although the tons shipped and ton-miles also declined in 1989, the number of vessels and energy use increased slightly from 1988 to 1989.

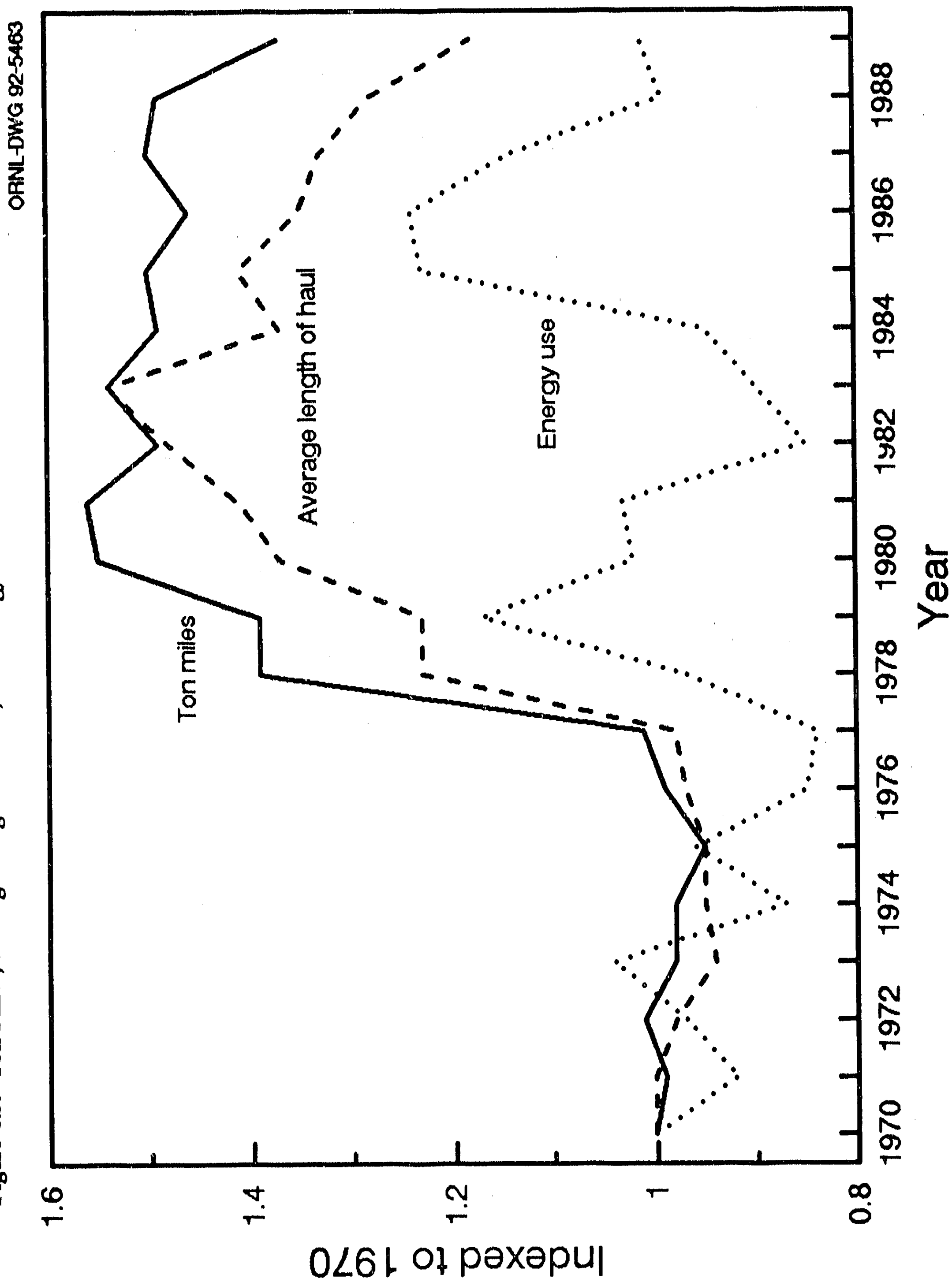
Table 6.6
Summary Statistics for Domestic Waterborne Commerce, 1970-89

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
			Average annual percentage change			
1970-89	2.2%	1.7%	0.8%	0.9%	-1.6%	0.1%
1982-89	-1.0%	-1.2%	2.0%	-3.1%	3.8%	2.6%

Sources:
1970-88 Number of vessels - Personal communication with the U.S. Department of the Army, Corps of Engineers, New Orleans, LA, 1988.
1989 Number of vessels - U.S. Department of the Army, Corps of Engineers, Waterborne Transportation Lines of the United States, 1989, New Orleans, LA, 1991.
1970-89 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 1989, Part 5: National Summaries, New Orleans, LA, 1991, p. 89, 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.

Figure 6.5. Ton-Miles, Average Length of Haul, and Energy Use for Domestic Waterborne Commerce, 1970-89



Source: See Table 6.6.

Petroleum accounted for over 40% of all domestic marine cargo in 1989. The majority of the petroleum was shipped coastwise (53%) and internal and local (46%). Barge traffic accounted for 94% of all internal and local waterborne commerce.

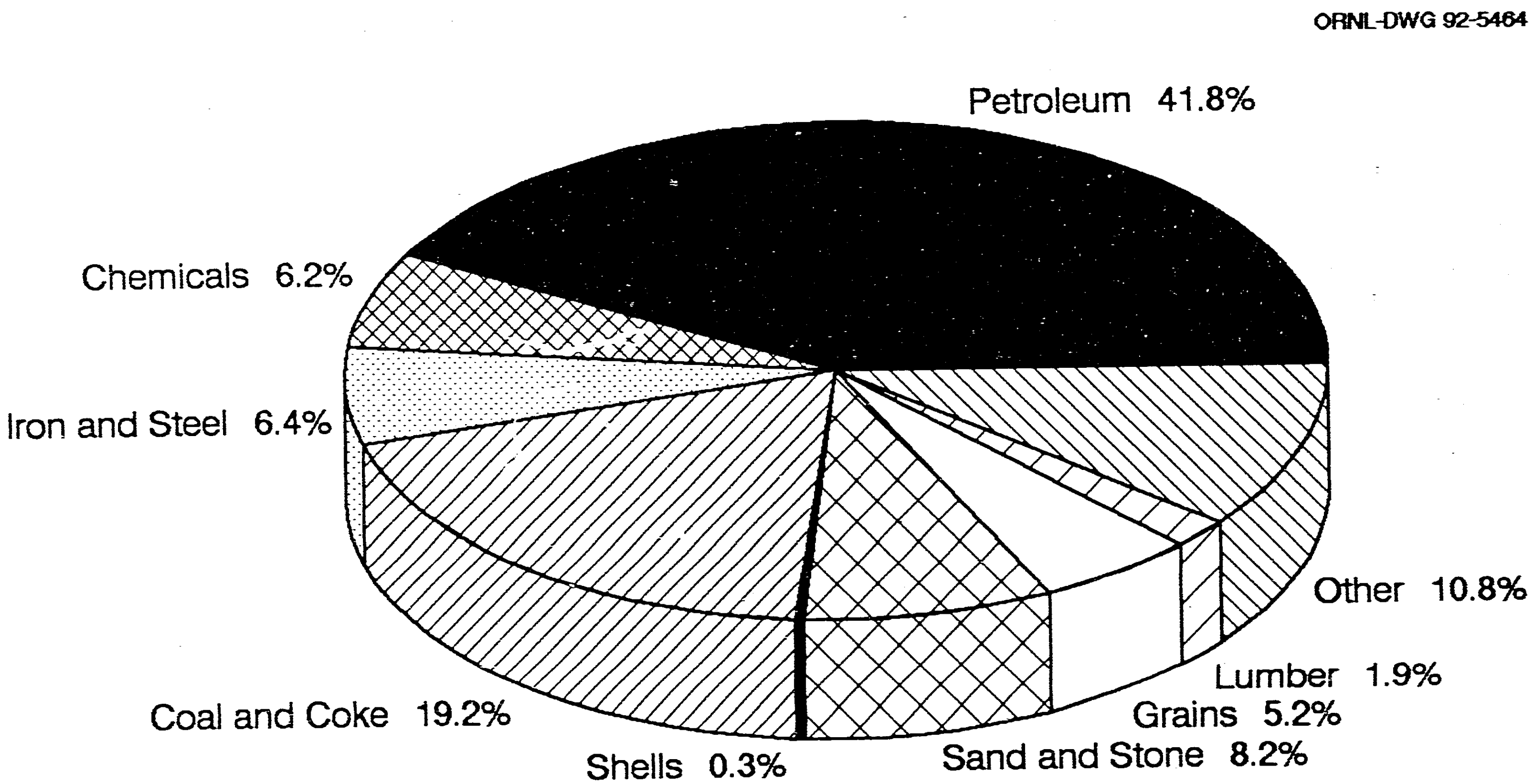
Table 6.7
Breakdown of Domestic Marine Cargo by Commodity Class, 1989

