

Transportation Energy Data Book

Edition 36



OAK RIDGE NATIONAL LABORATORY
MANAGED BY UT-BATTELLE FOR THE US DEPARTMENT OF ENERGY

Transportation Energy Data Book

Quick Facts

Petroleum

- In 2016 the U.S. produced more than 12 million barrels of petroleum per day (mmbd), or 13.5% of the world's 91.3 mmbd.
- The U.S. consumed 19.5 mmbd, or 21% of the world's 95.4 mmbd in 2015.
- Net imports of petroleum to the U.S. in 2016 were nearly 5 mmbd, which was 25% of U.S. petroleum consumption.
- U.S. transportation petroleum use was 70% of total U.S. petroleum use in 2016.
- In 2016 U.S. transportation petroleum use was 111% of total U.S. petroleum production.
- Petroleum comprised 92% of U.S. transportation energy use in 2016.
- Cars and light trucks accounted for 63% of U.S. transportation petroleum use in 2015.
- Medium trucks (Class 3-6) accounted for 4% of U.S. transportation petroleum use in 2015.
- Heavy trucks (Class 7-8) and buses accounted for 19% of U.S. transportation petroleum use in 2015.
- Nonhighway modes accounted for the rest of U.S. transportation petroleum use in 2015 (14%).

Energy

- In 2016 U.S. transportation energy use accounted for over 28% of total U.S. energy use.
- Cars and light trucks accounted for 59% of U.S. transportation energy use in 2015.
- Medium trucks accounted for 5% of U.S. transportation energy use in 2015.
- Heavy trucks and buses accounted for 19% of U.S. transportation energy use in 2015.
- Nonhighway modes accounted for the rest of U.S. transportation energy use in 2015 (18%).

Light Vehicle Characteristics

- In 2015 there were 113 million cars and 129 million light trucks in the U.S. (242 million total light vehicles).
- Light vehicles accounted for 90% of the 3.1 trillion vehicle miles driven in the U.S. in 2015.
- U.S. cars:
 - 6,873,000 cars were sold in 2016 which was 40% of new light vehicle sales.
 - In 2016 the average age of a U.S. car was 11.6 years.
 - In 2015 the average fuel economy for the U.S. car fleet (all cars on the road) was 26.2 mpg.
- U.S. light trucks:
 - 10,296,000 light trucks were sold in 2016 which was 60% of new light vehicle sales.
 - In 2016 the average age of a U.S. light truck was 11.6 years.
 - In 2015 the average fuel economy for the U.S. light truck fleet (all light trucks on the road) was 18.8 mpg.
- The average U.S. household vehicle travels 11,300 miles per year (2009 NHTS).

Heavy Truck Characteristics

- 11,203,000 heavy trucks were registered in the U.S. in 2015.
- Heavy trucks and buses accounted for 10% of the 3.1 trillion vehicle miles driven in 2015.
- In 2002 (the last time a survey was conducted), heavy trucks accounted for 80% of medium and heavy truck fuel use.

Center for Transportation Analysis
Energy and Transportation Science Division

TRANSPORTATION ENERGY DATA BOOK: EDITION 36

Stacy C. Davis
Susan E. Williams
Oak Ridge National Laboratory

Robert G. Boundy
Roltek, Inc.

December 2017

Transportation Energy Data Book: Edition 36
can be found online at:
cta.ornl.gov/data

Prepared for the
Vehicle Technologies Office
Office of Energy Efficiency and Renewable Energy
U.S. Department of Energy

Prepared by the
Oak Ridge National Laboratory
Oak Ridge, Tennessee 37831-6073
Managed by
UT-BATTELLE, LLC
for the
U.S. DEPARTMENT OF ENERGY
under Contract No. DE-AC05-00OR22725

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Stacy C. Davis
Oak Ridge National Laboratory
National Transportation Research Center
2360 Cherahala Boulevard
Knoxville, Tennessee 37932
Telephone: (865) 946-1256
FAX: (865) 946-1541
E-mail: DAVISSC@ornl.gov
Website Location: cta.ornl.gov/data

Rachael Nealer
Vehicle Technologies Office
Energy Efficiency and Renewable Energy
Department of Energy, EE-3V
Forrestal Building
1000 Independence Avenue, S.W.
Washington, D.C. 20585
Telephone: (202) 586-3916
FAX: (202) 586-1600
E-mail: Rachael.Nealer@ee.doe.gov
Website Location: energy.gov/eere/vehicles

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FOREWORD

Thank you for reading the 36th edition of the *Transportation Energy Data Book*. We hope you find the information you are looking for on transportation and energy. Beginning with this edition, the Data Book will only be posted on-line in both PDF and spreadsheet format at the website cta.ornl.gov/data. Please utilize the flexibility and convenience of PDF viewing, downloading, and searching. We will continue to update the Data Book as new source data are made available throughout the year, instead of waiting for a once-a-year update. We thank you for your support and flexibility as we make this transition and please do not hesitate to reach out if you have any questions or concerns. I have put together a few highlights of this year's Data Book:

- Before getting too far into the *Transportation Energy Data Book* check out Table 1.6 and Figure 1.5 which show some interesting trends on net imports of oil consumed for transportation.
- Energy use by transportation source can be found in Table 2.3 and broken down by consumption and Btu in Table 2.7 and Table 2.8, respectively. These tables and corresponding Figure 2.6, show how energy is being used across the transportation sector.
- You do not want to miss Table 2.15 on transportation energy consumption per mile; with our changing transportation environment, these data can inform the energy implications of our behavior and choices.
- Once you have gotten through the first couple chapters of petroleum consumption and energy use, there is still plenty of information on vehicles (light duty and heavy duty), alternative fuels, fleets, households, non-highway, the economy, and emissions.
- Note one change in the Data Book in this edition is the conversion factor for converting electricity usage into British thermal units (Btu). For this edition, only end-use energy was counted for electricity, and one kilowatt-hour (kWhr) of electricity is equal to 3,412 Btu. This change affected data in the energy-by-mode series going back to 1970. The rail and pipeline modes were most affected because they use a greater share of electricity than other transportation modes.
- Check out some highlights of the GREET model (Figure 11.3 and 11.4), and data that helps inform household transportation needs in terms of economics of operating and purchasing vehicles (Table 10.10-10.13), mileage (Figure 8.5 and Table 8.14), and more.

Every figure and table compiled here is thanks to the hard work and diligence of our staff at Oak Ridge National Laboratory, specifically, Stacy Davis, Susan Williams, and Bob Boundy. We hope you enjoy this edition of the *Transportation Energy Data Book*. If you have any questions or suggestions for future improvements, please let us know.

Rachael Nealer
Vehicle Technologies Office
Office of Energy Efficiency and Renewable Energy
U.S. Department of Energy

ACKNOWLEDGMENTS

The authors would like to express their gratitude to the many individuals who assisted in the preparation of this document. First, we would like to thank Rachael Nealer, Jacob Ward, David Gohlke, Kelly Fleming, and the Vehicle Technologies Office staff for their continued support of the Transportation Energy Data Book project. We would also like to thank Mark Robbins for the cover design. We are indebted to Debbie Bain, who has masterfully prepared the manuscript since 1998.

This book would not be possible without the leadership, guidance, and vision of Phil Patterson, who began this book in the 1970's. We hope to continue this report into the future with the same level of excellence. The authors and the transportation research community will be forever grateful for his efforts.

ABSTRACT

The *Transportation Energy Data Book: Edition 36* is a statistical compendium prepared and published by Oak Ridge National Laboratory (ORNL) under contract with the U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, Vehicle Technologies Office. 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. The latest edition of the Data Book is available via the Internet (cta.ornl.gov/data).

This edition of the Data Book has 12 chapters which focus on various aspects of the transportation industry. Chapter 1 focuses on petroleum; Chapter 2 – energy; Chapter 3 – highway vehicles; Chapter 4 – light vehicles; Chapter 5 – heavy vehicles; Chapter 6 – alternative fuel vehicles; Chapter 7 – fleet vehicles; Chapter 8 – household vehicles; Chapter 9 – nonhighway modes; Chapter 10 – transportation and the economy; Chapter 11 – greenhouse gas emissions; and Chapter 12 – criteria pollutant emissions. The sources used represent the latest available data. There are also three appendices which include detailed source information for some tables, measures of conversion, and the definition of Census divisions and regions. A glossary of terms is also included for the reader's convenience.

INTRODUCTION

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

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 36 updates much of the same type of data that is found in previous editions.

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 to document the estimation procedures. The attempt is to provide sufficient information for the conscientious user to evaluate the estimates and to form their own opinions as to their utility. Clearly, the accuracy of the estimates cannot exceed the accuracy of the primary data, an accuracy which in most instances is unknown. In cases where data accuracy is known or substantial errors are strongly suspected in the data, the reader is alerted. In all cases it should be recognized that the estimates are not precise.

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

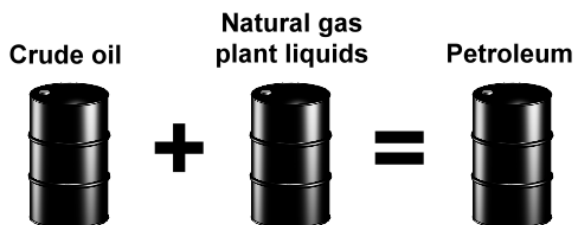
Chapter 1

Petroleum

Summary Statistics from Tables/Figures in this Chapter

Source		
Table 1.3	World Petroleum Production, 2016 (million barrels per day)	91.32
	<i>U.S. Production (million barrels per day)</i>	12.35
	<i>U.S. Share</i>	13.5%
Table 1.4	World Petroleum Consumption, 2015 (million barrels per day)	95.36
	<i>U.S. Consumption (million barrels per day)</i>	19.53
	<i>U.S. Share</i>	20.5%
Figure 1.4	Average Refinery Yield, 2016	OECD ^b OECD ^b
		Europe Americas
	<i>Gasoline</i>	20.1% 41.5%
	<i>Diesel oil</i>	29.9% 28.7%
	<i>Residual fuel</i>	9.2% 4.2%
	<i>Kerosene</i>	15.2% 8.6%
	<i>Other</i>	10.3% 14.2%
Table 1.12	U.S. transportation petroleum use as a percent of U.S. petroleum production, 2016	110.9%
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Table 1.16	Highway share of transportation petroleum consumption, 2015	86.2%
Table 1.16	Light vehicle share of transportation petroleum consumption, 2015	63.1%

In this document, petroleum is defined as crude oil (including lease condensate) and natural gas plant liquids.



^a Organization for Economic Co-operation and Development.



As new technologies appear and new areas are explored, the amount of proved reserves of crude oil and natural gas has grown. Although the reserves of natural gas in the United States were 84% higher in 2015 than it was in 1980, the U.S. share of World natural gas reserves is lower.

Table 1.1
Proved Reserves of Crude Oil and Natural Gas, 1980–2015

Year	Crude Oil Reserves (billion barrels)		U.S. Share of Crude Oil Reserves	Natural Gas Reserves (trillion cubic feet)		U.S. Share of Natural Gas Reserves
	World	United States		World	United States	
1980	643.3	31.2	4.9%	2,592.0	201.0	7.8%
1981	650.7	31.3	4.8%	2,653.9	199.0	7.5%
1982	669.0	31.0	4.6%	2,927.0	201.7	6.9%
1983	667.2	29.5	4.4%	3,038.4	201.5	6.6%
1984	668.1	29.3	4.4%	3,208.5	200.2	6.2%
1985	699.3	30.0	4.3%	3,407.2	197.5	5.8%
1986	700.1	29.9	4.3%	3,490.1	193.4	5.5%
1987	699.4	28.3	4.1%	3,648.7	191.6	5.3%
1988	888.9	28.7	3.2%	3,796.6	187.2	4.9%
1989	907.4	28.2	3.1%	3,933.2	168.0	4.3%
1990	1,001.9	27.9	2.8%	3,987.5	167.1	4.2%
1991	1,000.0	27.6	2.8%	4,215.6	169.3	4.0%
1992	990.7	25.9	2.6%	4,376.7	167.1	3.8%
1993	997.3	25.0	2.5%	4,884.4	165.0	3.4%
1994	999.5	24.1	2.4%	5,013.8	162.4	3.2%
1995	1,000.4	23.6	2.4%	4,981.9	163.8	3.3%
1996	1,008.6	23.5	2.3%	4,935.3	165.1	3.3%
1997	1,019.8	23.3	2.3%	4,947.0	166.5	3.4%
1998	1,021.4	23.9	2.3%	5,087.6	167.2	3.3%
1999	1,034.1	22.4	2.2%	5,141.9	164.0	3.2%
2000	1,018.2	23.2	2.3%	5,150.0	167.4	3.3%
2001	1,029.6	23.5	2.3%	5,288.9	177.4	3.4%
2002	1,033.4	23.8	2.3%	5,457.6	183.5	3.4%
2003	1,214.5	24.0	2.0%	5,505.4	186.9	3.4%
2004	1,266.2	23.1	1.8%	6,079.1	189.0	3.1%
2005	1,278.5	22.6	1.8%	6,046.6	192.5	3.2%
2006	1,289.2	23.0	1.8%	6,124.6	204.4	3.3%
2007	1,319.9	22.3	1.7%	6,190.9	211.1	3.4%
2008	1,328.5	22.8	1.7%	6,213.7	237.7	3.8%
2009	1,336.4	20.6	1.5%	6,262.4	244.7	3.9%
2010	1,356.7	23.3	1.7%	6,638.2	272.5	4.1%
2011	1,475.0	26.5	1.8%	6,708.2	304.6	4.5%
2012	1,523.4	30.5	2.0%	6,809.3	334.1	4.9%
2013	1,643.9	33.4	2.0%	6,845.2	308.0	4.5%
2014	1,650.6	36.4	2.2%	6,972.5	338.3	4.9%
2015	1,658.0	32.3	1.9%	6,951.0	369.0	5.3%
<i>Average Annual Percentage Change</i>						
1970–2015	2.7%	0.1%		2.9%	1.8%	
2005–2015	2.6%	4.9%		1.4%	6.7%	

Source:

U.S. Department of Energy, Energy Information Administration, *International Energy Statistics*, August 2017.
(Additional resources: www.eia.doe.gov)



In 2016, the Organization of Petroleum Exporting Countries (OPEC) accounted for 43.4% of world oil production. World crude oil production reached an all-time high in 2016, while U.S. production was down slightly from 2015.

Table 1.2
World Crude Oil Production, 1960–2016^a
(million barrels per day)

Year	United States	U.S. share	Total OPEC ^b	OPEC share	Total non-OPEC	World
1960	7.04	33.5%	8.70	41.4%	12.29	20.99
1965	7.80	25.7%	14.35	47.3%	15.98	30.33
1970	9.64	21.0%	23.30	50.8%	22.59	45.89
1975	8.38	15.9%	26.01	49.2%	26.82	52.83
1980	8.60	14.4%	25.56	42.9%	34.00	59.56
1985	8.97	16.6%	15.54	28.8%	38.43	53.97
1986	8.68	15.4%	17.75	31.5%	38.57	56.33
1987	8.35	14.7%	17.89	31.6%	38.76	56.65
1988	8.14	13.9%	19.90	33.9%	38.80	58.70
1989	7.61	12.7%	21.61	36.1%	38.19	59.80
1990	7.36	12.2%	22.77	37.6%	37.73	60.50
1991	7.42	12.3%	22.72	37.8%	37.41	60.13
1992	7.17	11.9%	24.03	40.0%	36.08	60.10
1993	6.85	11.4%	24.78	41.2%	35.40	60.17
1994	6.66	10.9%	25.20	41.2%	35.97	61.17
1995	6.56	10.5%	25.86	41.4%	36.57	62.43
1996	6.46	10.1%	26.37	41.3%	37.45	63.82
1997	6.45	9.8%	27.64	42.0%	38.16	65.81
1998	6.25	9.3%	28.70	42.8%	38.33	67.03
1999	5.88	8.9%	27.53	41.7%	38.44	65.97
2000	5.82	8.5%	29.26	42.7%	39.27	68.53
2001	5.80	8.5%	28.40	41.7%	39.73	68.13
2002	5.74	8.5%	26.72	39.7%	40.57	67.29
2003	5.65	8.1%	28.22	40.6%	41.24	69.46
2004	5.44	7.5%	30.67	42.2%	41.92	72.60
2005	5.18	7.0%	32.16	43.5%	41.70	73.87
2006	5.09	6.9%	31.84	43.3%	41.63	73.48
2007	5.08	6.9%	31.60	43.2%	41.58	73.18
2008	5.00	6.8%	32.97	44.5%	41.08	74.05
2009	5.35	7.3%	31.29	42.9%	41.58	72.87
2010	5.48	7.4%	32.20	43.2%	42.34	74.54
2011	5.65	7.6%	32.39	43.4%	42.23	74.62
2012	6.49	8.5%	33.57	44.2%	42.46	76.03
2013	7.47	9.8%	32.62	42.8%	43.56	76.18
2014	8.76	11.2%	32.68	41.9%	45.38	78.06
2015	9.42	11.7%	33.94	42.2%	46.50	80.44
2016	8.88	11.0%	34.94	43.4%	45.63	80.57
<i>Average annual percentage change</i>						
1960–2016	0.4%		2.5%		2.4%	2.4%
1970–2016	-0.2%		0.9%		1.5%	1.2%
2006–2016	5.7%		0.9%		0.9%	0.9%

Source:

U.S. Department of Energy, Energy Information Administration, *International Energy Statistics* website, August 2017. (Additional resources: www.eia.doe.gov)

^a Includes lease condensate. Excludes natural gas plant liquids.

^b See Glossary for membership.



This table shows petroleum production, which includes both crude oil and natural gas plant liquids. Because other liquids and processing gain are not included, the world total is often smaller than world petroleum consumption (Table 1.4). The United States was responsible for 13.5% of the world's petroleum production in 2016 and 11.0% of the world's crude oil production (Table 1.2).

Table 1.3
World Petroleum Production, 1973–2016^a
(million barrels per day)

Year	United States	U.S. share	Total OPEC ^b	OPEC share	Total non-OPEC	Non-OPEC share	World
1973	10.95	18.7%	29.99	51.3%	28.48	48.7%	58.47
1975	10.01	18.0%	26.16	47.0%	28.48	51.2%	55.62
1980	10.17	16.1%	26.05	41.3%	35.77	56.8%	63.00
1985	10.58	18.3%	16.20	28.0%	40.90	70.6%	57.90
1990	8.91	13.7%	23.71	36.4%	40.80	62.6%	65.14
1991	9.08	14.0%	23.65	36.4%	40.53	62.4%	64.95
1992	8.87	13.7%	25.02	38.5%	39.37	60.6%	64.95
1993	8.58	13.2%	25.83	39.6%	38.82	59.5%	65.23
1994	8.39	12.6%	26.52	39.8%	39.21	58.9%	66.55
1995	8.32	12.2%	27.19	40.0%	40.21	59.1%	68.01
1996	8.29	11.9%	27.70	39.8%	41.26	59.3%	69.52
1997	8.27	11.5%	29.05	40.5%	42.05	58.7%	71.65
1998	8.01	11.0%	30.21	41.4%	42.33	58.0%	73.04
1999	7.73	10.7%	29.13	40.4%	43.02	59.6%	72.15
2000	7.73	10.3%	32.78	43.8%	42.12	56.2%	74.90
2001	7.67	10.3%	32.05	42.8%	42.78	57.2%	74.83
2002	7.62	10.3%	30.37	41.0%	43.73	59.0%	74.10
2003	7.37	9.6%	31.91	41.7%	44.60	58.3%	76.52
2004	7.25	9.0%	34.75	43.4%	45.38	56.6%	80.12
2005	6.90	8.4%	36.50	44.7%	45.23	55.3%	81.73
2006	6.82	8.4%	36.16	44.3%	45.44	55.7%	81.59
2007	6.86	8.4%	35.98	44.1%	45.51	55.9%	81.49
2008	6.78	8.2%	37.53	45.5%	44.97	54.5%	82.50
2009	7.26	8.9%	35.84	44.0%	45.62	56.0%	81.46
2010	7.55	9.0%	36.85	44.1%	46.65	55.9%	83.49
2011	7.86	9.4%	37.03	44.2%	46.76	55.8%	83.79
2012	8.89	10.4%	38.32	44.8%	47.27	55.2%	85.59
2013	10.07	11.7%	37.23	43.4%	48.61	56.6%	85.84
2014	11.78	13.4%	37.20	42.2%	50.98	57.8%	88.18
2015	12.76	14.0%	38.55	42.4%	52.47	57.6%	91.01
2016	12.35	13.5%	39.62	43.4%	51.70	56.6%	91.32
<i>Average annual percentage change</i>							
1973–2016	0.3%		0.6%		1.4%		1.0%
2006–2016	6.1%		0.9%		1.3%		1.1%

Source:

U.S. Department of Energy, Energy Information Administration, *International Energy Statistics* website, August 2017. (Additional resources: www.eia.doe.gov)

^a Includes natural gas plant liquids, crude oil and lease condensate. Does not account for all inputs or refinery processing gain.

^b Organization of Petroleum Exporting Countries. See Glossary for membership.

^c Not comparable with previous data. Includes other inputs and refinery processing gains.



During the 1980s and 1990s, the United States accounted for about one-quarter of the world's petroleum consumption, but from 2000 to 2012 that share had been decreasing. In 2015 the United States accounted for only 20.5%. World petroleum consumption decreased in 2009 but has continued to increase beginning with 2010. Non-OECD consumption has continued to increase.

Table 1.4
World Petroleum Consumption, 1960–2015
(million barrels per day)

Year	United States	U.S. share	Total OECD ^a	Total non-OECD	World
1960	9.80	45.9%	15.78	5.56	21.34
1965	11.51	37.0%	22.81	8.33	31.14
1970	14.70	31.4%	34.69	12.12	46.81
1975	16.32	29.0%	39.14	17.06	56.20
1980	17.06	27.0%	42.03	21.09	63.12
1985	15.73	26.2%	37.70	22.39	60.08
1986	16.28	26.3%	38.83	22.99	61.82
1987	16.67	26.4%	39.59	23.51	63.11
1988	17.28	26.6%	40.92	24.05	64.98
1989	17.33	26.2%	41.62	24.47	66.09
1990	16.99	25.5%	41.75	24.79	66.54
1991	16.71	24.9%	42.22	24.97	67.19
1992	17.03	25.3%	43.25	24.15	67.40
1993	17.24	25.5%	43.69	23.93	67.62
1994	17.72	25.7%	44.92	24.09	69.01
1995	17.72	25.2%	45.40	24.86	70.26
1996	18.31	25.5%	46.53	25.35	71.88
1997	18.62	25.3%	47.30	26.29	73.60
1998	18.92	25.5%	47.49	26.78	74.27
1999	19.52	25.7%	48.48	27.50	75.98
2000	19.70	25.6%	48.50	28.56	77.06
2001	19.65	25.3%	48.54	29.19	77.73
2002	19.76	25.2%	48.51	29.91	78.42
2003	20.03	25.0%	49.23	30.84	80.07
2004	20.73	24.9%	50.05	33.16	83.21
2005	20.80	24.6%	50.38	34.25	84.63
2006	20.69	24.1%	50.16	35.54	85.70
2007	20.68	23.9%	50.04	36.46	86.49
2008	19.50	22.8%	48.36	37.28	85.64
2009	18.77	21.9%	46.30	39.29	85.58
2010	19.18	21.5%	47.00	42.17	89.17
2011	18.88	21.0%	46.33	43.56	89.88
2012	18.49	20.3%	45.93	45.16	91.09
2013	18.96	20.5%	46.07	46.26	92.32
2014	19.11	20.4%	45.77	47.84	93.61
2015	19.53	20.5%	46.34	49.02	95.36
<i>Average annual percentage change</i>					
1960–2015	1.3%		2.0%	4.0%	2.8%
1970–2015	0.6%		0.6%	3.2%	1.6%
2005–2015	-0.6%		-0.8%	3.3%	1.1%

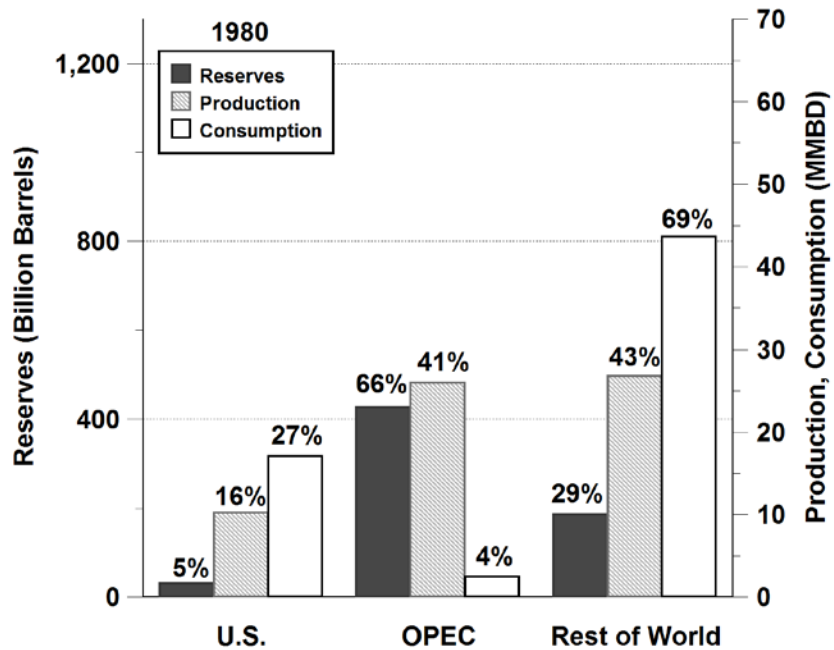
Source:

U.S. Department of Energy, Energy Information Administration, *International Energy Statistics* website, August 2017. (Additional resources: www.eia.doe.gov)

^a Organization for Economic Cooperation and Development. See Glossary for membership.

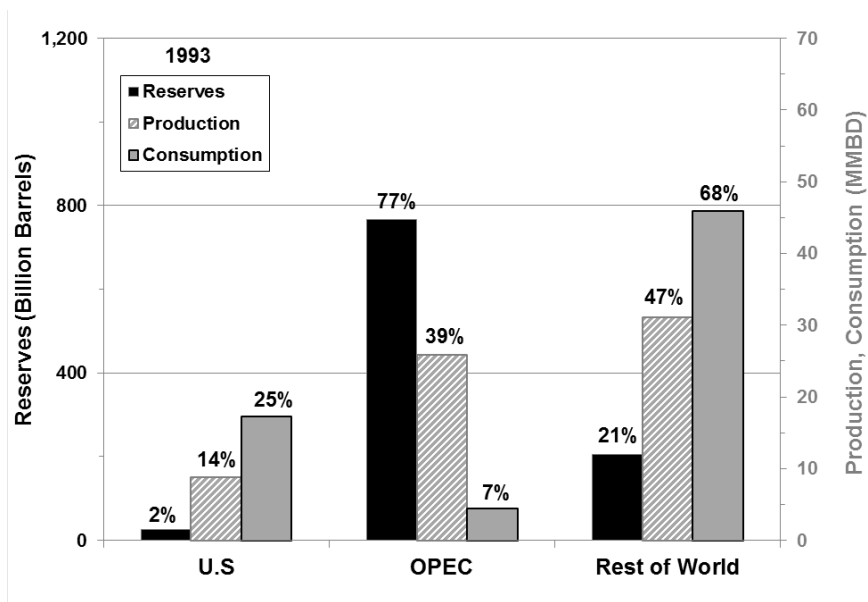


Figure 1.1. World Oil Reserves, Production, and Consumption, 1980



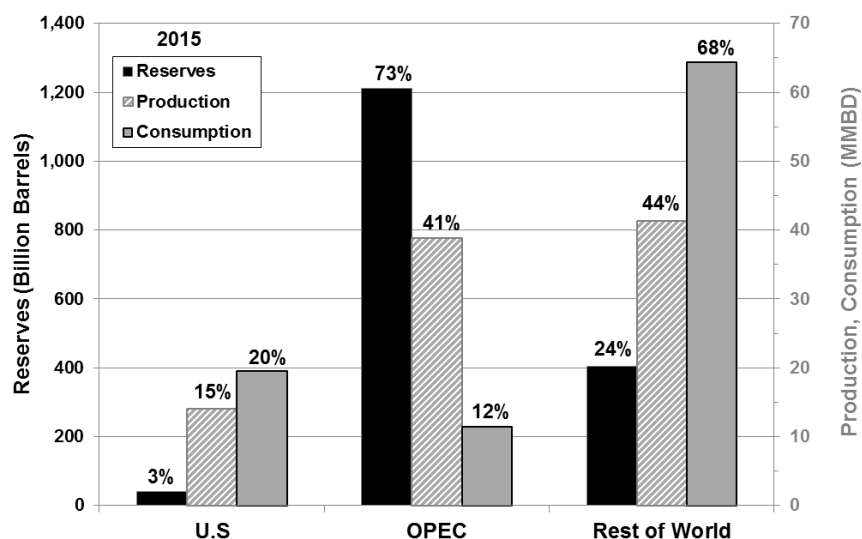
Source:
See Table 1.5.

Figure 1.2. World Oil Reserves, Production, and Consumption, 1993



Source:
See Table 1.5.



Figure 1.3. World Oil Reserves, Production, and Consumption, 2015

Source:
See Table 1.5.

Table 1.5
World Oil Reserves, Production, and Consumption, 1980, 1993 and 2015

	Crude oil reserves (billion barrels)	Reserve share	Petroleum production (million barrels per day)	Production share	Petroleum consumption (million barrels per day)	Consumption share
1980						
United States	31.2	5%	10.2	16%	17.1	27%
OPEC	426.7	66%	26.0	41%	2.5	4%
Rest of world	185.4	29%	26.8	43%	43.6	69%
1993						
United States	25.0	2%	8.84	14%	17.2	25%
OPEC	767.2	77%	25.85	39%	4.5	7%
Rest of world	205.2	21%	31.18	47%	45.9	68%
2015						
United States	40.0	3%	14.1	15%	19.5	20%
OPEC	1,212.0	73%	38.8	41%	11.5	12%
Rest of world	405.0	24%	41.3	44%	64.4	68%

Note: Total consumption is higher than total production due to refinery gains including alcohol and liquid products produced from coal and other sources. See Glossary for OPEC countries.

Sources:

Energy Information Administration, *International Energy Statistics*, August 2017. (Additional resources: www.eia.doe.gov)



The share of petroleum imported to the United States can be calculated using total imports or net imports. Net imports, which are the preferred data, rose to over 50% of U.S. petroleum consumption for the first time in 1998, while total imports reached 50% for the first time in 1993. OPEC share of net imports has been below 50% since 1993. Net imports as a share of consumption decreased to 24.1% in 2015 but rose slightly in 2016.

Table 1.6
U.S. Petroleum Imports, 1960–2016
(million barrels per day)

Year	Net OPEC ^a imports	Net OPEC ^a share	Net imports	Net imports as a share of U.S. consumption	Total imports
1960	1.23	68.0%	1.61	16.5%	1.81
1965	1.44	58.3%	2.28	19.8%	2.47
1970	1.29	37.8%	3.16	21.5%	3.42
1975	3.60	59.5%	5.85	35.8%	6.06
1980	4.30	62.2%	6.36	37.3%	6.91
1985	1.83	36.1%	4.29	27.3%	5.07
1986	2.84	45.6%	5.44	33.4%	6.22
1987	3.06	45.8%	5.91	35.5%	6.68
1988	3.52	47.6%	6.59	38.1%	7.40
1989	4.14	51.4%	7.20	41.6%	8.06
1990	4.30	53.6%	7.16	42.2%	8.02
1991	4.09	53.7%	6.63	39.6%	7.63
1992	4.09	51.9%	6.94	40.7%	7.89
1993	4.27	49.6%	7.62	44.2%	8.62
1994	4.25	47.2%	8.05	45.5%	9.00
1995	4.00	45.3%	7.89	44.5%	8.83
1996	4.21	44.4%	8.50	46.4%	9.48
1997	4.57	45.0%	9.16	49.2%	10.16
1998	4.91	45.8%	9.76	51.6%	10.71
1999	4.95	45.6%	9.91	50.8%	10.85
2000	5.20	45.4%	10.42	52.9%	11.46
2001	5.53	46.6%	10.90	55.5%	11.87
2002	4.61	39.9%	10.55	53.4%	11.53
2003	5.16	42.1%	11.24	56.1%	12.26
2004	5.70	43.4%	12.10	58.4%	13.15
2005	5.59	40.7%	12.55	60.3%	13.71
2006	5.52	40.2%	12.39	59.9%	13.71
2007	5.98	44.4%	12.04	58.2%	13.47
2008	5.95	46.1%	11.11	57.0%	12.92
2009	4.78	40.9%	9.67	51.5%	11.69
2010	4.91	41.6%	9.44	49.2%	11.79
2011	4.56	39.8%	8.45	44.8%	11.44
2012	4.27	40.3%	7.39	40.0%	10.60
2013	3.72	37.7%	6.24	32.9%	9.86
2014	3.24	35.0%	5.07	26.5%	9.24
2015	2.89	30.6%	4.71	24.1%	9.45
2016	3.45	34.2%	4.87	24.8%	10.06
<i>Average annual percentage change</i>					
1960–2016	1.9%		2.0%		3.1%
1970–2016	2.2%		0.9%		2.4%
2006–2016	-4.6%		-8.9%		-3.0%

Source:

U.S. Department of Energy, Energy Information Administration, *Monthly Energy Review*, Washington, DC, August 2017, Table 3.3a. (Additional resources: www.eia.gov)

^a Organization of Petroleum Exporting Countries. See Glossary for membership.



More than half of the oil imported to the United States in 2016 was from the western hemisphere. Canada, Mexico, and Venezuela provided most of the oil from the western hemisphere, along with small amounts from Brazil, Columbia, Ecuador, and the U.S. Virgin Islands (these countries are not listed separately).

Table 1.7
Imported Crude Oil by Country of Origin, 1973–2016
(million barrels per day)

Year	Saudi Arabia	Venezuela	Nigeria	Other OPEC ^a countries	Canada	Mexico	Russia	Other non-OPEC countries	Total imports
1973	0.49	1.13	0.46	0.91	1.32	0.02	0.03	1.90	6.26
1975	0.71	0.70	0.76	1.42	0.85	0.07	0.01	1.52	6.06
1980	1.26	0.48	0.86	1.70	0.45	0.53	0.00	1.62	6.91
1985	0.17	0.60	0.29	0.76	0.77	0.82	0.01	1.64	5.07
1986	0.68	0.79	0.44	0.92	0.81	0.70	0.02	1.86	6.22
1987	0.75	0.80	0.53	0.97	0.85	0.65	0.01	2.10	6.68
1988	1.07	0.79	0.62	1.03	1.00	0.75	0.03	2.11	7.40
1989	1.22	0.87	0.82	1.23	0.93	0.77	0.05	2.17	8.06
1990	1.34	1.02	0.80	1.13	0.93	0.76	0.04	1.99	8.02
1991	1.80	1.03	0.70	0.55	1.03	0.81	0.03	1.67	7.63
1992	1.72	1.17	0.68	0.52	1.07	0.83	0.02	1.88	7.89
1993	1.41	1.30	0.74	0.82	1.18	0.92	0.05	2.19	8.62
1994	1.40	1.33	0.64	0.87	1.27	0.98	0.03	2.46	9.00
1995	1.34	1.48	0.63	0.55	1.33	1.07	0.02	2.41	8.83
1996	1.36	1.68	0.62	0.56	1.42	1.24	0.03	2.57	9.48
1997	1.41	1.77	0.70	0.69	1.56	1.39	0.01	2.63	10.16
1998	1.49	1.72	0.70	1.00	1.60	1.35	0.02	2.83	10.71
1999	1.48	1.49	0.66	1.33	1.54	1.32	0.09	2.95	10.85
2000	1.57	1.55	0.90	1.19	1.81	1.37	0.07	3.00	11.46
2001	1.66	1.55	0.89	1.43	1.83	1.44	0.09	2.98	11.87
2002	1.55	1.40	0.62	1.03	1.97	1.55	0.21	3.20	11.53
2003	1.77	1.38	0.87	1.14	2.07	1.62	0.25	3.15	12.26
2004	1.56	1.55	1.14	1.45	2.14	1.66	0.30	3.34	13.15
2005	1.54	1.53	1.17	1.36	2.18	1.66	0.41	3.87	13.71
2006	1.46	1.42	1.11	1.52	2.35	1.71	0.37	3.76	13.71
2007	1.48	1.36	1.13	2.00	2.45	1.53	0.41	3.09	13.47
2008	1.53	1.19	0.99	2.25	2.49	1.30	0.47	2.70	12.92
2009	1.00	1.06	0.81	1.90	2.48	1.21	0.56	2.66	11.69
2010	1.10	0.99	1.02	1.80	2.54	1.28	0.61	2.46	11.79
2011	1.19	0.95	0.82	1.59	2.73	1.21	0.62	2.32	11.44
2012	1.37	0.96	0.44	1.51	2.95	1.03	0.48	1.87	10.60
2013	1.33	0.81	0.28	1.30	3.14	0.92	0.46	1.62	9.86
2014	1.17	0.79	0.09	1.19	3.39	0.84	0.33	1.44	9.24
2015	1.06	0.83	0.08	0.93	3.76	0.76	0.37	1.66	9.45
2016	1.10	0.80	0.24	1.31	3.80	0.67	0.43	1.71	10.06

Sources:

U.S. Department of Energy, Energy Information Administration, *Monthly Energy Review*, Washington, DC, July 2017, Tables 3.3c and 3.3d. (Additional resources: www.eia.gov)

^a Organization of Petroleum Exporting Countries. See Glossary for membership.