Commodity class	Coastwise[a] Tons shipped (millions)	Coastwise[a] Average haul per ton (miles)	Lakewise[b] Tons shipped (millions)	Lakewise[b] Average haul per ton (miles)	Internal and local[c] Tons shipped (millions)	Internal and local[c] Average haul per ton (miles)	Total domestic Tons shipped (millions)	Total domestic Percentage	Total domestic Average haul per ton (miles)
Petroleum and products	245	1,733	2	234	211	192	459	41.8	1,016
Chemicals and related products	15	1,333	[d]	268	52	592	68	6.2	760
Iron, iron ore, and steel	[d]	1,431	57	643	13	914	70	6.4	699
Coal and coke	13	533	19	552	179	432	211	19.2	450
Sand, gravel, and stone	3	142	24	325	64	145	90	8.2	192
Shells	[d]	1,572	[d]	[d]	3	112	3	0.3	107
Grains	1	1,623	1	977	55	1,078	57	5.2	1,072
Logs and lumber	2	1,410	[d]	61	19	95	21	1.9	197
All others	23	1,199	6	326	90	468	119	10.8	602
Total	302	1,602	109	535.0	686	399	1,097	100.0	743
Barge traffic (million tons)	89.9		3.9		644.8		743.2		
Percentage by barge	29.8%		3.6%		94.0%		67.7%		

Source:
U.S. Department of the Army, Corps of Engineers, Waterborne Commerce of the United States, Calendar Year 1989, Part 5: National Summaries, New Orleans, LA, 1991, pp. 32, 93.

[a]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.
[b]Applies to traffic between United States ports on the Great Lakes.
[c]Internal applies to traffic between ports or landing wherein the entire movement takes place on inland waterways. Locr' applies to movements of freight within the confines of a port.
[d]Negligible.

Figure 6.6. Breakdown of Domestic Marine Cargo by Commodity Class, 1989



Source: See Table 6.7.

Section 6.3. Pipeline

Pipeline shipments of natural gas, which were at the lowest point in 1986, continued to rise in 1989. The distance of petroleum transport by pipeline had increased only slightly in 1988 as evidenced by a 1% decrease in tons of petroleum transported and a 2% decrease in ton-miles. The movement of crude petroleum (ton-miles) also declined in 1989, while the movement of refined petroleum products stayed approximately the same.

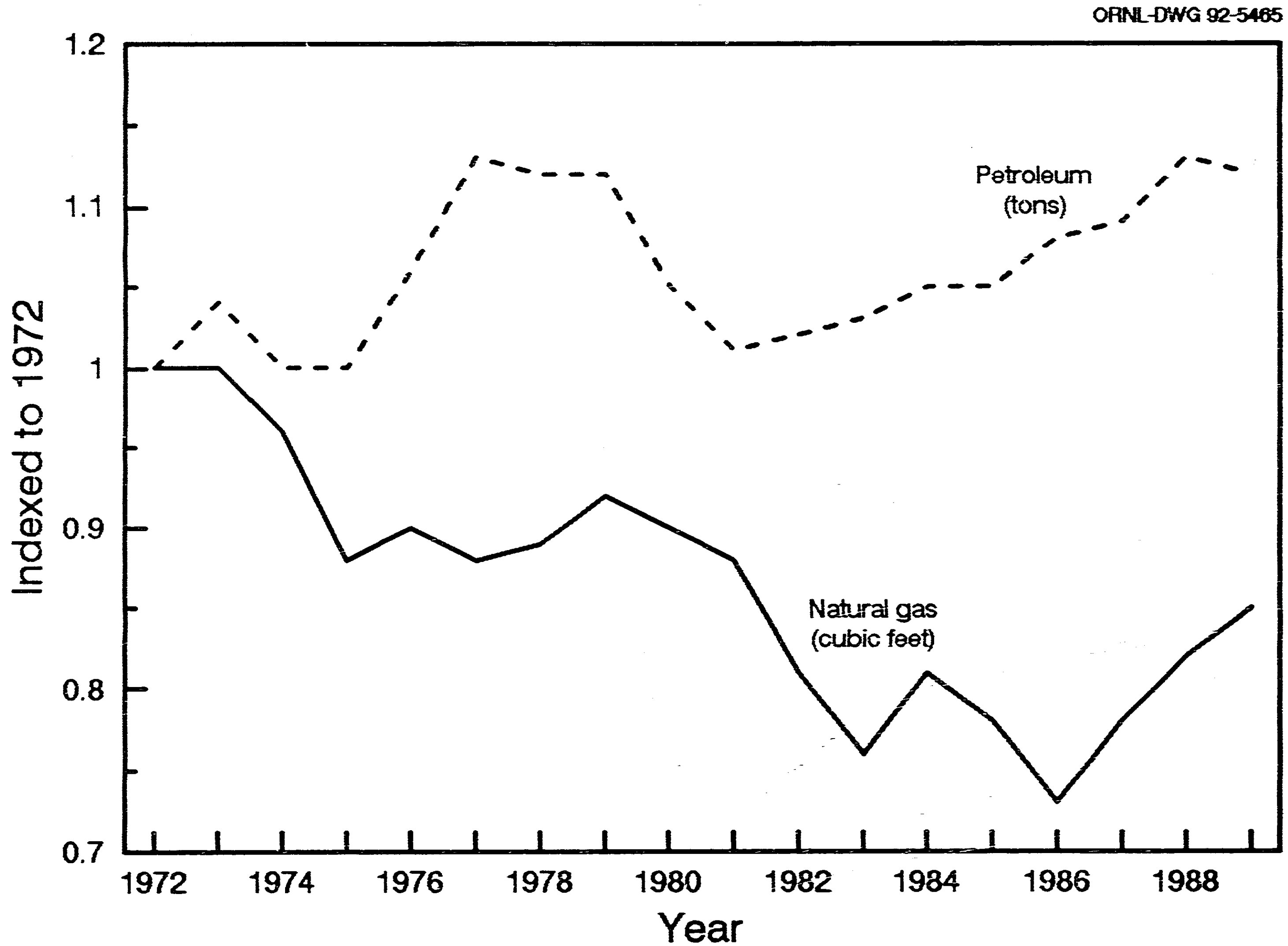
Table 6.8
Pipeline Shipments of Energy, 1972-89