The Strategic Petroleum Reserve (SPR) began in October 1977 as a result of the 1975 Energy Policy and Conservation Act. Its purpose is to provide protection against oil supply disruptions. The U.S. consumed 19.6 million barrels per day in 2016. At that rate of consumption, the SPR supply would last 35 days if used exclusively and continuously.

Table 1.8
Crude Oil Supplies, 1973-2016

Year	Strategic Petroleum Reserve	Other crude oil stocks ^a	Total crude oil stocks	U.S. petroleum consumption (million barrels per day)	Number of days the SPR would supply the U.S. ^b
1973	0.0	242.5	242.5	17.3	0
1980	107.8	358.2	466.0	17.1	6
1985	493.3	320.9	814.2	15.7	31
1986	511.6	331.2	842.8	16.3	31
1987	540.6	349.0	889.6	16.7	32
1988	559.5	330.4	889.9	17.3	32
1989	579.9	341.3	921.1	17.3	33
1990	585.7	322.7	908.4	17.0	34
1991	568.5	324.6	893.1	16.7	34
1992	574.7	318.1	892.9	17.0	34
1993	587.1	335.4	922.5	17.2	34
1994	591.7	337.2	928.9	17.7	33
1995	591.6	303.3	895.0	17.7	33
1996	565.8	283.9	849.7	18.3	31
1997	563.4	304.7	868.1	18.6	30
1998	571.4	323.5	894.9	18.9	30
1999	567.2	284.5	851.7	19.5	29
2000	540.7	285.5	826.2	19.7	27
2001	550.2	312.0	862.2	19.6	28
2002	599.1	277.6	876.7	19.8	30
2003	638.4	268.9	907.3	20.0	32
2004	675.6	285.7	961.3	20.7	33
2005	684.5	307.7	992.2	20.8	33
2006	688.6	295.8	984.4	20.7	33
2007	696.9	268.4	964.3	20.7	34
2008	701.8	308.2	1,010.1	19.5	36
2009	726.6	307.1	1,033.8	18.8	39
2010	726.5	312.1	1,038.6	19.1	38
2011	696.0	308.2	1,004.2	18.9	37
2012	695.3	337.8	1,033.1	18.5	38
2013	696.0	327.2	1,023.2	19.0	37
2014	691.0	360.1	1,051.8	19.1	36
2015	695.1	449.2	1,144.3	19.5	36
2016	695.1	484.3	1,179.4	19.6	35

Sources:

U.S. Department of Energy, Energy Information Administration, *Monthly Energy Review*, Washington, DC, July 2017, Tables 3.1 and 3.4. (Additional resources: www.eia.gov)

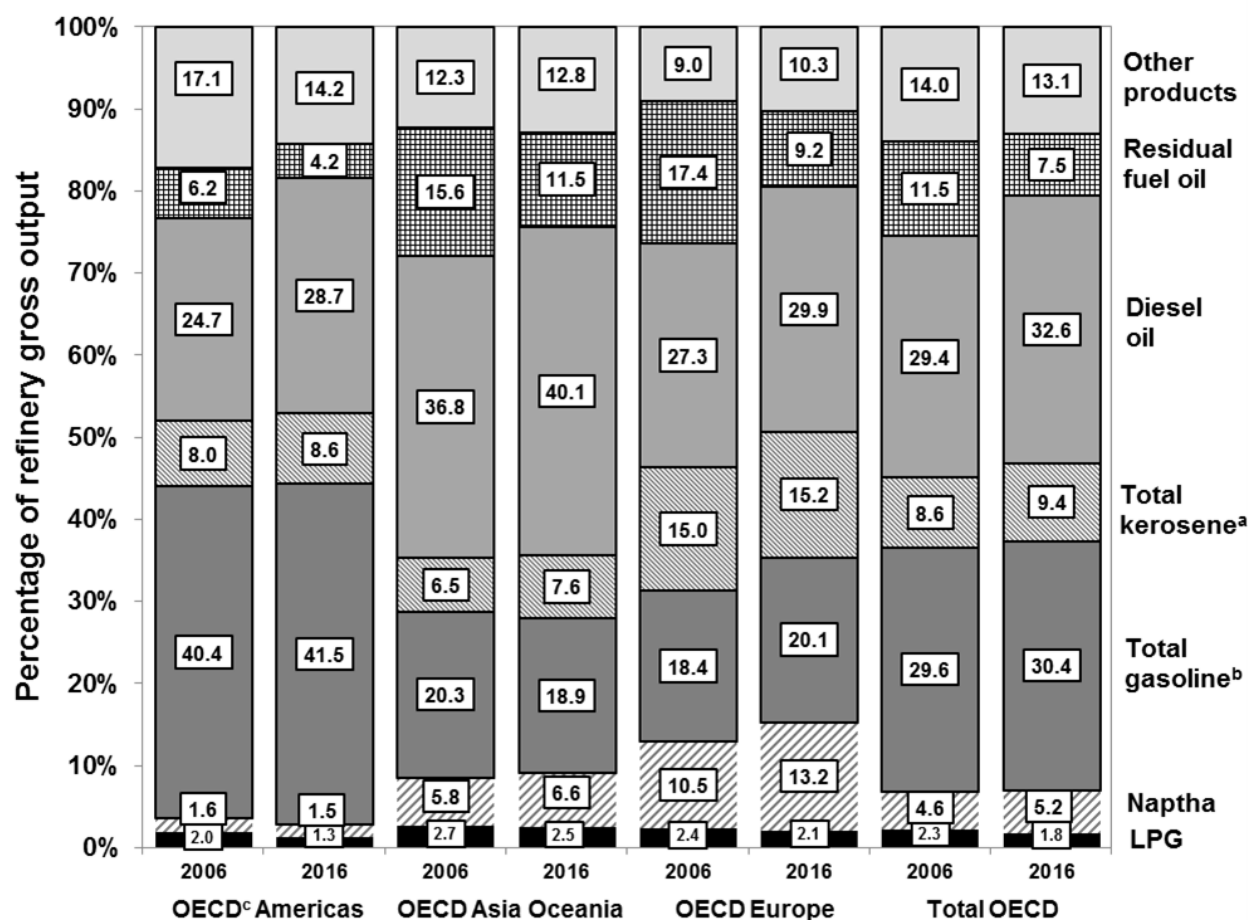
^a Other crude oil stocks include stocks held by petroleum companies, as well as stocks of Alaskan crude oil in transit.

^b Strategic Petroleum Reserves divided by U.S. consumption per day. This would only hold true if the SPR were the only oil used for that many days.



Other parts of the world refine crude oil to produce more diesel fuel and less gasoline than does OECD Americas. The OECD Asia Oceania countries produce the lowest share of gasoline in 2016.

Figure 1.4. Refinery Gross Output by World Region, 2006 and 2016



Source:

International Energy Agency, *Monthly Oil Survey*, May 2017 and *Monthly Oil Statistics*, February 2007. (Additional resources: www.iea.org)

^a Includes jet kerosene and other kerosene.

^b Includes motor gasoline, jet gasoline, and aviation gasoline.

^c Organization for Economic Cooperation and Development. See Glossary for membership.



Oxygenate refinery input increased significantly in 1995, most certainly due to the Clean Air Act Amendments of 1990 which mandated the sale of reformulated gasoline in certain areas beginning in January 1995. The use of MTBE has declined over the last ten years due to many states banning the additive. The other hydrocarbons and liquids category includes unfinished oils, motor gasoline blending components and aviation gasoline blending components.

Table 1.9
U.S. Refinery Input of Crude Oil and Petroleum Products, 1987–2015
(thousand barrels)

Year	Crude oil	Natural gas liquids	Oxygenates			Other hydrocarbons and liquids	Total input to refineries
			Fuel ethanol	MTBE ^a	Other oxygenates ^b		
1987	4,691,783	280,889	c	c	d	132,720	5,105,392
1988	4,848,175	304,566	c	c	d	105,645	5,258,386
1989	4,891,381	182,109	c	c	d	223,797	5,297,287
1990	4,894,379	170,589	c	c	d	260,108	5,325,076
1991	4,855,016	172,306	c	c	d	280,265	5,307,587
1992	4,908,603	171,701	c	c	d	272,676	5,352,980
1993	4,968,641	179,213	3,351	49,393	1,866	280,074	5,482,538
1994	5,061,111	169,868	3,620	52,937	1,918	193,808	5,483,262
1995	5,100,317	172,026	9,055	79,396	4,122	190,411	5,555,327
1996	5,195,265	164,552	11,156	79,407	3,570	214,282	5,668,232
1997	5,351,466	151,769	11,803	86,240	4,246	201,268	5,806,792
1998	5,434,383	146,921	11,722	89,362	4,038	206,135	5,892,561
1999	5,403,450	135,756	13,735	94,784	4,147	225,779	5,877,651
2000	5,514,395	138,921	15,268	90,288	4,005	201,135	5,964,012
2001	5,521,637	156,479	16,929	87,116	4,544	192,632	5,979,337
2002	5,455,530	155,429	26,320	90,291	2,338	224,567	5,955,475
2003	5,585,875	152,763	55,626	67,592	1,937	163,459	6,027,252
2004	5,663,861	154,356	74,095	47,600	940	194,203	6,135,055
2005	5,555,332	161,037	84,088	39,751	612	295,064	6,135,884
2006	5,563,354	182,924	117,198	11,580	57	322,989	6,198,102
2007	5,532,097	184,383	136,603	1,610	0	349,807	6,204,500
2008	5,361,287	177,559	190,084	480	0	548,843	6,277,893
2009	5,232,656	177,194	240,955	90	0	518,998	6,169,893
2010	5,374,094	161,479	285,883	901	0	523,015	6,345,372
2011	5,404,347	178,884	297,266	1,154	0	541,059	6,422,710
2012	5,489,516	186,270	304,155	806	0	425,946	6,406,693
2013	5,589,006	181,112	310,568	915	0	495,476	6,577,077
2014	5,784,637	186,601	317,171	719	1	490,213	6,779,342
2015	5,908,550	188,722	325,858	830	0	446,744	6,870,704
<i>Average annual percentage change</i>							
1987–2015	0.8%	-1.4%	d	d	d	4.4%	1.1%
2005–2015	0.6%	1.6%	14.5%	-32.1%	-100.0%	4.2%	1.1%

Source:

U.S. Department of Energy, Energy Information Administration, *Petroleum Supply Annual 2015*, Vol. 1, September 2016, Table 16, and annual. (Additional resources: www.eia.doe.gov)

^a Methyl tertiary butyl ether (MTBE).

^b Includes methanol and other oxygenates.

^c Reported in “Other hydrocarbons and liquids” category in this year.

^d Data are not available.



When crude oil and other hydrocarbons are processed into products that are, on average, less dense than the input, a processing volume gain occurs. Due to this gain, the product yield from a barrel of crude oil is more than 100%. For the last 20 years, the processing volume gain has been about 5-7%.

Table 1.10
U.S. Refinery Yield of Petroleum Products from a Barrel of Crude Oil, 1978–2016
(percentage)

Year	Motor gasoline	Distillate fuel oil	Jet fuel	Liquefied petroleum gas	Other ^a	Total ^b
1978	44.1	21.4	6.6	2.3	29.6	104.0
1980	44.5	19.7	7.4	2.4	30.0	104.0
1985	45.6	21.6	9.6	3.1	24.6	104.5
1986	45.7	21.2	9.8	3.2	24.8	104.7
1987	46.4	20.5	10.0	3.4	24.5	104.8
1988	46.0	20.8	10.0	3.6	24.4	104.8
1989	45.7	20.8	10.1	4.0	24.2	104.8
1990	45.6	20.9	10.7	3.6	24.1	104.9
1991	45.7	21.3	10.3	3.8	24.1	105.2
1992	46.0	21.2	9.9	4.3	24.0	105.4
1993	46.1	21.9	9.2	4.1	24.2	105.5
1994	45.5	22.3	9.8	4.2	23.8	105.6
1995	46.4	21.8	9.7	4.5	23.3	105.7
1996	45.7	22.7	10.4	4.5	22.6	105.9
1997	45.7	22.5	10.3	4.6	22.6	105.7
1998	46.2	22.3	9.9	4.4	23.1	105.9
1999	46.5	22.3	10.2	4.5	22.6	106.1
2000	46.2	23.1	10.3	4.5	22.1	106.2
2001	46.2	23.8	9.8	4.3	21.6	105.7
2002	47.3	23.2	9.8	4.3	21.4	106.0
2003	46.9	23.7	9.5	4.2	22.2	106.5
2004	46.8	23.9	9.7	4.0	22.4	106.8
2005	46.2	25.0	9.8	3.6	21.6	106.2
2006	45.8	25.4	9.3	3.9	21.7	106.1
2007	45.5	26.1	9.1	4.1	21.7	106.5
2008	44.2	27.8	9.7	4.1	20.8	106.6
2009	46.6	26.6	9.2	4.1	19.9	106.4
2010	46.3	27.2	9.2	4.3	19.8	106.8
2011	45.6	28.6	9.3	4.0	19.1	106.6
2012	45.7	28.7	9.4	4.0	18.6	106.4
2013	45.7	29.1	9.4	3.9	18.5	106.6
2014	45.7	29.5	9.4	4.0	17.6	106.2
2015	46.0	29.5	9.6	3.7	17.1	105.9
2016	47.0	28.4	9.8	3.7	17.1	106.0

Source:

Department of Energy, Energy Information Administration, *Petroleum Supply Navigator*, July 2017. (Additional resources: www.eia.doe.gov)

^a Includes aviation gasoline (0.1%), kerosene (0.1%), residual fuel oil (2.5%), naphtha and other oils for petrochemical feedstock use (1.1%), other oils for petrochemical feedstock use (0.6%), special naphthas (0.2%), lubricants (0.6%), petroleum coke (5.4%) asphalt and road oil (1.9%), still gas (4.1%), and miscellaneous products (0.5%).

^b Products sum to greater than 100% due to processing gain. The processing gain for years 1978 to 1980 is assumed to be 4 percent.



Domestic petroleum production increased in 2009 for the first time in 20 years and continued to increase through 2015. Most of the petroleum imported by the United States is in the form of crude oil. The United States does export small amounts of petroleum, mainly refined petroleum products which go to Canada and Mexico.

Table 1.11
United States Petroleum Production, Imports, and Exports, 1950–2016
(million barrels per day)

	Domestic production			Net imports			Exports		
	Crude oil	Natural gas plant liquids	Total ^a	Crude oil	Petroleum products	Total	Crude oil	Petroleum products	Total
1950	5.41	0.50	5.91	0.49	0.36	0.85	0.10	0.21	0.31
1955	6.81	0.77	7.58	0.78	0.47	1.25	0.03	0.34	0.37
1960	7.05	0.93	7.98	1.02	0.80	1.82	0.01	0.19	0.20
1965	7.80	1.21	9.01	1.24	1.23	2.47	0.00	0.18	0.19
1970	9.64	1.66	11.30	1.32	2.10	3.42	0.01	0.25	0.26
1975	8.38	1.63	10.01	4.11	1.95	6.06	0.01	0.20	0.21
1980	8.60	1.57	10.17	5.26	1.65	6.91	0.29	0.26	0.54
1985	8.97	1.61	10.58	3.20	1.87	5.07	0.20	0.58	0.78
1990	7.36	1.56	8.91	5.89	2.12	8.02	0.11	0.75	0.86
1995	6.56	1.76	8.32	7.23	1.61	8.83	0.09	0.85	0.95
1996	6.46	1.83	8.29	7.51	1.97	9.48	0.11	0.87	0.98
1997	6.45	1.82	8.27	8.23	1.94	10.16	0.11	0.90	1.00
1998	6.25	1.76	8.01	8.71	2.00	10.71	0.11	0.83	0.94
1999	5.88	1.85	7.73	8.73	2.12	10.85	0.12	0.82	0.94
2000	5.82	1.91	7.73	9.07	2.39	11.46	0.05	0.99	1.04
2001	5.80	1.87	7.67	9.33	2.54	11.87	0.02	0.95	0.97
2002	5.74	1.88	7.62	9.14	2.39	11.53	0.01	0.97	0.98
2003	5.65	1.72	7.37	9.67	2.60	12.26	0.01	1.01	1.03
2004	5.44	1.81	7.25	10.09	3.06	13.15	0.03	1.02	1.05
2005	5.18	1.72	6.90	10.13	3.59	13.71	0.03	1.13	1.17
2006	5.09	1.74	6.83	10.12	3.59	13.71	0.02	1.29	1.32
2007	5.08	1.78	6.86	10.03	3.44	13.47	0.03	1.41	1.43
2008	5.00	1.78	6.79	9.78	3.13	12.92	0.03	1.77	1.80
2009	5.35	1.91	7.26	9.01	2.68	11.69	0.04	1.98	2.02
2010	5.48	2.07	7.55	9.21	2.58	11.79	0.04	2.31	2.35
2011	5.65	2.22	7.86	8.94	2.50	11.44	0.05	2.94	2.99
2012	6.49	2.41	8.90	8.53	2.07	10.60	0.07	3.14	3.21
2013	7.47	2.61	10.07	7.73	2.13	9.86	0.13	3.49	3.62
2014	8.76	3.02	11.78	7.34	1.90	9.24	0.35	3.83	4.18
2015	9.42	3.34	12.76	7.36	2.09	9.45	0.47	4.27	4.74
2016	8.88	3.48	12.35	7.88	2.18	10.06	0.52	4.67	5.19
<i>Average annual percentage change</i>									
1950–2016	0.8%	3.0%	1.1%	4.3%	2.8%	3.8%	2.5%	4.8%	4.4%
1970–2016	-0.2%	1.6%	0.2%	4.0%	0.1%	2.4%	9.0%	6.5%	6.7%
2006–2016	5.7%	7.2%	6.1%	-2.5%	-4.9%	-3.0%	33.0%	13.7%	14.7%

Source:

U.S. Department of Energy, Energy Information Administration, *Monthly Energy Review*, Washington, DC, July 2017, Tables 3.1 and 3.3b. (Additional resources: www.eia.gov)

^a Total domestic production includes crude oil, natural gas plant liquids and small amounts of other liquids.



U.S. petroleum production has been increasing and petroleum imports decreasing from 2008 through 2015. Net imports of petroleum in 2015 were at the lowest level since 1985. In 2016, domestic production declined slightly.

Table 1.12
Petroleum Production and Transportation Petroleum Consumption in Context, 1950–2016

	Domestic petroleum production ^a	Net petroleum imports	Transportation petroleum consumption	U.S. petroleum consumption	World petroleum consumption	Net imports as a share of U.S. consumption	U.S. petroleum consumption as a share of world consumption	Transportation petroleum use as a share of domestic production
	(million barrels per day)							
1950	5.91	0.55	3.36	6.46	^b	8.4%	^b	56.8%
1955	7.58	0.88	4.46	8.46	^b	10.4%	^b	58.8%
1960	7.99	1.62	5.15	9.82	21.34	16.5%	46.0%	64.5%
1965	9.01	2.28	6.04	11.51	31.14	19.8%	37.0%	67.0%
1970	11.30	3.16	7.78	14.70	46.81	21.5%	31.4%	68.9%
1975	10.01	5.85	8.92	16.32	56.20	35.8%	29.0%	89.4%
1980	10.17	6.36	9.55	17.06	63.12	37.3%	27.0%	93.9%
1985	10.58	4.29	9.84	15.73	60.08	27.3%	26.2%	93.0%
1990	8.91	7.16	10.99	16.99	66.54	42.2%	25.5%	123.2%
1995	8.32	7.89	11.50	17.72	70.26	44.5%	25.2%	138.2%
1996	8.29	8.50	11.83	18.31	71.88	46.4%	25.5%	142.6%
1997	8.27	9.16	12.14	18.62	73.60	49.2%	25.3%	146.8%
1998	8.01	9.76	12.40	18.92	74.27	51.6%	25.5%	154.8%
1999	7.73	9.91	12.74	19.52	75.98	50.8%	25.7%	164.8%
2000	7.73	10.42	12.99	19.70	76.93	52.9%	25.6%	168.0%
2001	7.67	10.90	12.91	19.65	77.73	55.5%	25.3%	168.4%
2002	7.62	10.55	13.18	19.76	78.46	53.4%	25.2%	172.9%
2003	7.37	11.24	13.25	20.03	80.09	56.1%	25.0%	179.8%
2004	7.25	12.10	13.67	20.73	83.06	58.4%	25.0%	188.6%
2005	6.90	12.55	13.90	20.80	84.56	60.3%	24.6%	201.6%
2006	6.83	12.39	14.11	20.69	85.57	59.9%	24.2%	206.7%
2007	6.86	12.04	14.20	20.68	86.72	58.2%	23.8%	207.0%
2008	6.78	11.11	13.50	19.50	86.05	57.0%	22.7%	199.0%
2009	7.26	9.67	13.16	18.77	84.97	51.5%	22.1%	181.3%
2010	7.55	9.44	13.35	19.18	89.17	49.2%	21.5%	176.9%
2011	7.86	8.45	13.14	18.88	89.88	44.8%	21.0%	167.2%
2012	8.90	7.39	12.86	18.49	91.09	40.0%	20.3%	144.6%
2013	10.07	6.24	13.09	18.96	92.32	32.9%	20.5%	130.0%
2014	11.78	5.07	13.29	19.11	93.61	26.5%	20.4%	112.9%
2015	12.76	4.71	13.60	19.53	95.36	24.1%	20.5%	106.6%
2016	12.35	4.87	13.69	19.63	^b	24.8%	^b	110.9%
<i>Average annual percentage change</i>								
1950–2016	1.1%	3.4%	2.2%	1.7%	^b			
1970–2016	0.2%	0.9%	1.2%	0.6%	^b			
2006–2016	6.1%	-8.9%	-0.3%	-0.5%	^b			

Sources:

U.S. Department of Energy, Energy Information Administration, *Monthly Energy Review*, Washington, DC, July 2017, Tables 2.5, 3.1, and A3. (Pre-1973 data from the *Annual Energy Review*). World petroleum consumption - U.S. Department of Energy, Energy Information Administration, *International Energy Statistics* website, August 2017. (Additional resources: www.eia.doe.gov)

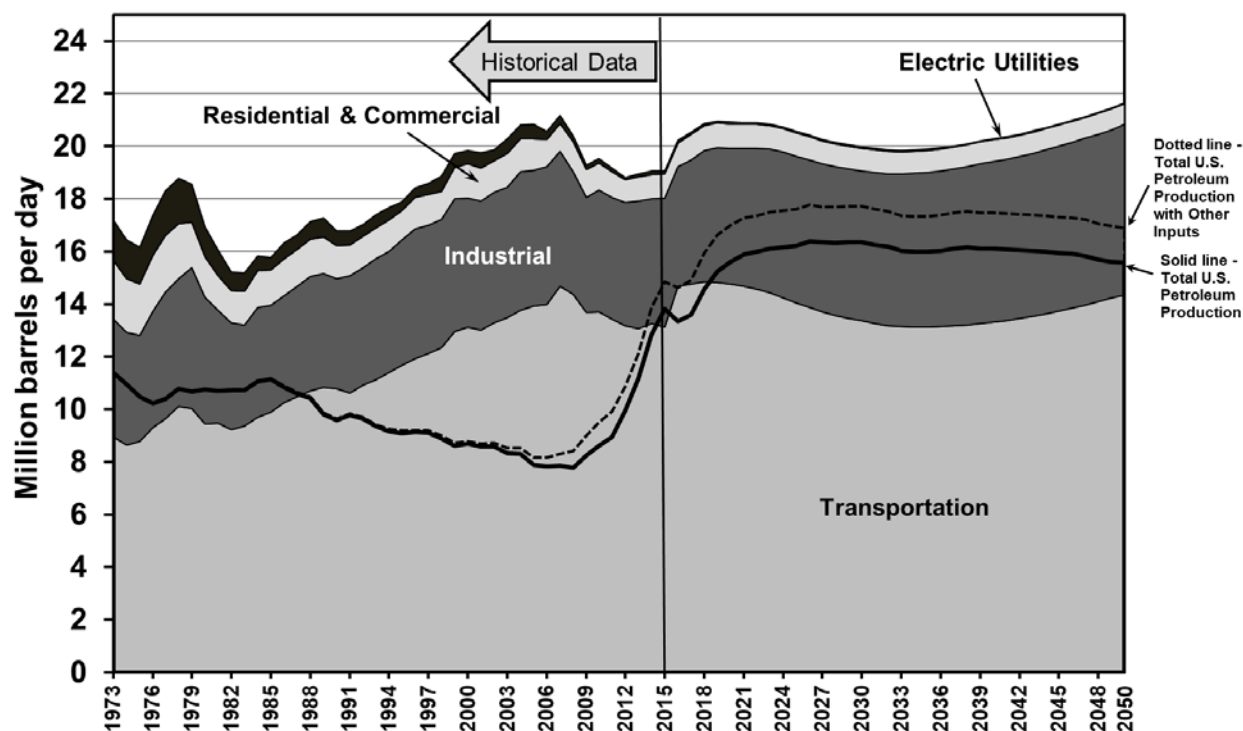
^a Total domestic production includes crude oil, natural gas plant liquids and small amounts of other liquids.

^b Data are not available.



Before 1989 the U.S. produced enough petroleum to meet the needs of the transportation sector, but was still short of meeting the petroleum needs of all the sectors, including industrial, residential and commercial, and electric utilities. In 1973 the gap between what the U.S. produced and what was consumed was 5.8 million barrels per day. By 2050, the gap is expected to be only about 4.8 million barrels per day if petroleum and other inputs are included or 6.1 million barrels per day if only conventional petroleum is used.

Figure 1.5. United States Petroleum Production and Consumption – All Sectors, 1973–2050



Notes: “Total U.S. Petroleum Production” includes crude oil, natural gas plant liquids, and refinery gains. It does not include dry natural gas.

“Total U.S. Petroleum Production” is for all uses.

“Total U.S. Petroleum Production with Other Inputs” also includes non-petroleum sources such as ethanol, biomass, liquids from coal, other blending components, other hydrocarbons, and ethers which were domestically produced.

The change from historical values to projected values is between 2015 and 2016.

The sharp increase in the value for heavy trucks between 2006 and 2007 is the result of the Federal Highway Administration’s methodology change.

Sources:

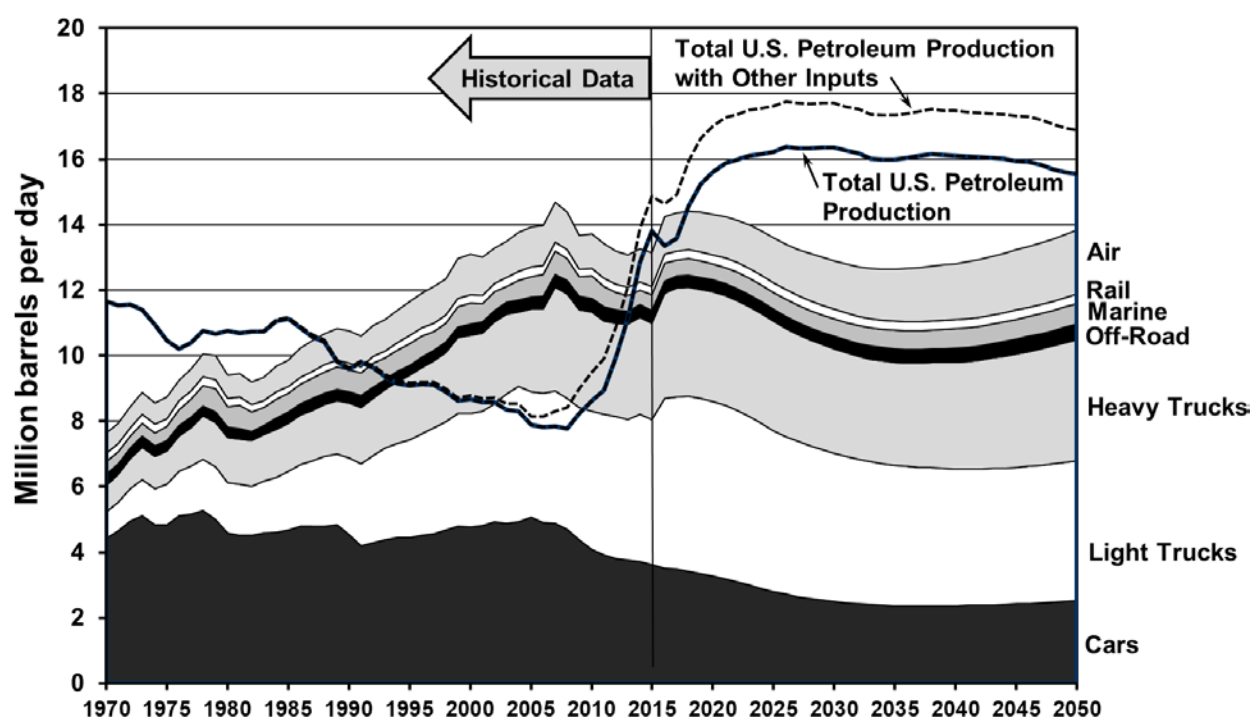
Historical transportation petroleum use – See Tables 1.14 and 1.15. Historical petroleum use for other sectors – See Table 1.13. Historical U.S. petroleum production – Energy Information Administration, *Monthly Energy Review August 2017*, Table 3.1. Historical other inputs - Energy Information Administration, *Monthly Energy Review August 2017*, Tables 10.3 and 10.4. Forecasted petroleum use and petroleum production – Energy Information Administration, *2017 Annual Energy Outlook*, January 2017, reference case tables 7, 11, and 36.



In 1989, for the first time, the petroleum consumption for transportation surpassed total U.S. petroleum production, which was declining. These contrasting trends in production and consumption created a gap that was met with foreign imports of petroleum. In 2009, however, the U.S. production of petroleum (for all uses including, but not limited to, transportation) began to increase substantially because of new hydraulic fracturing and oil extraction technology. In 2015, total production exceeded all transportation sector petroleum consumption. With other inputs included, such as ethanol, domestic production has exceeded transportation consumption since 2014. Transportation accounts for about 70% of all U.S. petroleum consumption.

The Energy Information Administration expects petroleum production to be greater than transportation consumption through 2040. Including non-petroleum sources such as ethanol, the production will exceed transportation demand by about three million barrels per day in 2050.

Figure 1.6. United States Petroleum Production and Transportation Consumption, 1970–2050



Notes: “Total U.S. Petroleum Production” includes crude oil, natural gas plant liquids, and refinery gains. It does not include dry natural gas.

“Total U.S. Petroleum Production” is for all uses, including but not limited to transportation.

“Total U.S. Petroleum Production with Other Inputs” also includes non-petroleum sources such as ethanol, biomass, liquids from coal, other blending components, other hydrocarbons, and ethers which were domestically produced.

The change from historical values to projected values is between 2015 and 2016.

The sharp increase in the value for heavy trucks between 2006 and 2007 is the result of the Federal Highway Administration’s methodology change.

Sources:

Historical transportation petroleum use – See Tables 1.14 and 1.15. Historical U.S. petroleum production – Energy Information Administration, *Monthly Energy Review August 2017*, Table 3.1. Historical other inputs - Energy Information Administration, *Monthly Energy Review August 2017*, Tables 10.3 and 10.4. Forecasted petroleum use and petroleum production – Energy Information Administration, *2017 Annual Energy Outlook*, January 2017, reference case tables 7, 11, and 36.



Transportation accounted for about 70% of the U.S. petroleum use from 2008 to 2016. Total petroleum consumption reached more than 20 million barrels per day from 2003 to 2007, but has been below that level from 2008 through present.

Table 1.13
Consumption of Petroleum by End-Use Sector, 1973–2016
 (million barrels per day)

Year	Transportation	Percentage	Residential	Commercial	Industrial	Electric utilities	Total
1973	9.05	52.3%	1.46	0.77	4.48	1.54	17.31
1975	8.95	54.8%	1.29	0.65	4.04	1.39	16.32
1980	9.55	56.0%	0.89	0.63	4.84	1.15	17.06
1981	9.49	59.1%	0.79	0.54	4.27	0.96	16.06
1982	9.31	60.8%	0.75	0.50	4.06	0.69	15.30
1983	9.41	61.8%	0.72	0.57	3.85	0.68	15.23
1984	9.59	61.0%	0.79	0.60	4.19	0.56	15.73
1985	9.84	62.6%	0.82	0.53	4.07	0.48	15.73
1986	10.19	62.6%	0.80	0.57	4.09	0.64	16.28
1987	10.51	63.0%	0.85	0.55	4.21	0.55	16.67
1988	10.84	62.7%	0.87	0.54	4.35	0.68	17.28
1989	10.89	62.8%	0.87	0.51	4.31	0.74	17.33
1990	10.99	64.7%	0.75	0.50	4.19	0.57	16.99
1991	10.56	63.2%	0.73	0.46	4.45	0.52	16.71
1992	10.94	64.2%	0.76	0.45	4.46	0.44	17.03
1993	10.98	63.7%	0.77	0.40	4.60	0.49	17.24
1994	11.46	64.7%	0.76	0.41	4.61	0.47	17.72
1995	11.50	64.9%	0.74	0.38	4.78	0.33	17.72
1996	11.83	64.6%	0.81	0.40	4.92	0.36	18.31
1997	12.14	65.2%	0.79	0.38	4.90	0.41	18.62
1998	12.40	65.5%	0.72	0.36	4.86	0.58	18.92
1999	12.74	65.3%	0.82	0.37	5.05	0.54	19.52
2000	12.99	65.9%	0.87	0.42	4.92	0.51	19.70
2001	12.91	65.7%	0.85	0.41	4.91	0.57	19.65
2002	13.18	66.7%	0.82	0.38	4.95	0.43	19.76
2003	13.25	66.1%	0.87	0.44	4.95	0.54	20.03
2004	13.67	65.9%	0.84	0.42	5.26	0.54	20.73
2005	13.90	66.8%	0.82	0.39	5.14	0.55	20.80
2006	14.11	68.2%	0.69	0.35	5.25	0.29	20.69
2007	14.20	68.7%	0.72	0.34	5.12	0.30	20.68
2008	13.50	69.2%	0.78	0.36	4.65	0.21	19.50
2009	13.16	70.1%	0.70	0.36	4.38	0.18	18.77
2010	13.35	69.6%	0.68	0.35	4.62	0.18	19.18
2011	13.14	69.6%	0.62	0.34	4.63	0.14	18.88
2012	12.86	69.6%	0.53	0.31	4.68	0.10	18.49
2013	13.09	69.1%	0.59	0.31	4.84	0.12	18.96
2014	13.29	69.6%	0.61	0.32	4.74	0.14	19.11
2015	13.60	69.6%	0.59	0.32	4.89	0.13	19.53
2016	13.69	69.8%	0.58	0.48	4.76	0.12	19.63
<i>Average annual percentage change</i>							
1973–2016	1.0%		-2.1%	-1.1%	0.1%	-5.8%	0.3%
2006–2016	-0.3%		-1.7%	3.2%	-1.0%	-8.4%	-0.5%

Source:

U.S. Department of Energy, Energy Information Administration, *Monthly Energy Review*, Washington, DC, July 2017, Tables 2.2–2.6. Converted to million barrels per day using Table A3. (Additional resources: www.eia.doe.gov)



Cars and light trucks use most of the petroleum in the transportation sector. Light trucks include pick-ups, minivans, sport-utility vehicles, and vans. See Table 2.9 for highway energy use in trillion Btu.