Year	Domestic natural gas consumption[a] (billion cubic feet)	Total petroleum transported (million tons)	Total petroleum transported (billion ton-miles)	Crude petroleum (billion ton-miles)	Refined petroleum products (billion ton-miles)	Energy use[b] (trillion Btu)
1972	22,100	876	476	285	191	985.3
1973	22,049	912	507	302	205	942.2
1974	21,223	879	506	303	203	877.9
1975	19,538	879	507	288	219	781.2
1976	19,946	934	515	303	212	749.0
1977	19,521	986	546	327	219	727.5
1978	19,627	982	586	360	226	680.0
1979	20,241	978	608	372	236	793.4
1980	19,877	921	588	363	226	838.5
1981	19,404	886	564	333	231	848.1
1982	18,001	897	566	335	231	798.8
1983	16,835	899	556	332	224	684.6
1984	17,951	917	568	333	235	726.2
1985	17,281	918	564	334	230	704.7
1986	16,221	949	578	335	243	684.1
1987	17,211	961	587	342	245	721.3
1988	18,030	989	607	356	251	824.0
1989	18,780	979	595	346	250	841.6
			Average annual percentage change			
1972-89	-1.0%	0.7%	1.3%	1.1%	1.6%	-0.9%
1982-89	0.6%	1.3%	0.7%	0.5%	1.1%	0.7%

Sources:
Natural gas consumption - U.S. Department of Energy, Energy Information Administration, Natural Gas Annual 1989, Washington, DC, September 1990, p. 2, and annual.
Petroleum transport, crude petroleum, and refined petroleum products - Transportation Policy Associates, Transportation in America, Eighth edition, Washington, DC, December 1990 Supplement, pp. 6, 10.
Energy use - See Appendix A for Table 2.7.

[a]Natural gas consumption is the best available indicator for the amount of natural gas transported by pipeline.
[b]Represents energy use for natural gas, crude petroleum, and refined petroleum pipelines.

Figure 6.7. Natural Gas and Petroleum Shipped by Pipeline, 1972-89



Source: See Table 6.8.

Section 6.4. Railroad

There were 15 railroad systems in 1989 which were designated by the Interstate Commerce Commission (ICC) as Class I freight railroads (Table 6.9). This designation was assigned on the basis of annual gross revenue of the railroad. A railroad whose revenues were 92 million dollars or more in 1988 was designated as a Class I railroad in 1989. The threshold for 1989 was set at 93.5 million dollars. The Class I designation is dropped if the railroad fails to meet the annual earnings threshold for three consecutive years.

The revenue ton-miles for Class I freight railroads rose to over 1 trillion ton-miles in 1989, due in part to the jump in average length of haul from 697 miles in 1988 to 723 miles in 1989. Although train-miles increased from 1988 to 1989, there were fewer cars attached to each train resulting in (1) a slight decline in car-miles in 1989, and (2) an energy use increase of only 0.1% from 1988 to 1989. The number of Class I railroad locomotives and freight cars have continued to decline since 1980.

The railroad freight industry experienced a 20.7% drop in its revenue carloadings from 1974 to 1989. Over the past 15 years, coal has not only remained the major commodity being hauled by the railroads, but its share of revenue carloads has also increased by 24.8% from 1974 to 1989. The largest decline, on the other hand, has been for metallic ores, which have dropped 72.6% during the period (Table 6.11).

Although the National Railroad Passenger Corporation (Amtrak) has reduced the number of locomotives and passenger cars in service in 1989, train-miles, car-miles, and revenue passenger-miles continue their upward trend. The average trip length increased by 9 miles in 1989 to 274 miles. As a result of the increased activity, energy use increased by 14.2% from 1988 to 1989 (Table 6.12).

Rail transit operations experienced increases in vehicle miles and passenger trips in 1989 which resulted in passenger-miles reaching 12 billion for the first time since 1970. Energy use increased only slightly from 1988 to 1989, possibly due to improvement in transit rail efficiency (Table 6.13).

Table 6.9
Class I Railroad Freight Systems in the United States
Ranked by Revenue Ton-Miles, 1989

Railroad	Revenue ton-miles (millions)	Percent
Burlington Northern Railroad Company	232,527	22.9
Union Pacific Railroad	183,042	18.1
CSX Transportation, Incorporation	146,927	14.5
Norfolk Southern Corporation	100,111	9.9
Atchison, Topeka and Santa Fe Railway	82,742	8.2
Consolidated Rail Corporation (Conrail)	82,125	8.1
Southern Pacific Transportation Company	69,382	6.8
Chicago and North Western Transportation Company	27,510	2.7
Soo Line Railroad	20,492	2.0
Illinois Central Railroad	17,311	1.7
St. Louis Southwestern Railway Company	17,026	1.7
Denver and Rio Grande Western Railroad	13,209	1.3
Kansas City Southern Railway	11,591	1.1
Grand Trunk Corporation	5,237	0.5
Florida East Coast Railway	4,609	0.5
Total	**1,013,841**	**100.0**

Source:
Association of American Railroads, Analysis of Class I Railroads 1989, July 1990, p. 163.

Table 6.10
Summary Statistics for Class I Freight Railroads, 1970-89[a]

Year	Number of locomotives in service[b]	Number of freight cars (thousands)[c]	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[d]	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	27,646	1,168	428	29,277	2,434	616	918,621	592	544.1
1981	27,023	1,111	408	27,968	2,386	626	910,169	571	519.7
1982	26,399	1,039	345	23,952	1,990	629	797,759	547	436.5
1983	25,060	1,007	346	24,358	1,936	641	828,275	521	431.6
1984	23,730	948	369	26,409	2,119	645	921,542	508	468.5
1985	22,166	867	347	24,920	1,985	664	876,984	487	426.9
1986	20,340	799	347	24,414	1,938	664	867,722	474	411.5
1987	18,977	749	361	25,627	1,926	688	943,747	443	417.9
1988	18,973	725	379	26,339	2,001	697	996,182	434	432.3
1989	18,703	688	383	26,196	1,988	723	1,013,841	427	432.9
				Average annual percentage change					
1970-89	-1.9%	-3.8%	-0.6%	-0.7%	-1.4%	1.8%	1.5%	-2.2%	-0.8%
1982-89	-4.8%	-5.7%	1.5%	1.3%	0.0%	2.0%	3.5%	-3.5%	-0.1%

Sources:
Association of American Railroads, Railroad Facts, 1990 Edition, Washington, DC, September 1990, pp. 27, 33, 34, 36, 48, 50.
Revenue tons - Association of American Railroads, Analysis of Class I Railroads 1989, July 1990, p. 109, and annual.
Energy use - See Appendix A for Table 2.7.