Table 1.14
Highway Transportation Petroleum Consumption by Mode, 1970–2015^a
(thousand barrels per day)

Year	Cars	Light trucks	Light vehicle subtotal	Motor-cycles	Buses	Class 3-6 trucks	Class 7-8 trucks	Heavy Trucks subtotal	Highway subtotal	Total transportation ^b
1970	4,424	803	5,227	4	62	140	598	738	6,031	7,301
1975	4,836	1,245	6,081	7	58	181	771	952	7,099	8,435
1980	4,565	1,552	6,117	13	68	247	1,055	1,302	7,500	9,092
1981	4,508	1,546	6,054	14	69	253	1,077	1,329	7,466	9,154
1982	4,509	1,481	5,989	13	71	253	1,077	1,330	7,403	8,929
1983	4,587	1,562	6,149	11	72	257	1,097	1,354	7,586	9,062
1984	4,609	1,670	6,280	11	69	266	1,132	1,398	7,758	9,351
1985	4,665	1,785	6,450	12	72	265	1,131	1,396	7,930	9,526
1986	4,773	1,897	6,670	12	76	271	1,155	1,426	8,184	9,882
1987	4,782	1,996	6,778	12	77	279	1,190	1,469	8,336	10,099
1988	4,784	2,130	6,914	13	80	284	1,211	1,495	8,503	10,328
1989	4,821	2,170	6,992	14	79	291	1,242	1,534	8,618	10,490
1990	4,538	2,323	6,861	12	78	304	1,294	1,597	8,549	10,414
1991	4,196	2,493	6,688	12	83	310	1,320	1,630	8,413	10,236
1992	4,268	2,670	6,938	12	87	315	1,345	1,660	8,698	10,574
1993	4,374	2,795	7,169	13	86	325	1,386	1,711	8,979	10,811
1994	4,428	2,878	7,305	13	86	343	1,463	1,806	9,211	11,082
1995	4,440	2,975	7,415	13	87	357	1,523	1,881	9,396	11,340
1996	4,515	3,089	7,604	13	88	367	1,564	1,931	9,636	11,595
1997	4,559	3,222	7,781	13	91	370	1,579	1,949	9,834	11,769
1998	4,677	3,292	7,969	13	93	382	1,630	2,012	10,086	12,004
1999	4,780	3,448	8,228	14	96	420	1,792	2,212	10,550	12,636
2000	4,766	3,453	8,219	14	98	437	1,861	2,298	10,630	12,786
2001	4,798	3,491	8,290	13	93	436	1,859	2,295	10,690	12,655
2002	4,923	3,602	8,525	12	91	456	1,944	2,401	11,029	12,939
2003	4,866	3,963	8,829	12	90	443	1,890	2,334	11,265	13,119
2004	4,919	4,137	9,055	13	92	411	1,752	2,162	11,323	13,387
2005	5,050	3,840	8,890	12	93	461	1,965	2,426	11,422	13,555
2006	4,893	3,959	8,852	14	94	470	2,006	2,476	11,436	13,600
2007	4,852	4,034	8,885	31	92	585	2,495	3,080	12,089	14,291
2008	4,664	3,992	8,656	32	95	591	2,521	3,112	11,895	13,985
2009	4,344	4,033	8,376	31	95	549	2,341	2,890	11,392	13,257
2010	4,060	4,220	8,280	28	90	558	2,379	2,937	11,335	13,294
2011	3,891	4,291	8,182	28	92	525	2,240	2,766	11,068	13,003
2012	3,777	4,331	8,108	32	95	525	2,238	2,763	10,998	12,794
2013	3,737	4,276	8,013	31	97	537	2,288	2,824	10,965	12,692
2014	3,684	4,502	8,185	30	98	545	2,325	2,871	11,184	12,873
2015	3,602	4,418	8,020	29	96	542	2,311	2,853	10,998	12,763
<i>Average annual percentage change</i>										
1970–2015	-0.5%	3.9%	1.0%	4.5%	1.0%	3.1%	3.0%	3.1%	1.3%	1.2%
2005–2015	-3.3%	1.4%	-1.0%	9.2%	0.3%	1.6%	1.6%	1.6%	-0.4%	-0.6%

Source:

See Appendix A, Section 2.1 Highway Energy Use.

^a Each gallon of petroleum product was assumed to equal one gallon of crude oil. The oil used to produce electricity is also estimated. See Appendix A, Section 2.4 for details.

^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).

^c Due to changes in the FHWA fuel use methodology, motorcycle, bus, and heavy truck data are not comparable with data before the year 2007. Car and light truck data changed after 2008; see Appendix A, Section 7, Car/Light Truck Shares.



Although about 18% of transportation energy use is for nonhighway modes, only 14% of transportation petroleum use is for nonhighway. This is because some nonhighway modes, such as pipelines and transit rail, use electricity. An estimate for the petroleum used to make electricity is included in the data. See Table 2.10 for nonhighway transportation energy use in trillion Btu.

Table 1.15
Nonhighway Transportation Petroleum Consumption by Mode, 1970–2015^a
(thousand barrels per day)

Year	Air	Water	Pipeline	Rail	Nonhighway subtotal	Total transportation ^b
1970	625	381	14	250	1,270	7,301
1975	651	423	16	246	1,336	8,435
1980	697	625	11	259	1,592	9,092
1985	814	564	4	214	1,596	9,526
1986	884	601	6	207	1,698	9,882
1987	920	626	5	211	1,763	10,099
1988	958	644	6	217	1,825	10,328
1989	960	688	6	218	1,872	10,490
1990	991	655	5	214	1,865	10,414
1991	928	690	4	201	1,823	10,236
1992	942	724	3	207	1,876	10,574
1993	961	653	4	213	1,831	10,811
1994	1,004	635	4	229	1,871	11,082
1995	1,036	668	2	238	1,944	11,340
1996	1,068	644	3	244	1,959	11,595
1997	1,113	574	3	245	1,935	11,769
1998	1,102	566	4	246	1,918	12,004
1999	1,202	625	4	255	2,086	12,636
2000	1,236	662	3	254	2,156	12,786
2001	1,161	546	4	255	1,966	12,655
2002	1,079	572	3	256	1,910	12,939
2003	1,094	496	3	262	1,855	13,119
2004	1,188	596	3	276	2,064	13,387
2005	1,226	625	3	279	2,133	13,555
2006	1,216	661	2	285	2,163	13,600
2007	1,215	709	2	276	2,202	14,291
2008	1,160	664	1	265	2,091	13,985
2009	1,029	613	1	221	1,864	13,257
2010	1,040	677	1	240	1,959	13,294
2011	1,044	638	1	253	1,935	13,003
2012	1,006	543	1	247	1,797	12,794
2013	987	486	1	253	1,727	12,692
2014	997	426	1	265	1,689	12,873
2015	1,025	486	1	253	1,765	12,763
<i>Average annual percentage change</i>						
1970–2015	1.1%	0.5%	-5.7%	0.0%	0.7%	1.2%
2005–2015	-1.8%	-2.5%	-10.4%	-1.0%	-1.9%	-0.6%

Source:

See Appendix A, Section 2.3. Nonhighway Energy Use.

^a Each gallon of petroleum product was assumed to equal one gallon of crude oil. The oil used to produce electricity is also estimated. See Appendix A, Section 2.3 Nonhighway Energy Use for details.

^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).



Highway vehicles were responsible for 86.2% of all transportation petroleum use in 2015. See Table 2.8 for transportation energy use in trillion Btu.

Table 1.16
Transportation Petroleum Use by Mode, 2014–2015^a

	Thousand barrels per day		Percentage of total ^b		Percentage of total U.S. petroleum consumption ^b	
	2014	2015	2014	2015	2014	2015
HIGHWAY	11,184.1	10,998.1	86.9%	86.2%	58.5%	56.3%
Light vehicles	8,215.3	8,048.9	63.8%	63.1%	43.0%	41.2%
Cars	3,683.6	3,601.6	28.6%	28.2%	19.3%	18.4%
Light trucks ^c	4,501.8	4,418.1	35.0%	34.6%	23.6%	22.6%
Motorcycles	29.9	29.2	0.2%	0.2%	0.2%	0.1%
Buses	97.9	96.4	0.8%	0.8%	0.5%	0.5%
Transit	41.2	38.9	0.3%	0.3%	0.2%	0.2%
Intercity	16.3	16.5	0.1%	0.1%	0.1%	0.1%
School	40.3	40.9	0.3%	0.3%	0.2%	0.2%
Medium/heavy trucks	2,871.0	2,852.8	22.3%	22.3%	15.0%	14.6%
Class 3-6	545.5	542.0	4.2%	4.2%	2.9%	2.8%
Class 7-8	2,325.5	2,310.8	18.1%	18.1%	12.2%	11.8%
NONHIGHWAY	1,689.1	1,764.8	13.1%	13.8%	8.9%	9.0%
Air	997.0	1,024.9	7.7%	8.0%	5.2%	5.2%
General aviation	108.6	102.6	0.8%	0.8%	0.6%	0.5%
Domestic air carriers	682.2	712.9	5.3%	5.6%	3.6%	3.7%
International air carriers	206.2	209.4	1.6%	1.6%	1.1%	1.1%
Water	426.3	485.6	3.3%	3.8%	2.2%	2.5%
Freight	301.0	360.0	2.3%	2.8%	1.6%	1.8%
Recreational	125.4	125.6	1.0%	1.0%	0.7%	0.6%
Pipeline	0.9	0.8	0.0%	0.0%	0.0%	0.0%
Rail	264.9	253.5	2.1%	2.0%	1.4%	1.3%
Freight (Class I)	254.2	242.9	2.0%	1.9%	1.3%	1.2%
Passenger	10.7	10.6	0.1%	0.1%	0.1%	0.1%
Transit	0.2	0.2	0.0%	0.0%	0.0%	0.0%
Commuter	6.2	6.3	0.0%	0.1%	0.0%	0.0%
Intercity	4.3	4.1	0.0%	0.0%	0.0%	0.0%
HWY & NONHWY						
TOTAL^d	12,873.2	12,762.9	100.0%	100.0%	67.4%	65.3%
Off-Highway	1,095.3	1,115.1				

Source:

See Appendix A, Section 2. Energy Use Sources.

^a Each gallon of petroleum product was assumed to equal one gallon of crude oil. The oil used to produce electricity is also estimated. See Appendix A, Section 2.4 for details.

^b Percentages may not sum to totals due to rounding.

^c Two-axle, four-tire trucks.

^d Civilian consumption only. Totals may not include all possible uses of fuels for transportation (e.g., snowmobiles).



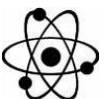


Chapter 2

Energy

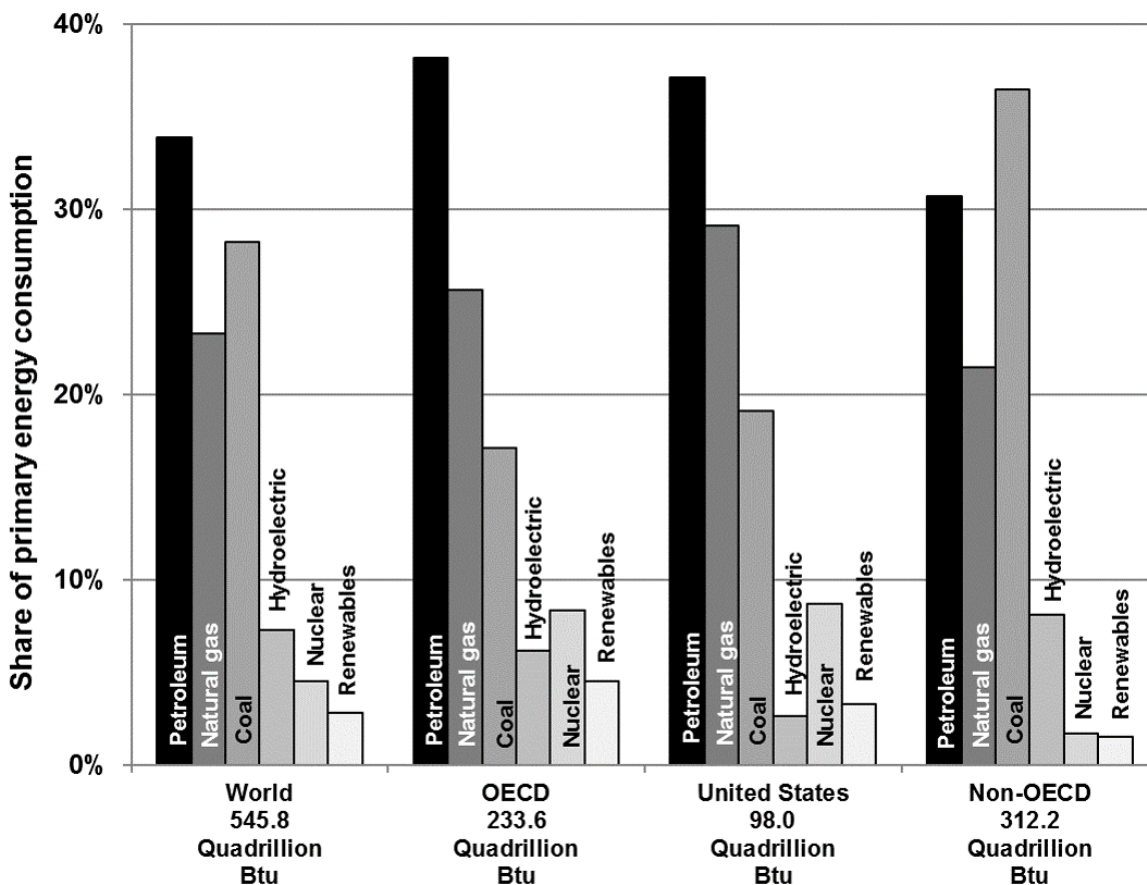
Summary Statistics from Tables in this Chapter

Source			
Table 2.1	Transportation share of U.S. energy consumption, 2016		28.7%
Table 2.2	Petroleum share of transportation energy consumption, 2016		91.9%
Table 2.6	Fuel ethanol consumption (million gallons)		14,399.1
	Biodiesel consumption (million gallons)		2,059.6
Table 2.8	Transportation energy use by mode, 2015	(trillion Btu)	(transportation energy share)
	<i>Cars</i>	6,797	26.3%
	<i>Light trucks</i>	8,348	32.3%
	<i>Medium/heavy trucks</i>	5,984	23.1%
	<i>Buses</i>	203	0.8%
	<i>Total Highway</i>	21,386	82.6%
	<i>Air</i>	2,118	8.2%
	<i>Water</i>	1,046	4.0%
	<i>Pipeline</i>	767	3.0%
	<i>Rail</i>	563	2.2%



Petroleum accounted for 34% of the world's energy use in 2014. Although petroleum and natural gas are the dominant energy sources for OECD countries, the non-OECD countries rely on coal and petroleum. The U.S. shares of primary energy sources are similar to the OECD countries as a whole, but with a lesser reliance on renewables.

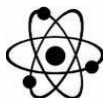
Figure 2.1. World Consumption of Primary Energy, 2014



Note: The United States data are shown separately but are also included in the OECD data.

Source:

U.S. Department of Energy, Energy Information Administration, *International Energy Statistics*, August 2017.
(Additional resources: www.eia.doe.gov)



Total energy use was 97.4 quads in 2016 with transportation using 28.7%. The Energy Information Administration includes renewable energy in each sector.

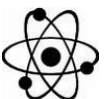
Table 2.1
U. S. Consumption of Total Energy by End-Use Sector, 1973–2016
(quadrillion Btu)

Year	Transportation	Percentage transportation of total	Industrial	Commercial	Residential	Total ^a
1973	18.6	24.6%	32.6	9.5	14.9	75.7
1975	18.2	25.4%	29.4	9.5	14.8	72.0
1980	19.7	25.2%	32.0	10.6	15.8	78.1
1981	19.5	25.6%	30.7	10.6	15.3	76.1
1982	19.1	26.1%	27.6	10.9	15.5	73.1
1983	19.2	26.3%	27.4	10.9	15.4	73.0
1984	19.7	25.7%	29.6	11.4	16.0	76.7
1985	20.1	26.3%	28.8	11.5	16.0	76.4
1986	20.8	27.1%	28.3	11.6	16.0	76.7
1987	21.5	27.2%	28.4	11.9	16.3	79.1
1988	22.3	27.0%	30.7	12.6	17.1	82.7
1989	22.5	26.5%	31.3	13.2	17.8	84.8
1990	22.4	26.5%	31.8	13.3	16.9	84.5
1991	22.1	26.2%	31.4	13.4	17.4	84.4
1992	22.4	26.1%	32.6	13.4	17.4	85.8
1993	22.8	26.1%	32.6	13.8	18.2	87.4
1994	23.4	26.3%	33.5	14.1	18.1	89.1
1995	23.8	26.2%	34.0	14.7	18.5	91.0
1996	24.4	26.0%	34.9	15.2	19.5	94.0
1997	24.8	26.2%	35.2	15.7	19.0	94.6
1998	25.3	26.8%	34.8	16.0	19.0	95.0
1999	25.9	26.8%	34.8	16.4	19.6	96.7
2000	26.6	26.9%	34.7	17.2	20.4	98.8
2001	26.3	27.3%	32.7	17.1	20.0	96.2
2002	26.8	27.5%	32.7	17.3	20.8	97.6
2003	26.9	27.5%	32.6	17.3	21.1	97.9
2004	27.8	27.8%	33.5	17.7	21.1	100.1
2005	28.3	28.2%	32.4	17.9	21.6	100.2
2006	28.7	28.9%	32.4	17.7	20.7	99.5
2007	28.9	28.6%	32.4	18.3	21.5	101.0
2008	27.5	27.8%	31.3	18.4	21.7	98.9
2009	26.7	28.4%	28.5	17.9	21.1	94.1
2010	27.1	27.8%	30.5	18.1	21.8	97.4
2011	26.7	27.6%	30.8	18.0	21.3	96.8
2012	26.2	27.8%	30.9	17.4	19.9	94.2
2013	26.8	27.5%	31.4	17.9	21.1	97.2
2014	27.0	27.5%	31.6	18.3	21.4	98.3
2015	27.4	28.1%	31.3	18.2	20.5	97.4
2016	27.9	28.7%	30.8	18.2	20.4	97.4
<i>Average annual percentage change</i>						
1973–2016	0.9%		-0.1%	1.5%	0.7%	0.6%
2006–2016	-0.3%		-0.5%	0.3%	-0.1%	-0.2%

Source:

U.S. Department of Energy, Energy Information Administration, *Monthly Energy Review*, July 2017, Washington, DC, Table 2.1. (Additional resources: www.eia.doe.gov)

^a Electrical energy losses have been distributed among the sectors.



In transportation, the alcohol fuels blended into gasoline to make gasohol (10% ethanol or less) are counted under “renewables” and are not in with petroleum. The petroleum category, however, still contains other blending agents that are not actually petroleum, but are not broken out into a separate category.

Table 2.2
Distribution of Energy Consumption by Source, 1973 and 2016
(percentage)

Energy source	Transportation		Residential		Commercial	
	1973	2016	1973	2016	1973	2016
Petroleum ^a	95.8	91.9	18.8	4.7	16.8	4.7
Natural gas ^b	4.0	2.7	33.4	22.3	27.8	17.8
Coal	0.0	0.0	0.6	0.0	1.7	0.1
Renewable	0.0	5.1	2.4	2.8	0.1	1.4
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0
Electricity ^c	0.2	0.3	44.8	70.2	53.6	76.0
Total	100.0	100.0	100.0	100.0	100.0	100.0

Energy source	Industrial		Electric utilities	
	1973	2016	1973	2016
Petroleum ^a	27.9	26.6	17.8	0.6
Natural gas ^b	31.8	31.1	19.0	27.3
Coal	12.4	3.9	44.0	34.4
Renewable	3.7	7.5	14.4	14.8
Nuclear	0.0	0.0	4.6	22.3
Electricity ^c	24.2	30.9	0.2	0.6
Total	100.0	100.0	100.0	100.0

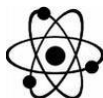
Source:

U.S. Department of Energy, Energy Information Administration, *Monthly Energy Review*, July 2017, Washington, DC, Tables 2.2, 2.3, 2.4, 2.5, and 2.6. (Additional resources: www.eia.doe.gov)

^a In transportation, the petroleum category contains some blending agents which are not petroleum.

^b Includes supplemental gaseous fuels. Transportation sector includes pipeline fuel and natural gas vehicle use.

^c Includes electrical system energy losses.



Total transportation energy consumption was 27.9 quads in 2016. Petroleum has accounted for more than 90% of transportation energy consumption since the mid-1950's. Renewables, including ethanol and biodiesel, were 5% of the total in 2016.

Table 2.3. Distribution of Transportation Energy Consumption by Source, 1950–2016

Year	Petroleum ^a	Natural gas ^b	Coal	Renewables	Electricity ^c	Total (trillion Btu)
1950	78.8%	1.5%	18.4%	0.0%	1.3%	8,492.5
1955	92.1%	2.7%	4.4%	0.0%	0.8%	9,550.2
1960	95.6%	3.4%	0.7%	0.0%	0.3%	10,595.9
1965	95.4%	4.2%	0.1%	0.0%	0.3%	12,432.5
1970	95.1%	4.6%	0.0%	0.0%	0.2%	16,098.2
1975	96.5%	3.3%	0.0%	0.0%	0.2%	18,245.0
1980	96.5%	3.3%	0.0%	0.0%	0.2%	19,696.7
1985	96.9%	2.6%	0.0%	0.2%	0.2%	20,087.9
1986	97.1%	2.4%	0.0%	0.3%	0.2%	20,788.8
1987	97.0%	2.5%	0.0%	0.3%	0.2%	21,468.9
1988	96.6%	2.8%	0.0%	0.3%	0.2%	22,317.7
1989	96.6%	2.9%	0.0%	0.3%	0.2%	22,477.9
1990	96.5%	3.0%	0.0%	0.3%	0.2%	22,419.6
1991	96.6%	2.8%	0.0%	0.3%	0.2%	22,118.0
1992	96.7%	2.7%	0.0%	0.4%	0.2%	22,415.1
1993	96.5%	2.8%	0.0%	0.4%	0.2%	22,711.7
1994	96.3%	3.0%	0.0%	0.4%	0.2%	23,365.1
1995	96.3%	3.0%	0.0%	0.5%	0.2%	23,851.1
1996	96.4%	3.0%	0.0%	0.3%	0.2%	24,439.2
1997	96.2%	3.2%	0.0%	0.4%	0.2%	24,751.3
1998	96.7%	2.6%	0.0%	0.4%	0.2%	25,260.1
1999	96.7%	2.6%	0.0%	0.5%	0.2%	25,949.5
2000	96.7%	2.5%	0.0%	0.5%	0.2%	26,555.3
2001	96.7%	2.5%	0.0%	0.5%	0.2%	26,282.2
2002	96.5%	2.6%	0.0%	0.6%	0.2%	26,845.7
2003	96.5%	2.3%	0.0%	0.9%	0.2%	26,900.2
2004	96.5%	2.2%	0.0%	1.0%	0.3%	27,842.8
2005	96.3%	2.2%	0.0%	1.2%	0.3%	28,280.3
2006	95.9%	2.2%	0.0%	1.7%	0.3%	28,716.7
2007	95.3%	2.3%	0.0%	2.1%	0.3%	28,858.3
2008	94.2%	2.5%	0.0%	3.0%	0.3%	27,486.3
2009	93.5%	2.7%	0.0%	3.5%	0.3%	26,687.1
2010	93.1%	2.7%	0.0%	4.0%	0.3%	27,059.1
2011	92.6%	2.7%	0.0%	4.3%	0.3%	26,712.1
2012	92.3%	3.0%	0.0%	4.4%	0.3%	26,219.3
2013	91.6%	3.3%	0.0%	4.8%	0.3%	26,749.8
2014	92.1%	2.8%	0.0%	4.8%	0.3%	26,996.5
2015	92.2%	2.7%	0.0%	4.8%	0.3%	27,355.2
2016	91.9%	2.6%	0.0%	5.1%	0.3%	27,925.3

Source:

U.S. Department of Energy, Energy Information Administration, *Monthly Energy Review*, July 2017, Washington, DC, Table 2.5. (Additional resources: www.eia.doe.gov)

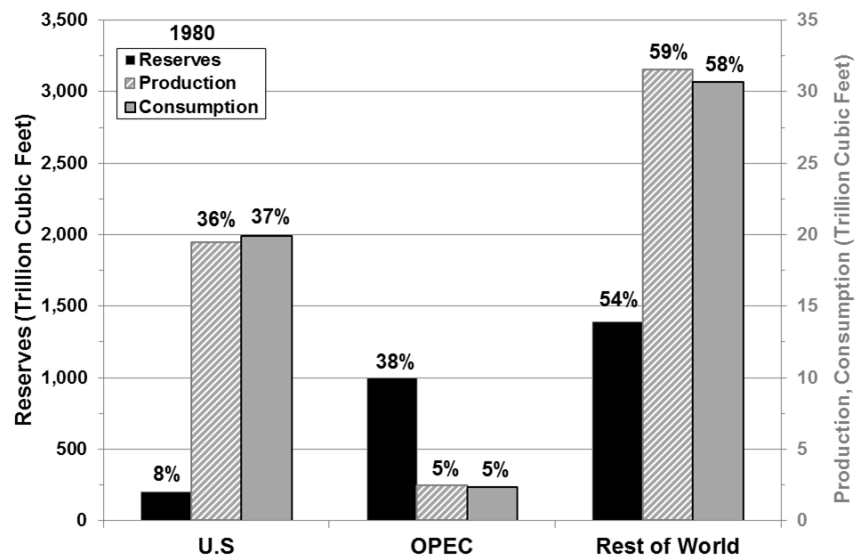
^a In transportation, the petroleum category contains some blending agents which are not petroleum.

^b Includes supplemental gaseous fuels. Transportation sector includes pipeline fuel and natural gas vehicle use.

^c Includes electrical system energy losses.

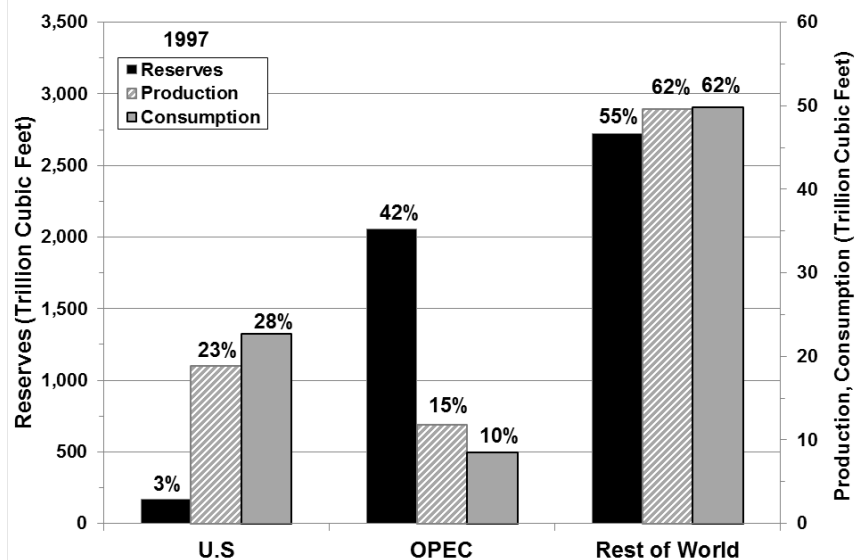


Figure 2.2. World Natural Gas Reserves, Production, and Consumption, 1980



Source:
See Table 2.4.

Figure 2.3. World Natural Gas Reserves, Production, and Consumption, 1997



Source:
See Table 2.4.

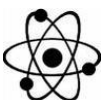
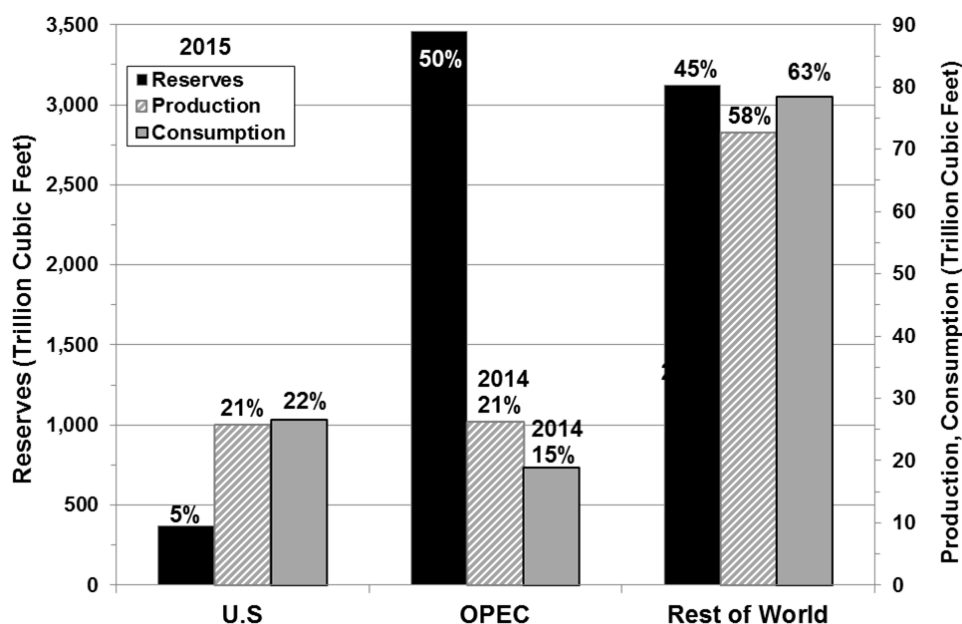


Figure 2.4. World Natural Gas Reserves, Production and Consumption, 2015**Source:**

See Table 2.4.

Table 2.4
World Natural Gas Reserves, Production, and Consumption, 1980, 1997, and 2015
 (trillion cubic feet)

	Natural gas reserves	Reserve share	Natural gas production	Production share	Natural gas consumption	Consumption share
1980						
United States	201.0	8%	19.4	36%	19.9	37%
OPEC	997.1	38%	2.4	5%	2.4	5%
Rest of world	1,387.6	54%	31.5	59%	30.7	58%
1997						
United States	166.5	3%	18.9	23%	22.7	28%
OPEC	2,057.6	42%	11.9	15%	8.5	10%
Rest of world	2,722.7	55%	49.7	62%	49.9	62%
2015						
United States	368.7	5%	25.8	21%	26.6	22%
OPEC	3,461.4	50%	26.2	21%	18.9	15%
Rest of world	3,120.4	45%	72.6	58%	78.4	63%

Note: Production data are dry gas production. OPEC production and consumption are 2014 data. See Glossary for OPEC countries.

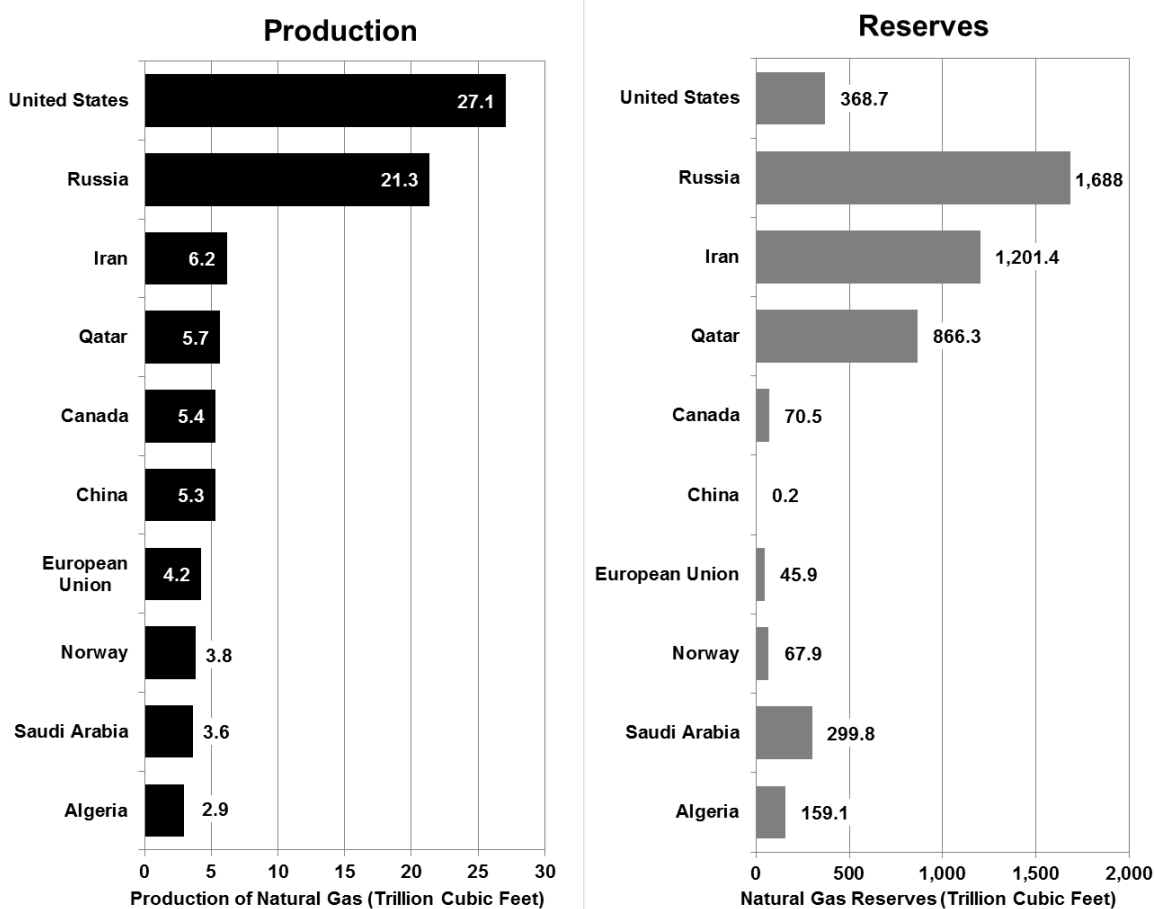
Source:

Energy Information Administration, *International Energy Statistics*, and *International Energy Outlook*, August 2017.
 (Additional resources: www.eia.doe.gov)



In 2015, the United States and Russia were by far the top natural gas producing countries with more than triple that of any other country. Although the United States produced more than Russia, Russia has almost five times more reserves.

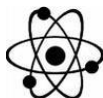
Figure 2.5. Natural Gas Production and Reserves for the Top Ten Natural Gas Producing Countries, 2015



Note: The Energy Information Administration *International Energy Statistics* was formerly the source of this figure, but did not have 2015 production data available at the time of publication.

Source:

U.S. Central Intelligence Agency, *The World Factbook*, August 2017. (Additional resources: www.cia.gov/library/publications/the-world-factbook)



The Energy Information Administration no longer publishes national data on alternative use. They do publish fuel use data for four types of alternative fuel vehicle fleets at www.eia.gov/renewable/afv.

Table 2.5
Alternative Fuel and Oxygenate Consumption, 2005–2011
(thousand gasoline–equivalent gallons)

	2005	2006	2007	2008	2009	2010	2011
Alternative fuel							
Liquefied petroleum gas	188,171	173,130	152,360	147,784	129,631	126,354	124,457
Compressed natural gas	166,878	172,011	178,585	189,358	199,513	210,007	220,247
Liquefied natural gas	22,409	23,474	24,594	25,554	25,652	26,072	26,242
E85 ^a	38,074	44,041	54,091	62,464	71,213	90,323	137,165
Electricity ^b	5,219	5,104	5,037	5,050	4,956	4,847	7,635
Hydrogen	25	41	66	117	140	152	174
Biodiesel	91,649	267,623	367,764	324,329	334,809	270,170	910,968
Other	2	2	2	2	2	0	0
Subtotal	512,427	685,426	782,479	754,658	756,916	727,925	1,426,888
Oxygenates							
MTBE ^c	1,654,500	435,000	0	0	0	0	0
Ethanol in gasohol	2,756,663	3,729,168	4,694,304	6,442,781	7,343,133	8,527,431	8,563,841
Total	4,923,590	4,849,594	5,476,783	7,197,439	8,099,342	9,255,356	9,990,729

Note: These are the latest data available from the Energy Information Administration. See text box for additional information.