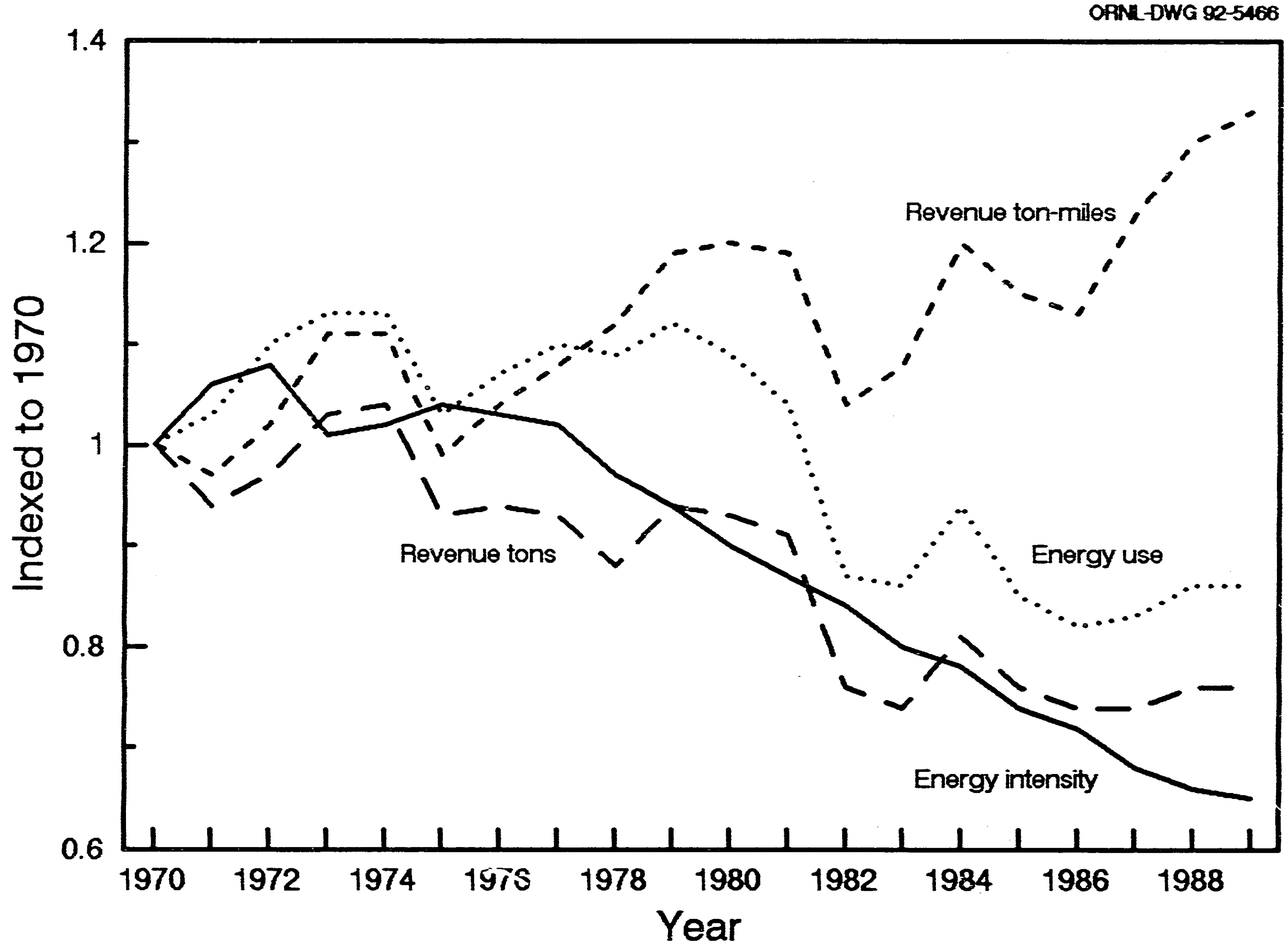
[a]Class I railroads are defined by the Interstate Commerce Commission as having annual operating revenues equal to or over $93.5 million in 1989. Operating Class I railroads account for more than 95 percent of the industry's freight.

[b]Does not include self-powered units. After 1971, 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.

[c]Does not include private or shipper-owned cars.

[d]Data represent total locomotives used in freight and passenger service. Separate estimates are not available.

Figure 6.8. Revenue Tons, Revenue Ton-Miles, Energy Intensity, and Energy Use for Class I Freight Railroads, 1970-89



Source: See Table 6.10.

Although revenue carloadings have declined by 20% from 1974 to 1989, coal is still the commodity with the highest share of carloadings. Many commodities have drastically reduced rail shipments from 1974 to 1989, such as metallic ores, primary metal products, and food.

Table 6.11
Railroad Revenue Carloadings by Commodity Group, 1974 and 1989

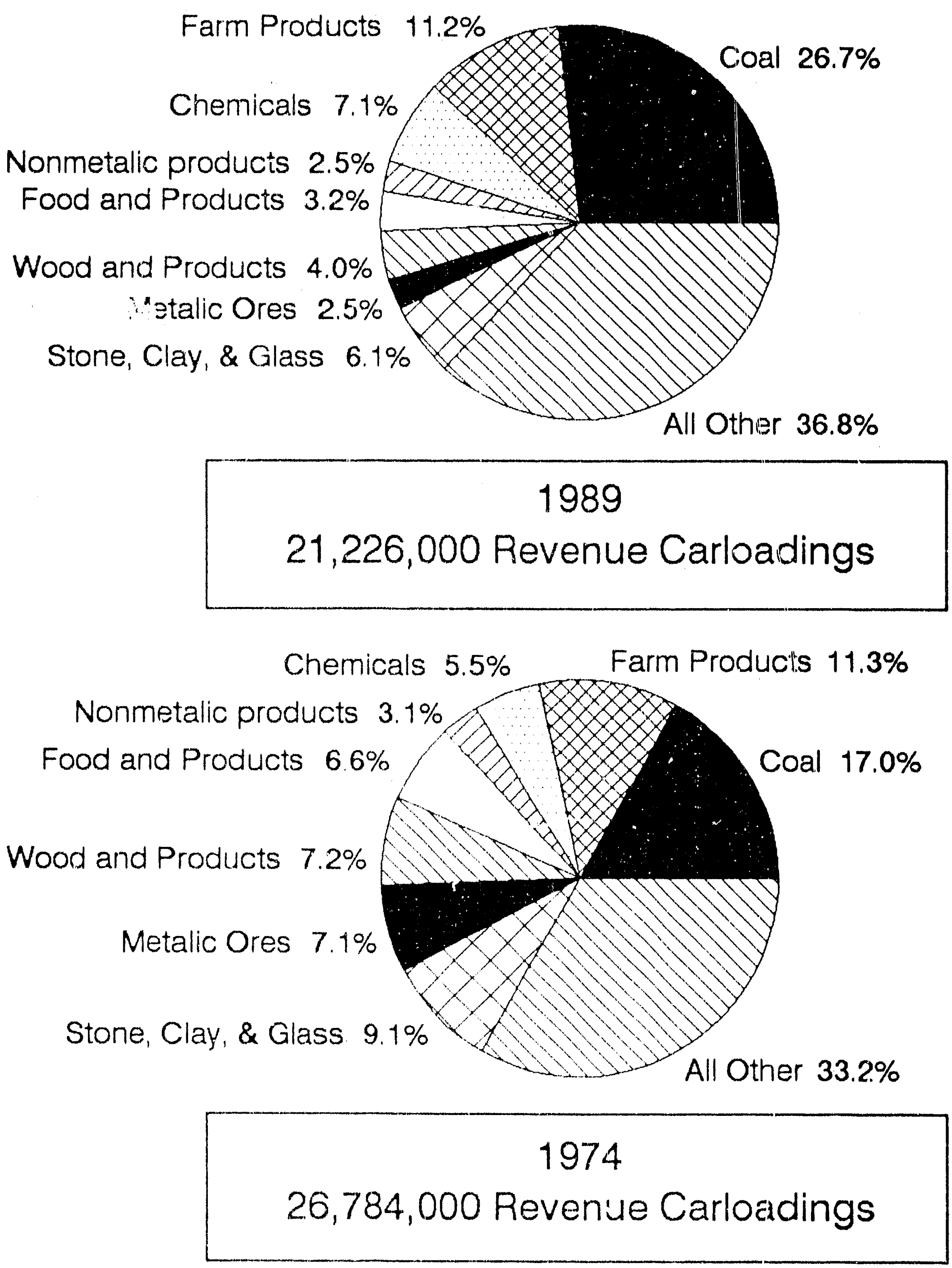
Commodity group	Carloadings (thousands) 1974	Carloadings (thousands) 1989	1989 Percent distribution	Percentage change 1974-89
Coal	4,544	5,672	26.7	24.8
Farm products	3,021	2,386	11.2	-21.0
Chemicals and allied products	1,464	1,497	7.1	2.3
Nonmetallic products[a]	821	530	2.5	-35.4
Food and kindred products[b]	1,777	681	3.2	-61.7
Lumber and wood products[c]	1,930	842	4.0	-56.4
Metallic ores	1,910	523	2.5	-72.6
Stone, clay and glass	2,428	1,289	6.1	-46.9
Pulp, paper, and allied	1,180	615	2.9	-47.9
Petroleum and coke products	877	550	2.6	37.3
Primary metal products	1,366	480	2.3	-64.9
Waste and scrap material	889	444	2.1	-50.1
Transportation equipment	1,126	1,080	5.1	-4.1
Others	3,451	4,639	21.9	34.4
Total	26,784	21,228	100.0	-20.7