Source:

U.S. Department of Energy, Energy Information Administration, Alternative Fuel Vehicle Data website, May 2013, www.eia.doe.gov/renewable. (Additional resources: www.eia.doe.gov)

^a Consumption includes gasoline portion of the mixture.

^b Vehicle consumption only; does not include power plant inputs.

^c Methyl Tertiary Butyl Ether. This category includes a very small amount of other ethers, primarily Tertiary Amyl Methyl Ether (TAME) and Ethyl Tertiary Butyl Ether (ETBE).



Ethanol is an oxygenate blended with gasoline in amounts up to 10% to be used in conventional vehicles, and is blended in higher amounts up to 85% for use in flex-fuel vehicles. The production of ethanol grew to over 15 billion gallons in 2016, with consumption reaching over 14 billion gallons. Beginning in 2010, the United States began exporting more fuel ethanol than it imports. Biodiesel is a renewable fuel typically made from vegetable oils or animal fats. It can be burned in standard diesel engines and is often blended with petroleum diesel. In 2016, over 2.0 billion gallons of biodiesel were consumed.

Table 2.6
Fuel Ethanol and Biodiesel Production, Net Imports, and Consumption, 1981–2016
(million gallons)

Year	Fuel ethanol			Biodiesel		
	Production	Net imports	Consumption	Production	Net imports	Consumption
1981	83.1	a	83.1	a	a	a
1985	617.1	a	617.1	a	a	a
1990	747.7	a	747.7	a	a	a
1991	866.3	a	866.3	a	a	a
1992	985.0	a	985.0	a	a	a
1993	1,154.3	10.2	1,151.0	a	a	a
1994	1,288.9	11.7	1,288.9	a	a	a
1995	1,357.7	16.3	1,382.6	a	a	a
1996	973.5	13.1	991.7	a	a	a
1997	1,288.3	3.6	1,255.8	a	a	a
1998	1,405.0	2.8	1,387.6	a	a	a
1999	1,465.0	3.7	1,442.7	a	a	a
2000	1,622.3	4.9	1,653.4	a	a	a
2001	1,765.2	13.2	1,740.7	8.6	1.7	10.3
2002	2,140.2	12.9	2,073.1	10.5	5.9	16.4
2003	2,804.4	12.3	2,826.0	14.2	(0.7)	13.5
2004	3,404.4	148.8	3,552.2	28.0	(1.1)	26.8
2005	3,904.4	135.8	4,058.6	90.8	0.0	90.8
2006	4,884.3	731.1	5,481.2	250.4	10.5	260.9
2007	6,521.0	439.2	6,885.7	489.8	(136.1)	353.7
2008	9,308.8	529.6	9,683.4	678.1	(374.6)	303.6
2009	10,937.8	198.2	11,036.6	515.8	(194.9)	321.8
2010	13,297.9	(382.8)	12,858.5	343.4	(85.0)	260.1
2011	13,929.1	(1,023.3)	12,893.3	967.5	(38.1)	886.2
2012	13,218.0	(247.4)	12,881.9	990.7	(92.5)	899.0
2013	13,292.7	(242.0)	13,215.6	1,359.5	146.0	1,428.8
2014	14,312.8	(771.6)	13,444.0	1,279.0	109.4	1,416.9
2015	14,807.2	(740.5)	13,946.7	1,263.3	246.9	1,494.2
2016	15,329.1	(1,010.1)	14,399.1	1,555.5	605.0	2,059.6
Average annual percentage change						
1981-2016	16.1%	a	15.9%	a	a	a
2006-2016	12.1%	a	10.1%	20.0%	50.0%	23.0%

Note: The Energy Information Administration no longer publishes the nationwide consumption of E-85. Net imports are total imports minus exports.

Source:

U.S. Department of Energy, Energy Information Administration, *Monthly Energy Review*, Washington, DC, July 2017, Table 10.3. (Additional resources: www.eia.doe.gov)

^a Data are not available.



As data about alternative fuel use become available, an attempt is made to incorporate them into this table. Sometimes assumptions must be made in order to use the data. Please see Appendix A for a description of the methodology used to develop these data. See Table 1.16 for transportation petroleum use in thousand barrels per day.

Table 2.7
Domestic Consumption of Transportation Energy by Mode and Fuel Type, 2015^a
(trillion Btu)

	Gasoline	Diesel fuel	Liquefied petroleum gas	Jet fuel	Residual fuel oil	Natural gas	Electricity ^b	Total ^c
<u>HIGHWAY</u>	15,343.4	5,947.2	70.1	-	-	21.9	3.7	21,386.3
Light vehicles	14,733.1	414.1	49.5	-	-	-	3.4	15,200.1
Cars	6,754.8	38.3					3.4	6,796.5
Light trucks ^d	7,922.3	375.8	49.5				0.0	8,347.6
Motorcycles	56.0							56.0
Buses	8.9	170.9	0.7	-	-	21.9	0.3	202.7
Transit	1.1	57.4	0.7			21.9	0.3	81.5
Intercity		35.1						35.1
School	7.8	78.3						86.1
Medium/heavy trucks	601.3	5,362.3	20.0	-	-	-	-	5,983.6
Class 3-6 trucks	553.2	750.7	19.8					1,323.7
Class 7-8 trucks	48.1	4,611.5	0.2					4,659.9
<u>NONHIGHWAY</u>	214.6	927.3	-	2,095.6	464.6	686.9	104.2	4,493.2
Air	22.0	-	-	2,095.6	-	-	-	2,117.7
General aviation	22.0			186.9				208.9
Domestic air carriers				1,475.4				1,475.4
International air carriers ^e				433.4				433.4
Water	192.6	388.4	-	-	464.6	-	-	1,045.6
Freight		335.0			464.6			799.6
Recreational	192.6	53.4						246.0
Pipeline	-	-	-	-	-	686.9	80.3	767.1
Rail	-	538.8	-	-	-	-	24.0	562.8
Freight (Class I)		516.4						516.4
Passenger		22.4					24.0	46.3
Transit							16.1	16.1
Commuter		13.3					6.1	19.4
Intercity		9.1					1.8	10.9
TOTAL HWY & NONHWY^c	15,558.0	6,874.5	70.1	2,095.6	464.6	708.8	107.9	25,879.5

Source:

See Appendix A, Section 2. Energy Use Sources.

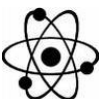
^a Civilian consumption only. Totals may not include all possible uses of fuels for transportation (e.g., snowmobiles).

^b Only end-use energy was counted for electricity. Previous editions included primary energy use for electricity which included generation and distribution losses.

^c Totals may not sum due to rounding.

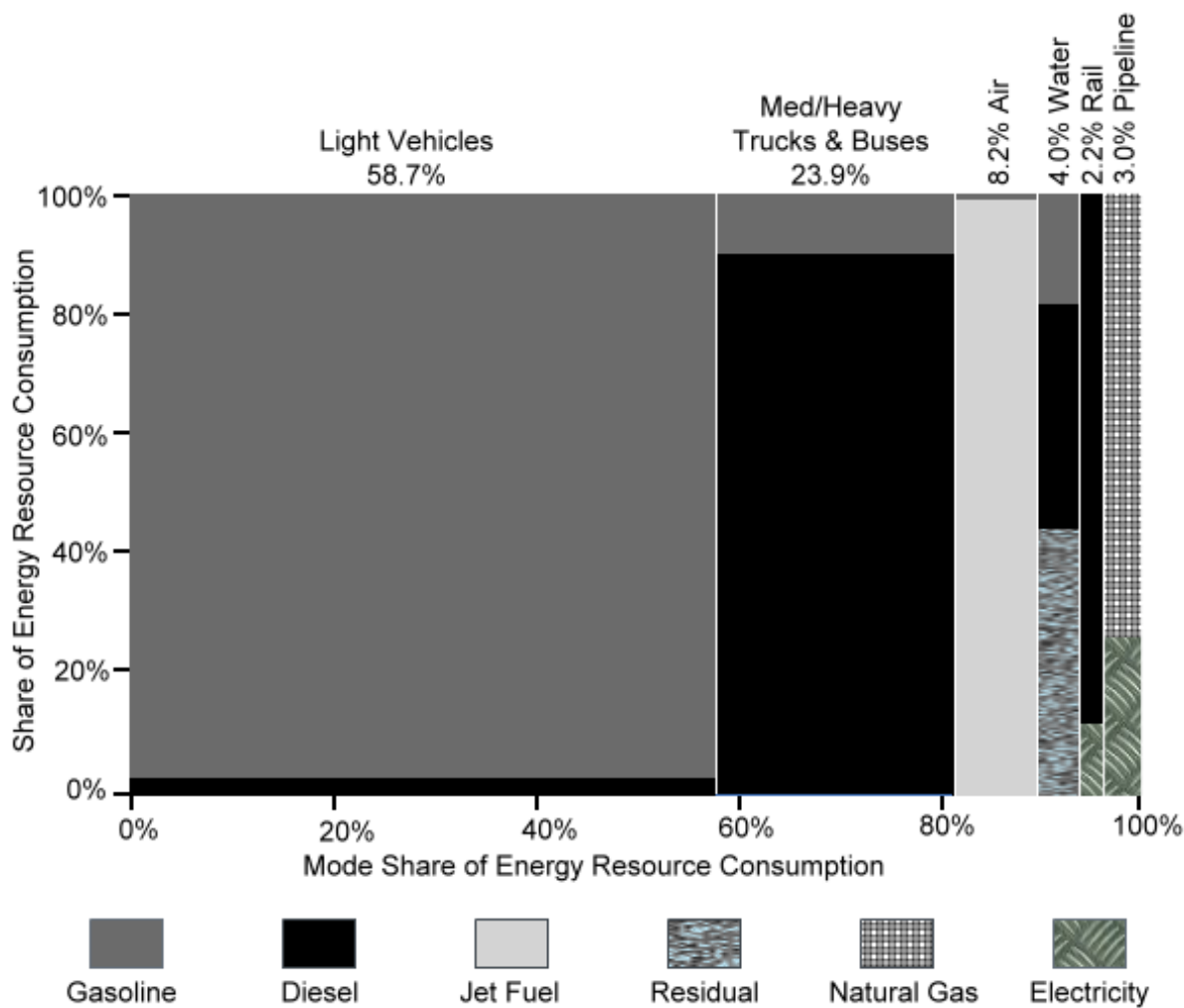
^d Two-axle, four-tire trucks.

^e One half of fuel used by domestic carriers in international operation.



The gasoline and diesel used in highway modes accounts for the majority of transportation energy use (81.6%) and nearly all highway use.

Figure 2.6. Domestic Consumption of Transportation Energy Use by Mode and Fuel Type, 2015^a

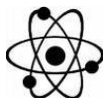


Note: Residual fuel oil is heavier oil which can be used in vessel bunkering.

Source:

See Table 2.7 or Appendix A, Section 2. Energy Use Sources.

^a Civilian consumption only. Totals may not include all possible uses of fuels for transportation (e.g., snowmobiles). Only end-use energy was counted for electricity. Previous editions included primary energy use for electricity which included generation and distribution losses.



Nonhighway modes were responsible for 18.0% of all transportation energy use in 2015. See Table 1.16 for transportation energy use in thousand barrels per day.

Table 2.8
Transportation Energy Use by Mode, 2014–2015^a

	Trillion Btu		Percentage of total based on Btus	
	2014	2015	2014	2015
<u>HIGHWAY</u>	21,741.7	21,386.3	83.3%	82.6%
Light vehicles	15,514.5	15,200.1	59.4%	58.7%
Cars	6,951.2	6,796.5	26.6%	26.3%
Light trucks ^b	8,505.9	8,347.6	32.6%	32.3%
Motorcycles	57.3	56.0	0.2%	0.2%
Buses	205.6	202.7	0.8%	0.8%
Transit	86.2	81.5	0.3%	0.3%
Intercity	34.6	35.1	0.1%	0.1%
School	84.9	86.1	0.3%	0.3%
Medium/heavy trucks	6,021.6	5,983.6	23.1%	23.1%
Class 3-6 trucks	1,332.1	1,323.7	5.1%	5.1%
Class 7-8 trucks	4,689.5	4,659.9	18.0%	18.0%
<u>NONHIGHWAY</u>	4,367.5	4,493.2	16.7%	17.4%
Air	2,059.6	2,117.7	7.9%	8.2%
General aviation	221.0	208.9	0.8%	0.8%
Domestic air carriers	1,411.9	1,475.4	5.4%	5.7%
International air	426.7	433.4	1.6%	1.7%
Water	918.2	1,045.6	3.5%	4.0%
Freight	672.8	799.6	2.6%	3.1%
Recreational	245.4	246.0	0.9%	1.0%
Pipeline	802.6	767.1	3.1%	3.0%
Rail	587.0	562.8	2.2%	2.2%
Freight (Class I)	540.5	516.4	2.1%	2.0%
Passenger	46.5	46.3	0.2%	0.2%
Transit	16.4	16.1	0.1%	0.1%
Commuter	19.2	19.4	0.1%	0.1%
Intercity	11.0	10.9	0.0%	0.0%
HWY & NONHWY TOTAL	26,109.3	25,879.5	100.0%	100.0%
Off-highway	2,194.3	2,234.3		

Source:

See Appendix A, Section 2. Energy Use Sources.

^a Civilian consumption only. Totals may not include all possible uses of fuels for transportation (e.g., snowmobiles). Only end-use energy was counted for electricity. Previous editions included primary energy use for electricity which included generation and distribution losses.

^b Two-axle, four-tire trucks.



Light trucks include pick-ups, minivans, sport-utility vehicles, and vans. See Table 1.14 for highway petroleum use in thousand barrels per day.

Table 2.9
Highway Transportation Energy Consumption by Mode, 1970–2015
(trillion Btu)

Year	Cars	Light trucks	Light vehicles subtotal	Motor-cycles	Buses	Class 3-6 trucks	Class 7-8 trucks	Heavy trucks subtotal	Highway subtotal	Total transportation ^a
1970	8,479	1,539	10,018	7	129	333	1,220	1,553	11,707	15,192
1975	9,298	2,384	11,682	14	124	430	1,574	2,003	13,823	17,204
1980	8,800	2,975	11,775	26	143	929	1,757	2,686	14,630	18,760
1981	8,693	2,963	11,656	27	145	1,065	1,659	2,724	14,552	18,558
1982	8,673	2,837	11,510	25	151	1,182	1,525	2,707	14,393	18,055
1983	8,802	2,990	11,792	22	152	1,121	1,649	2,770	14,736	18,188
1984	8,837	3,197	12,034	22	146	1,072	1,801	2,873	15,075	18,773
1985	8,932	3,413	12,345	23	153	986	1,897	2,883	15,404	19,017
1986	9,138	3,629	12,767	23	160	920	2,038	2,958	15,908	20,086
1987	9,157	3,819	12,976	24	164	858	2,203	3,061	16,225	20,578
1988	9,158	4,078	13,236	25	169	860	2,257	3,118	16,548	21,131
1989	9,232	4,156	13,388	26	169	869	2,330	3,199	16,782	21,487
1990	8,688	4,451	13,139	24	167	891	2,442	3,334	16,664	21,383
1991	8,029	4,774	12,803	23	177	895	2,507	3,402	16,405	20,985
1992	8,169	5,117	13,286	24	184	897	2,570	3,468	16,962	21,646
1993	8,368	5,356	13,724	25	183	906	2,671	3,577	17,509	22,125
1994	8,470	5,515	13,985	26	183	936	2,842	3,778	17,972	22,729
1995	8,489	5,695	14,184	25	184	954	2,983	3,937	18,330	23,263
1996	8,634	5,917	14,551	24	186	958	3,088	4,045	18,806	23,773
1997	8,710	6,169	14,879	25	192	945	3,141	4,086	19,182	24,126
1998	8,936	6,303	15,239	26	196	967	3,251	4,218	19,679	24,461
1999	9,134	6,602	15,736	26	203	1,054	3,584	4,638	20,603	25,758
2000	9,100	6,607	15,707	26	209	1,085	3,734	4,819	20,761	26,069
2001	9,161	6,678	15,839	24	196	1,074	3,738	4,813	20,872	25,741
2002	9,391	6,883	16,274	24	192	1,114	3,921	5,035	21,525	26,331
2003	9,255	7,551	16,806	24	190	1,083	3,812	4,895	21,915	26,512
2004	9,331	7,861	17,192	25	194	1,003	3,532	4,535	21,946	26,970
2005	9,579	7,296	16,875	24	196	1,126	3,963	5,088	22,183	27,377
2006	9,316	7,550	16,866	28	199	1,149	4,045	5,193 ^b	22,286	27,554
2007	9,221	7,679	16,900	59	195	1,429	5,031	6,460	23,615	29,013
2008	8,831	7,572	16,404	61	200	1,444	5,083	6,527	23,192	28,381
2009	8,209	7,635	15,843	60	200	1,341	4,720	6,061	22,165	26,895
2010	7,657	7,971	15,628	53	190	1,363	4,797	6,160	22,032	26,974
2011	7,336	8,104	15,440	53	195	1,283	4,517	5,801	21,489	26,388
2012	7,121	8,180	15,300	61	200	1,282	4,512	5,794	21,356	26,001
2013	7,047	8,077	15,124	58	204	1,310	4,613	5,924	21,310	25,905
2014	6,951	8,506	15,454	57	206	1,332	4,689	6,022	21,742	26,109
2015	6,802	8,348	15,141	56	203	1,324	4,660	5,984	21,392	25,880
<i>Average annual percentage change</i>										
1970-2015	-0.5%	3.8%	0.9%	4.7%	1.0%	3.1%	3.0%	3.0%	1.3%	1.2%
2005-2015	-3.4%	1.4%	-1.1%	8.8%	0.4%	1.6%	1.6%	1.6%	-0.4%	-0.6%

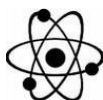
Note: Totals may not add due to rounding.