Sources:
1974 - Association of American Railroads, Railroad Facts, 1976 Edition, Washington, DC, 1975, p. 26.
1989 - Association of American Railroads, Railroad Facts, 1990 Edition, Washington, DC, September 1990, p. 25.

[a]Nonmetallic products include crushed stone, gravel, sand, and other nonmetallic minerals.
[b]Food and kindred products include grain mill products.
[c]Lumber and wood products include primary forest products.

Figure 6.9. Distribution of Railroad Revenue Carloadings, 1974 and 1989

ORNL-DWG 92-5466



Source: See Table 6.11.

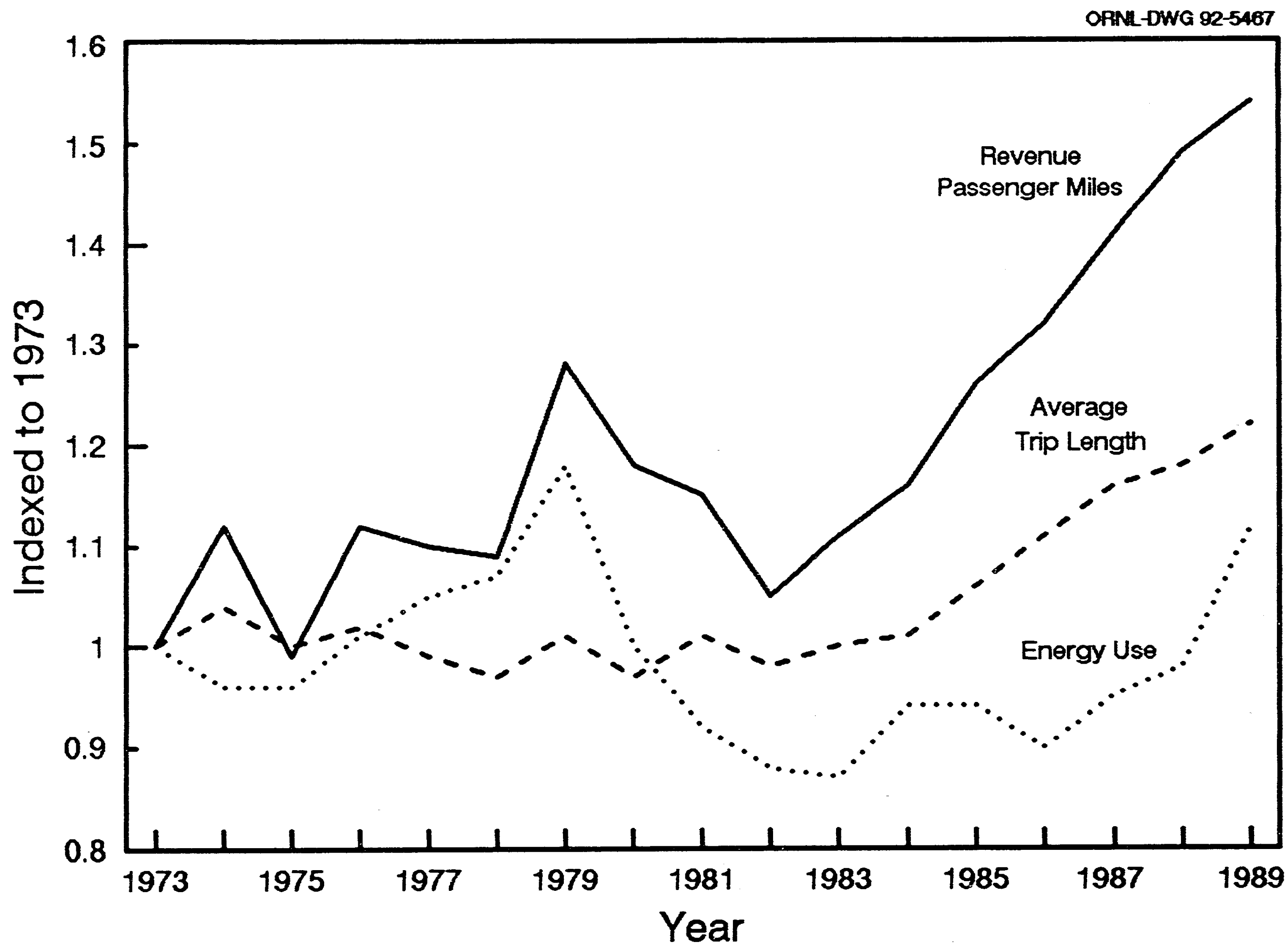
Table 6.12
Summary Statistics for the National Railroad Passenger Corporation (Amtrak), 1971-89

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
				Average annual percentage change				
1971-89	0.5%[b]	2.3%	3.6%	4.0%	6.2%	2.1%	-2.0%[c]	-0.7%[c]
1982-89	-3.3%	-1.4%	1.0%	4.0%	5.6%	3.2%	-2.0%	3.5%

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 - 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.
1985-89: Personal communication with the Corporate Accounting Office of Amtrak, Washington, DC.

[a]Data are not available.
[b]Average annual percentage change is for years 1972-89.
[c]Average annual percentage change is for years 1973-89.

Figure 6.10. Revenue Passenger-Miles, Average Trip Length, and Energy Use for Amtrak, 1973-89



Source: See Table 6.12.

Table 6.13
Summary Statistics for Rail Transit Operations, 1970-89[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	2,705	12,539	4.6	3,397	42.6
			Average annual percentage change				
1970-89	0.3%	1.2%	1.3%	-0.1%	-1.9%[g]	1.7%	1.8%
1982-89	0.6%	3.2%	3.0%	2.7%	0.0%	1.5%	4.2%

Sources:
American Public Transit Association, 1990 Transit Fact Book, Washington, DC, September 1990, pp. 10, 11.
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.

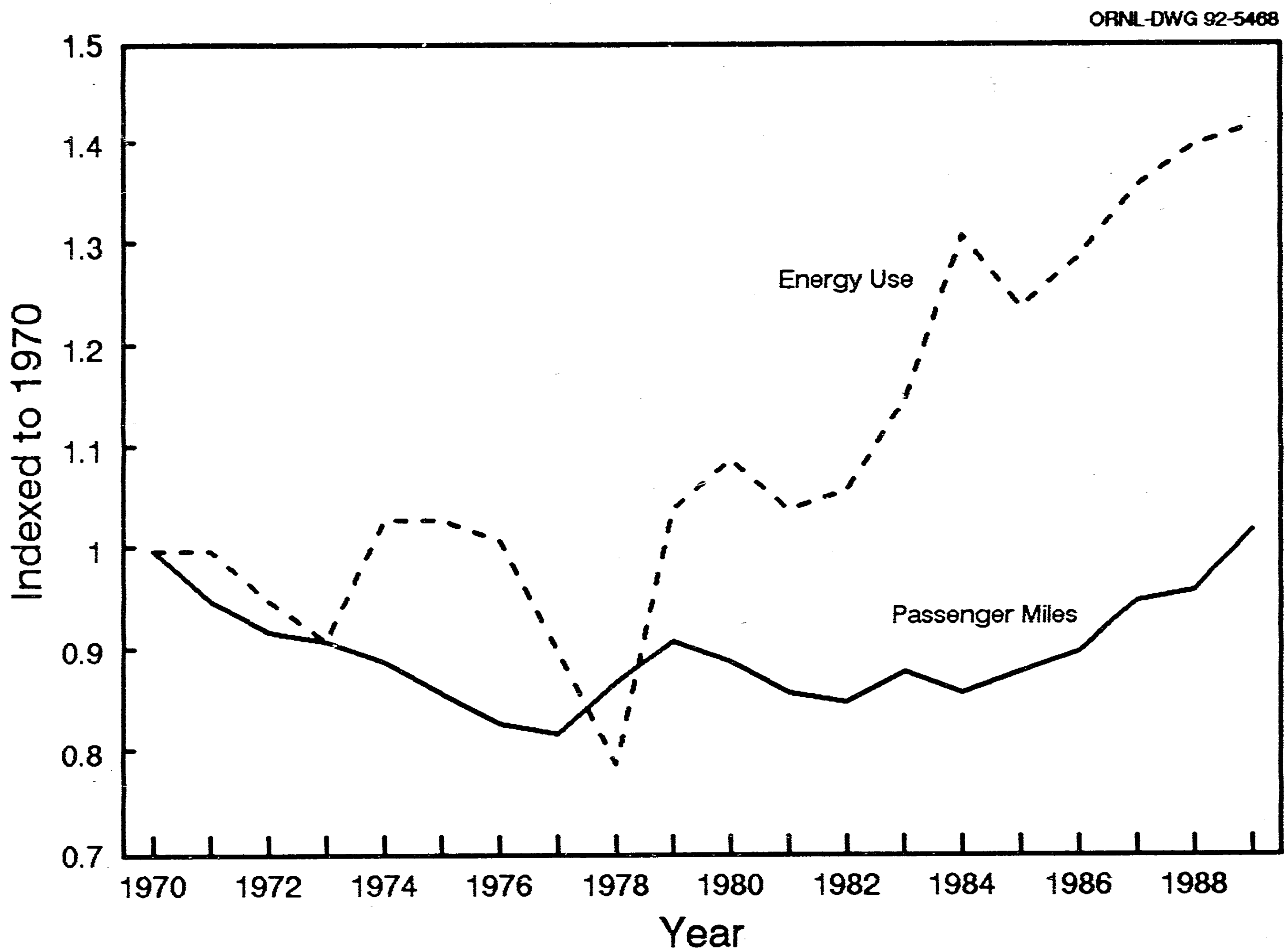
[d]Calculated as the ratio of passenger miles to passenger trips.

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

[f]Data are not available.

[g]Average annual percentage change is calculated for years 1977-89.

Figure 6.11. Passenger-Miles and Energy Use for Rail Transit Operations, 1970-89



Source: See Table 6.13.

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

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
MVMA	Motor Vehicle Manufacturers Association
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
TPA	Transportation Policy Associates
TSC	Transportation Systems Center
vmt	vehicle-miles traveled

Table 2.7
Domestic Consumption of Transportation Energy by Mode and Fuel Type, 1989

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 1989, Table VM-1, p. 181. These were distributed as follows: 98.8% gasoline 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 1988, March 1990, p. 65.

Motorcycles

DOT, FHWA, Highway Statistics 1989, Table VM-1, p.181. For conversion purposes, fuel for all motorcycles was assumed to be gasoline.

Buses

Transit:

Diesel: APTA, 1990 Transit Fact Book, September 1990, Washington, DC, p. 62.

Gasoline: Total gallons of gasoline used by transit vehicles taken from APTA, 1990 Transit Fact Book, September 1990, Washington, DC, p. 62. According to APTA's Research and Statistics Department, motor bus accounts for approximately 5% of total transit gasoline use.

Intercity:

Estimate provided by Frank Smith, Transportation Policy Associates, Washington, DC.

School:

Estimate provided by Frank Smith, Transportation Policy Associates, Washington, DC.

Trucks

Total:

Sum of light trucks and other trucks.

Light Trucks:

DOT, FHWA, Highway Statistics 1989, Table VM-1, p. 181, 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 1989, Table VM-1, p. 181. 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 1989, Table 5.1, p. 5-6. 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, 1989, p.40. 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 1989" (Whitney Communications, N.Y. City). 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 1989, Table 1, p. 2. 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 29.305×10^{-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, 1989, p.40. 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, 1990 Transit Fact Book, September 1990, Washington, DC, p. 62. Transit was defined as the sum of "heavy rail" and "all 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 1989, July 1990, 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 1989, "Barrels and Dollars per Barrel," p. 34. For conversion purposes, estimates of jet fuel purchases were 64% JP4, 22% JP5, and 14% JP8, based on the breakdown from "Petroleum Procurement," p. 32. 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, 1970-1989

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 1986-89 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.
1988-89 - 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.

Motorcycles

Department of Transportation, Federal Highway Administration, Highway Statistics Summary to 1985, Table VM-201A; and Table VM-1 in the 1986-89 annual editions. For conversion purposes, fuel for all motorcycles was assumed to be gasoline.

Buses

Sum of transit, intercity and school.

Transit:

Diesel - APTA, 1990 Transit Fact Book, September 1990, Washington, DC, p. 62, and annual.

Gasoline - Total gallons of gasoline used by transit vehicles taken from APTA, 1990 Transit Fact Book, September 1990, Washington, DC, p. 62. According to APTA's Research and Statistics Department, motor bus accounts for approximately 5% of total transit gasoline use.

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.

1987-89 - Personal communication with Frank Smith, TPA, Washington, DC.

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.

1987-89 - Personal communication with Frank Smith, TPA, Washington, DC.

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 1986-89 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 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 1986-89 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 1988-89 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.
1985-89 - DOT, FAA, General Aviation Activity and Avionics Survey: Annual Summary Report, Calendar Year 1989, Table 5.1, p. 5-6. 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.
1982-89 - 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, 1989, p.40. 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 - 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.

1985-1989 - 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 1989" (Whitney Communications, N.Y. City). 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 1989, Table 1, p. 2. 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, 1989, p.40, 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, 1990 Transit Fact Book, September 1990, Washington, DC, p. 62, annual. Transit was defined as the sum of "heavy rail" and "all 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 1989, July 1990, p. 157, 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, 1989

Highway

Automobiles

Number of Vehicles - DOT, FHWA, Highway Statistics 1989, Table VM-1, p. 181.
Vmt - DOT, FHWA, Highway Statistics 1989, Table VM-1, p. 181.
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 1989, Table VM-1, p. 181. These were distributed as follows: 98.8% gasoline 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 1988, March 1990, p. 65.

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 1989, Table VM-1, p. 181) 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 1989, Table VM-1, p. 181) 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 1989, Table VM-1, p. 181) 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 1989, Table VM-1, p. 181, 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 1989, Table VM-1, p. 181. 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 1989, Table VM-1, p. 181.
Pmt - Calculated by ORNL as vmt multiplied by load factor.
Load Factor - DOT, TSC, National Transportation Statistics 1989, p. 23, passenger-miles divided by vehicle miles.
Energy Use - DOT, FHWA, Highway Statistics 1989, Table VM-1, p.181. 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, 1990 Transit Fact Book, September 1990, Washington, DC, pp. 10, 11, 12.
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 1989, p. 20.
Pmt - Eno Transportation Foundation, Transportation in America, Ninth Edition, Washington, DC, 1991, p. 47.
Energy Use - Personal communication with Frank Smith, TPA, Washington, DC.

School:

Number of Vehicles - School and other nonrevenue as reported in DOT, FHWA, Highway Statistics 1989, p. 20.
Energy Use - Personal communication with Frank Smith, TPA, Washington, DC.
Load Factor - Calculated by ORNL as pmt/vmt.
Pmt - National Safety Council, Accident Facts, 1990 Edition, Chicago, IL, p. 70.

Non-Highway

Air

Large Certified Route Air Carriers:

Vmt - Revenue aircraft miles flown, DOT, FAA, FAA Statistical Handbook of Aviation Calendar Year 1989, p. 6-4.

Pmt - Revenue pmt of domestic operations, scheduled and unscheduled, DOT, FAA, FAA Statistical Handbook of Aviation Calendar Year 1989, 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 1989, pp. 2-8, 3-13, 5-6.

Pmt - Eno Transportation Foundation, Transportation in America, Eighth Edition, Washington, DC, p. 9.

Load Factor - Calculated by ORNL as pmt/vmt.

Recreational Boating

Number of Vehicles - Whitney Communications, Boating Industry Magazine, Annual Report, "The Boating Business 1989." 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 1989" (Whitney Communications, N.Y. City). 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 - 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 1989, July 1990, p. 157. Fuel use for Class I passenger was derived as fuel use for passenger locomotive added to the weighted percent of fuel for yard switching. Diesel fuel consumed by work train was not included as it was considered to be indirect energy.

Transit and Commuter:

Number of Vehicles, Vmt and Pmt - APTA, 1990 Transit Fact Book, September 1990, Washington, DC, pp. 10, 11 and 12.

Load Factor - Calculated by ORNL as pmt/vmt.

Energy Use - APTA, 1990 Transit Fact Book, September 1990, Washington, DC, p. 62. Transit was defined as the sum of "heavy rail" and "all other."

Table 2.13
Energy Intensities of Passenger Modes, 1970-89

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 in Table 2.14 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 1987-89 editions.

Pmt - vmt times 1.7 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 1986-89 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.

1988-89 - 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.

Buses

Transit:

Vmt and Pmt - APTA, 1990 Transit Fact Book, September 1990, Washington, DC, pp. 55, 56, and annual.

Energy Use - Diesel: APTA, 1990 Transit Fact Book, September 1990, Washington, DC, p. 62, and annual.

Gasoline: Total gallons of gasoline used by transit vehicles taken from APTA, 1990 Transit Fact Book, September 1990, Washington, DC, p. 62. According to APTA's Research and Statistics Department, motor bus accounts for approximately 5% of total transit gasoline use.

Intercity:

Pmt - 1970-84 - American Bus Association, Annual Report, Washington, DC, annual.
1985-89 - Eno Transportation Foundation, Transportation in America, Ninth edition, Washington, DC, 1991, 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.
1987-89 - Personal communication with Frank Smith, TPA, 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.
1988-89 - National Safety Council, Accident Facts, 1990 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.
1987-89 - Personal communication with Frank Smith, TPA, Washington, DC.

Non-Highway

Air

Certificated Air Carriers:

Pmt - DOT, FAA, FAA Statistical Handbook of Aviation, Calendar Year 1989, Washington, DC, 1991, p. 6-4, and annual.

Energy Use - 1970-81 - DOT, Civil Aeronautics Board, Fuel Cost and Consumption, Washington, DC, annual.
1982-89 - 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, Ninth edition, Washington, DC, 1991, p.47.

Energy Use - 1970-74 - DOT, TSC, National Transportation Statistics,Cambridge, MA, 1981.
1975-85 - DOT, FAA, FAA Aviation Forecasts, Washington, DC, annual.
1985-89 - DOT, FAA, General Aviation Activity and Avionics Survey: Annual Summary Report 1988 Data, Table 5.1, p. 5-6. 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 - Personal communication with the Corporate Accounting Office of Amtrak.

Energy Use - 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 1989, July 1990, p. 157, 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.

Transit:

Pmt - APTA, 1990 Transit Fact Book, September 1990, Washington, DC, p. 11.

Energy Use - Transit and Commuter - APTA, 1990 Transit Fact Book, September 1990, Washington, DC, p. 62, annual. Transit was defined as the sum of "heavy rail" and "all other."

Table 2.14
Intercity Freight Movement and Energy Use in the United States, 1989

Highway

Trucks

Vehicles - 7.5% of total 2-axle, 4-tire trucks (as reported by DOT, FHWA in Highway Statistics 1989, Table VM-1, p.181) 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 1989, Table VM-1, p.181) 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, Ninth Edition, Washington, DC, 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 1989, Table VM-1, p.181) 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, Waterborne Transportation Lines of the United States, 1989, New Orleans, LA, 1991.

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 1989, Part 5: National Summaries, New Orleans, LA, 1990, p. 89.

Energy Intensity - Energy use divided by ton miles.

Energy Use - DOE, EIA, Fuel Oil and Kerosene Sales, 1989, p.40. 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 1989, Washington, DC, 1990, p. 2. 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 1989, Table 1, p. 2. 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 29.305×10^{-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, Ninth Edition, 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, Tons Shipped, Average Length of Haul - AAR, Railroad Facts, 1990 Edition, Washington, DC, September 1990, pp. 27, 33, 34, 36, 48, 50.

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, 1989, p. 40. Adjusted sales of distillate fuel oil for railroad.

Passenger - Transit and Commuter - APTA, 1990 Transit Fact Book, September 1990, Washington, DC, p. 62. Transit was defined as the sum of "heavy rail" and "all 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 1989, July 1990, 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.

Table 2.15
Energy Intensities of Freight Modes, 1970-89

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 in Table 2.16 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 1987-89 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. See Table 3.15 for light truck vmt.

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 1986-89 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 1988-89 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 1986-89 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 1988-89 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 1989, Part 5: National Summaries, New Orleans, LA, 1991, p. 89, 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, 1989, p.40. 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 - 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, 1990 Edition, Washington, DC, September 1990, 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, 1989, p. 40. Adjusted sales of distillate fuel oil for railroad.
Passenger - Transit and Commuter - APTA, 1990 Transit Fact Book, September 1990, Washington, DC, p. 62. Transit was defined as the sum of "heavy rail" and "all 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 1989, July 1990, 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.

Table 3.3
Vehicle Stock, New Sales and New Registrations
in the United States, 1989 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 1976-1988 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. 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 1989. This method assumed that all vehicles, large and small, were scrapped at the same rate.

Sales:

Domestic, import, and total sales were from MVMA, Facts and Figures '91, p. 15. The domestic sales were distributed by size class according to the following percentages: Two seater, 0.5%; Minicompact, 0%; Subcompact, 9.9%; Compact 36.1%; Midsize, 34.4%; and Large, 19.1%. The import sales were distributed by size class according to the following percentages: Two-seater, 3.9%; Minicompact, 0.8%; Subcompact, 47.0%; Compact, 36.1%; Midsize, 11.8; and Large, 0.4%. These percentages were derived from the ORNL Light-Duty Vehicle Market Shares Data System. Domestic-sponsored imports (captive imports) were included in the import figure only.

New Registrations:

Domestic - The number of registrations for new automobiles was derived as follows: new car registrations by make (as reported in H. A. Stark (ed.), Ward's Communication, Inc., 1991 Ward's Automotive Yearbook, Detroit, MI, p. 235), were classified by ORNL into EPA size classes. Totals included Federal Government registrations. Van registrations were not included.

Import - Calculated by ORNL as the difference between total and domestic.

Total - MVMA, Facts and Figures '91, p. 20.

See Glossary for definition of Automobile Size Classifications.

Fleet

Fleets of ten or more:

Stock and Registrations - E. J. Bobit (ed.), Bobit Publishing Company, Automotive Fleet Fact Book, Redondo Beach, CA, 1991, pp. 16, 22. 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 and Registrations - Calculated by ORNL as the difference between total auto and fleets.

Motorcycles

Stock - DOT, FHWA, Highway Statistics 1989, Table VM-1 p. 181.

Sales and Registrations - MIC, 1990 Motorcycle Statistical Annual, pp. 12 and 13. Domestic sales were assumed to equal U.S. production (p. 13), and included sales of motorcycles, scooters, and all terrain vehicles for on and off highway use. Import was the difference between total sales (p. 12) and domestic (p. 13).

Recreational Vehicles

Sales - Recreation Vehicle Industry Association, 1989... 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 - MVMA, Facts and Figures '91, p. 19.

Registrations - H. A. Stark (ed.), Ward's Communications, Inc., 1990 Ward's Automotive Yearbook, Detroit, MI, p. 244.

The Fuel Economy Gap for All Automobiles and Light Trucks in Operation

Methodology

The gaps were calculated using composite fuel economy data for all automobiles and trucks. When composite fuel economy data were not available, the fuel economy was calculated by harmonically weighting the fuel economy by vehicle miles of travel (vmt). The formula used to perform this calculation is:

$$CMPG = \sum_{i=a}^{z} \left[mpg_i^{-1} \times \left(\frac{yVMT_i}{tVMT_z} \right) \right]^{-1}$$

where

CMPG	=	the composite mpg
i	=	the model year of representation (i.e., year model was manufactured)
a	=	the first model year data point within the data set
z	=	the last model year data point within the data set, the measurement year
mpg	=	the model year mpg
yVMT	=	the model year vmt in year z
tVMT	=	the total vmt in year z (sum of all model year vmt).

To calculate the model year vmt, average annual miles per vehicle by age from RTECS and vehicles in operation by model year from R.L. Polk and Company were used in all cases except the NHTSA/TIUS gap comparison, where TIUS data were used instead.

Once the composite fuel economy data were calculated, they were applied to the gap formula:

$$GAP = \frac{(ON\text{-}ROAD\ MPG) - (TESTED\ MPG)}{(TESTED\ MPG)}$$

In the calculation of the automobile gaps, both on-road fuel economies (FHWA and RTECS) were already composite. The tested composite fuel economies were calculated separately for each comparison using the CMPG formula.

The first light truck gap was calculated using a NHTSA tested fuel economy compared against the FHWA on-road fuel economy. This gap is higher due, in part, to the fact that FHWA's composite fuel economy includes some trucks over 8,500 pounds GVW. The second light truck gap was calculated using NHTSA tested fuel economy compared with RTECS on-road fuel economy.

For the third light truck gap, TIUS fuel economy data by model year were harmonically averaged using class 1 (0-6,000 lbs. GVW) and 72 percent of class 2 (6,001-10,000 lbs. GVW) vmt data. TIUS data showed that approximately 72 percent of class 2 vmt were accounted for by trucks less than 8,500 pounds GVW. The NHTSA and TIUS model year fuel economy data were then harmonically averaged using the TIUS total vmt data to get composite fuel economy used to estimate this gap.

Source:

Maples, John D., and Philip D. Patterson, "The Fuel Economy Gap for All Automobiles and Light Trucks in Operation," Washington, DC, 1991.

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
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 x 10^6 ft-lb
	= 1055 J		= 3.671 x 10^5 kg-m
	= 39.30 x 10^{-5} hp-h		= 3.600 x 10^6 J
	= 39.85 x 10^{-5} metric hp-h		= 1.341 hp-h
	= 29.31 x 10^{-5} kWhr		= 1.360 metric hp-h
1 kg-m	= 92.95 x 10^{-4} Btu	1 Joule	= 94.78 x 10^{-5} Btu
	= 7.233 ft-lb		= 0.7376 ft-lb
	= 9.806 J		= 0.1020 kg-m
	= 36.53 x 10^{-7} hp-h		= 37.25 x 10^{-8} hp-h
	= 37.04 x 10^{-7} metric hp-h		= 37.77 x 10^{-8} metric hp-h
	= 27.24 x 10^{-7} kWhr		= 27.78 x 10^{-8} kWhr
1 hp-h	= 2544 Btu	1 metric hp-h	= 2510 Btu
	= 1.98 x 10^6 ft-lb		= 1.953 x 10^6 ft-lb
	= 2.738 x 10^6 kgm		= 27.00 x 10^4 kg-m
	= 2.685 x 10^6 J		= 2.648 x 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 x 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 x 10^{-3} bbl
	= 0.003785 m^3		= 1.00 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 x 10^5 U.S. gal/year
	= 839.3 imperial gal/day		= 3.063 x 10^5 imperial gal/year
	= 3815 liter/day		= 1.393 x 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

	TO				
FROM	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 1988 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 using the Gross National Product inflation factors. Table B.12 shows conversion factors for the Consumer Price Index inflation factors.

Table B.11
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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

Source:
U. S. Department of Commerce, Bureau of Economic Analysis, Survey of Current Business, Washington, DC, monthly.

Table B.12
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
1970	1.000	1.043	1.073	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
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
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
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
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
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
1976	0.682	0.712	0.736	0.781	0.866	0.945	1.000	1.065	1.145	1.275	1.449	1.598	1.696	1.750	1.824	1.889	1.926	1.997	2.078	2.178	2.296
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
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
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
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
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
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
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
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
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
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
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
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
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
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

Source:
U.S. Department of Labor, Bureau of Labor Statistics, Monthly Labor Review, 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. For 1988, the threshold for Class I railroads was $87.9 million. 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 was conducted in 1983, 1985, and 1987. Data for the 1987 RTECS are not yet available.

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, and 1987.

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.

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