Source:

See Appendix A, Section 2.1 Highway Energy Use.

^a 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). Only end-use energy was counted for electricity. Previous editions included primary energy use for electricity which included generation and distribution losses.

^b Due to changes in the FHWA fuel use methodology, motorcycle, bus, and heavy truck data are not comparable with data before the year 2007. Car and light truck data changed after 2008; see Appendix A for car/light truck shares.



About 18% of transportation energy use is for nonhighway modes. Air travel accounts for almost 45% of nonhighway energy use. See Table 1.15 for nonhighway petroleum use in thousand barrels per day.

Table 2.10
Nonhighway Transportation Energy Consumption by Mode, 1970–2015
(trillion Btu)

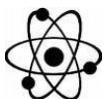
Year	Air	Water	Pipeline	Rail	Nonhighway subtotal	Total transportation ^a
1970	1,287	836	826	537	3,486	15,192
1975	1,234	927	680	540	3,381	17,204
1980	1,434	1,393	734	570	4,130	18,760
1981	1,453	1,270	742	541	4,006	18,558
1982	1,445	1,063	694	460	3,662	18,055
1983	1,440	974	583	455	3,452	18,188
1984	1,609	964	623	502	3,699	18,773
1985	1,677	871	597	468	3,613	19,017
1986	1,823	1,323	578	454	4,178	20,086
1987	1,899	1,378	613	464	4,354	20,578
1988	1,978	1,417	712	476	4,583	21,131
1989	1,981	1,516	729	478	4,705	21,487
1990	2,046	1,442	760	471	4,719	21,383
1991	1,916	1,523	699	442	4,580	20,985
1992	1,945	1,599	685	455	4,684	21,646
1993	1,986	1,437	723	469	4,615	22,125
1994	2,075	1,394	787	502	4,758	22,729
1995	2,141	1,468	803	523	4,935	23,263
1996	2,206	1,411	814	536	4,967	23,773
1997	2,300	1,250	856	537	4,943	24,126
1998	2,275	1,232	735	540	4,782	24,461
1999	2,483	1,367	745	560	5,156	25,758
2000	2,554	1,454	742	559	5,309	26,069
2001	2,397	1,186	724	561	4,869	25,741
2002	2,229	1,247	768	563	4,807	26,331
2003	2,260	1,074	689	575	4,597	26,512
2004	2,456	1,299	662	607	5,024	26,970
2005	2,532	1,368	681	613	5,194	27,377
2006	2,511	1,450	681	626	5,269	27,554
2007	2,509	1,559	720	610	5,399	29,013
2008	2,396	1,460	748	586	5,190	28,381
2009	2,127	1,340	771	492	4,731	26,895
2010	2,149	1,485	775	533	4,942	26,974
2011	2,157	1,392	790	560	4,900	26,388
2012	2,077	1,183	835	549	4,644	26,001
2013	2,037	1,055	942	562	4,595	25,905
2014	2,060	918	803	587	4,368	26,109
2015	2,118	1,046	767	563	4,493	25,880
<i>Average annual percentage change</i>						
1970–2015	1.1%	0.5%	-0.2%	0.1%	0.6%	1.2%
2005–2015	-1.8%	-2.6%	1.2%	-0.8%	-1.4%	-0.6%

Note: Totals may not add due to rounding.

Source:

See Appendix A, Section 2.3 Nonhighway Energy Use.

^a 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). Only end-use energy was counted for electricity. Previous editions included primary energy use for electricity which included generation and distribution losses.



The Environmental Protection Agency's MOVES model estimates fuel use for different types of nonroad equipment and off-highway vehicles. Most of these vehicles/equipment use diesel fuel. Recreational equipment, such as off-highway motorcycles, snowmobiles, and all-terrain vehicles, are mainly fueled by gasoline.

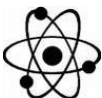
Table 2.11
Off-Highway Transportation-Related Fuel Consumption from the Nonroad Model, 2015
 (trillion Btu)

	Gasoline	Diesel	LPG	CNG	Total
Agricultural equipment <i>Tractors, mowers, combines, balers, and other farm equipment which has utility in its movement.</i>	8.6	610.6	0.0	0.0	619.3
Airport ground equipment	0.3	16.6	0.3	^a	17.2
Construction and mining equipment <i>Pavers, rollers, drill rigs, graders, backhoes, excavators, cranes, mining equipment</i>	11.4	987.4	1.9	^a	1,000.7
Industrial equipment <i>Forklifts, terminal tractors, sweeper/scrubbers</i>	8.2	140.7	210.9	19.1	378.9
Logging equipment <i>Feller/buncher/skidder</i>	1.8	22.2	^a	^a	24.0
Railroad maintenance equipment	0.2	3.9	0.0	^a	4.0
Recreational equipment <i>Off-road motorcycles, snowmobiles, all-terrain vehicles, golf carts, specialty vehicles</i>	188.0	2.1	0.1	^a	190.3
Total	218.5	1,783.5	213.2	19.1	2,234.3

Source:

Environmental Protection Agency, MOVES2014a model, www.epa.gov/otaq/models/moves.

^a There is no equipment listed for this fuel type.



Mowing equipment consumes nearly half of all the fuel used by lawn and garden equipment. The gasoline used in lawn and garden equipment is 2.0% of total gasoline use.

Table 2.12
Fuel Consumption from Lawn and Garden Equipment, 2015
(million gallons^a)

Equipment	Classification	Gasoline	Diesel	LPG	Total fuel consumption
<i>Mowing equipment</i>					
Front mowers	Commercial	20.8	130.2	0.0	151
Lawn & garden tractors	Commercial	248.4	26.9	0.0	275.3
Lawn & garden tractors	Residential	581.7	0.0	0.0	581.7
Lawn mowers	Commercial	166.2	0.0	0.0	166.2
Lawn mowers	Residential	220.7	0.0	0.0	220.7
Rear engine riding mowers	Commercial	18.3	0.0	0.0	18.3
Rear engine riding mowers	Residential	43.4	0.0	0.0	43.4
Total		1,299.50	157.1	0.0	1,456.60
<i>Soil and turf equipment</i>					
Commercial turf equipment ^b	Commercial	801.0	20.9	0.0	821.9
Rotary tillers < 6 HP	Commercial	92.1	0.0	0.0	92.1
Rotary tillers < 6 HP	Residential	19.9	0.0	0.0	19.9
Total		913.0	20.9	0.0	933.9
<i>Wood cutting equipment</i>					
Chain saws < 6 HP	Commercial	80.3	0.0	0.0	80.3
Chain saws < 6 HP	Residential	19.2	0.0	0.0	19.2
Chippers/stump grinders	Commercial	41.3	177.2	19.8	238.3
Shredders < 6 HP	Commercial	9.9	0.0	0.0	9.9
Total		150.7	177.2	19.8	347.7
<i>Blowers and vacuums</i>					
Leafblowers/vacuums	Commercial	219.2	0.0	0.0	219.2
Leafblowers/vacuums	Residential	19.5	0.0	0.0	19.5
Snowblowers	Commercial	37.9	2.3	0.0	40.2
Snowblowers	Residential	20.1	0.0	0.0	20.1
Total		296.7	2.3	0.0	299.0
<i>Trimming equipment</i>					
Trimmers/edgers/brush cutter	Commercial	67.8	0.0	0.0	67.8
Trimmers/edgers/brush cutter	Residential	27.8	0.0	0.0	27.8
Other lawn & garden equipment ^c	Commercial	24.8	0.5	0.0	25.3
Other lawn & garden equipment ^c	Residential	20.8	0.0	0.0	20.8
Total		141.2	0.5	0.0	141.7
Total all equipment		2,801.1	358.0	19.8	3,178.9

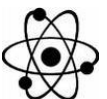
Source:

U.S. Environmental Protection Agency, MOVES2014a model, www.epa.gov/otaq/models/moves.

^a Numbers may not sum due to rounding.

^b Includes equipment such as aerators, dethatchers, sod cutters, hydro-seeders, turf utility vehicles, golf course greens mowers, and sand trap groomers.

^c Includes equipment not otherwise classified such as augers, sickle-bar mowers, and wood splitters.



The Federal Highway Administration (FHWA) cautions that data from 1993 on may not be directly comparable to earlier years. Some states have improved reporting procedures in recent years, and the estimation procedures were revised in 1994. The FHWA no longer publishes separate estimates of gasohol or ethanol used in gasohol.

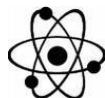
Table 2.13
Highway Usage of Gasoline and Diesel, 1973–2015
(billion gallons)

Year	Total gasoline and gasohol	Diesel ^a	Percent diesel	Total highway fuel use
1973	100.6	9.8	8.9%	110.5
1975	99.4	9.6	8.8%	109.0
1980	101.2	13.8	12.0%	115.0
1981	99.6	14.9	13.0%	114.5
1982	98.5	14.9	13.1%	113.4
1983	100.1	16.0	13.8%	116.1
1984	101.4	17.3	14.6%	118.7
1985	103.6	17.8	14.6%	121.3
1986	106.8	18.4	14.7%	125.2
1987	108.7	19.0	14.9%	127.7
1988	109.8	20.1	15.5%	129.9
1989	110.6	21.2	16.1%	131.9
1990	110.2	21.4	16.3%	131.6
1991	107.9	20.7	16.1%	128.6
1992	111.0	22.0	16.5%	132.9
1993	113.7	23.5	17.1%	137.2
1994	115.0	25.1	17.9%	140.1
1995	117.1	26.2	18.3%	143.3
1996	119.5	27.2	18.5%	146.7
1997	120.9	29.4	19.6%	150.3
1998	124.7	30.2	19.5%	154.9
1999	128.7	31.9	19.9%	160.7
2000	128.9	33.4	20.6%	162.3
2001	129.7	33.4	20.5%	163.1
2002	133.0	34.8	20.7%	167.8
2003	134.1	35.5	20.9%	169.6
2004	136.5	37.4	21.5%	173.9
2005	135.2	39.1	22.4%	174.3
2006	134.8	40.1	22.9%	174.9
2007	135.4	40.7	23.1%	176.1
2008	132.2	38.6	22.6%	170.8
2009	132.9	35.3	21.0%	168.1
2010	133.1	36.6	21.6%	169.7
2011	131.5	37.1	22.0%	168.6
2012	130.9	37.4	22.2%	168.3
2013	131.3	38.4	22.6%	169.7
2014	136.5	39.7	22.5%	176.2
2015	132.2	40.6	23.5%	172.9
<i>Average annual percentage change</i>				
1973–2015	0.7%	3.4%		1.1%
2005–2015	-0.2%	0.4%		-0.1%

Source:

U.S. Department of Transportation, Federal Highway Administration, *Highway Statistics 2015*, Washington, DC, 2016, Table MF-21 and annual. (Additional resources: www.fhwa.dot.gov)

^a Consists primarily of diesel fuel, with small quantities of other fuels, such as liquefied petroleum gas and E85.



Great care should be taken when comparing modal energy intensity data among modes. Because of the inherent differences among the transportation modes in the nature of services, routes available, and many additional factors, it is not possible to obtain truly comparable national energy intensities among modes. These values are averages, and there is a great deal of variability even within a mode.

Table 2.14
Passenger Travel and Energy Use, 2015 ^a

	Number of vehicles (thousands)	Vehicle-miles (millions)	Passenger-miles (millions)	Load factor (persons/vehicle)	Energy intensities		Energy use (trillion Btu)
					(Btu per vehicle-mile)	(Btu per passenger-mile)	
Cars	112,864.0	1,445,400	2,240,370	1.60	4,702	3,034	6,796.5
Personal trucks	113,054.6	1,123,226	2,066,736	1.80	6,156	3,345	6,870.1
Motorcycles	8,601.0	19,606	22,743	1.20	2,855	2,462	56.0
Demand response^b	71.4	1,595	2,267	1.4	20,047	14,106	32.0
Buses	^c	^c	^c	^c	^c	^c	202.7
Transit	64.2	2,216	20,239	9.1	36,760	4,025	81.5
Intercity ^d	^c	^c	^c	^c	^c	^c	35.1
School ^d	628.1	^c	^c	^c	^c	^c	86.1
Air	^c	^c	^c	^c	^c	^c	1,684.3
Certificated route ^e	^c	5,589	632,648	113.2	263,971	2,332	1,475.4
General aviation	210.0	^c	^c	^c	^c	^c	208.9
Recreational boats	13,915.6	^c	^c	^c	^c	^c	246.0
Rail	20.5	1,496	39,050	26.1	30,972	1,187	46.3
Intercity (Amtrak)	0.4	319	6,536	20.5	34,034	1,663	10.9
Transit	12.8	803	20,710	25.8	20,022	776	16.1
Commuter	7.3	374	11,804	31.6	51,888	1,643	19.4

Source:

See Appendix A, Section 3. Passenger Travel and Energy Use.

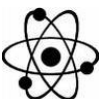
^a Only end-use energy was counted for electricity. Previous editions included primary energy use for electricity which included generation and distribution losses.

^b Demand response data are for 2014. Includes passenger cars, vans, and small buses operating in response to calls from passengers to the transit operator who dispatches the vehicles.

^c Data are not available.

^d Energy use is estimated.

^e Only domestic service and domestic energy use are shown on this table. (Previous editions included half of international energy.) These energy intensities may be inflated because all energy use is attributed to passengers—cargo energy use is not taken into account.



Great care should be taken when comparing modal energy intensity data among modes. Because of the inherent differences among the transportation modes in the nature of services, routes available, and many additional factors, it is not possible to obtain truly comparable national energy intensities among modes. These values are averages, and there is a great deal of variability even within a mode.

Table 2.15
Energy Intensities of Highway Passenger Modes, 1970–2015

Year	Cars		Light truck ^b	Transit Buses ^c	
	(Btu per vehicle-mile)	(Btu per passenger-mile)	(Btu per vehicle-mile)	(Btu per vehicle-mile)	(Btu per passenger-mile)
1970	9,250	4,868	12,479	31,796	2,472
1975	8,993	4,733	11,879	33,748	2,814
1980	7,916	4,279	10,224	36,553	2,813
1985	7,164	4,110	8,730	38,876	3,423
1986	7,194	4,197	8,560	37,889	3,545
1987	6,959	4,128	8,359	36,247	3,594
1988	6,683	4,033	8,119	36,673	3,706
1989	6,589	4,046	7,746	36,754	3,732
1990	6,169	3,856	7,746	37,374	3,794
1991	5,912	3,695	7,351	37,732	3,877
1992	5,956	3,723	7,239	40,243	4,310
1993	6,087	3,804	7,182	39,043	4,262
1994	6,024	3,765	7,212	36,932	4,225
1995	5,902	3,689	7,208	36,936	4,271
1996	5,874	3,683	7,247	37,238	4,315
1997	5,797	3,646	7,251	38,622	4,407
1998	5,767	3,638	7,260	41,062	4,374
1999	5,821	3,684	7,327	40,351	4,320
2000	5,687	3,611	7,158	41,466	4,506
2001	5,626	3,583	7,080	38,320	4,123
2002	5,662	3,607	7,125	37,340	4,110
2003	5,535	3,525	7,673	36,900	4,191
2004	5,489	3,496	7,653	37,665	4,342
2005	5,607	3,571	7,009	37,244	4,229
2006	5,511	3,510	6,974	39,397	4,297
2007	5,513	3,512	6,904	39,748	4,352
2008	5,466	3,526	6,830	39,726	4,328
2009	5,239	3,380	7,158	39,073	4,233
2010	5,117	3,301	6,919	35,858	4,107
2011	5,032	3,246	6,795	37,648	4,232
2012	4,949	3,193	6,674	37,037	4,023
2013	4,873	3,144	6,557	37,273	4,052
2014	4,839	3,122	6,677	35,237	3,810
2015	4,702	3,034	6,256	36,760	4,025
<i>Average annual percentage change</i>					
1970–2015	-1.5%	-1.0%	-1.5%	0.3%	1.1%
2005–2015	-1.7%	-1.6%	-1.2%	-0.1%	-0.5%

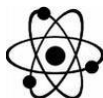
Source:

See Appendix A, Section 4. Highway Passenger Mode Energy Intensities.

^a Only end-use energy was counted for electricity. Previous editions included primary energy use for electricity which included generation and distribution losses.

^b All two-axle, four-tire trucks.

^c Series not continuous between 1983 and 1984 because of a change in data source by the American Public Transportation Association (APTA).



Great care should be taken when comparing modal energy intensity data among modes. Because of the inherent differences between the transportation modes in the nature of services, routes available, and many additional factors, it is not possible to obtain truly comparable national energy intensities among modes.

Table 2.16
Energy Intensities of Nonhighway Passenger Modes, 1970–2015^a

Year	Air	Rail		
	Certificated air carriers ^b (Btu per passenger-mile)	Intercity Amtrak (Btu per passenger-mile)	Rail transit (Btu per passenger-mile)	Commuter rail (Btu per passenger-mile)
1970	10,115	^c	712	^c
1975	7,625	3,311	866	^c
1980	5,561	2,859	763	^c
1981	5,774	2,414	855	^c
1982	5,412	2,551	891	^c
1983	5,133	2,359	931	^c
1984	5,298	2,417	1,002	1,798
1985	5,053	2,237	927	1,720
1986	5,011	2,037	1,004	1,720
1987	4,827	1,989	1,003	1,628
1988	4,861	1,967	1,014	1,666
1989	4,844	2,082	960	1,622
1990	4,797	2,052	998	1,622
1991	4,602	2,011	1,074	1,601
1992	4,455	2,117	1,041	1,565
1993	4,490	2,142	1,113	1,782
1994	4,407	1,917	1,102	1,605
1995	4,349	2,071	1,102	1,580
1996	4,199	2,194	996	1,541
1997	4,173	2,289	943	1,630
1998	3,987	2,246	931	1,612
1999	4,108	2,362	919	1,670
2000	3,960	2,651	923	1,542
2001	3,943	2,690	925	1,533
2002	3,718	2,537	948	1,542
2003	3,614	2,145	936	1,542
2004	3,505	2,068	907	1,536
2005	3,346	2,025	919	1,658
2006	3,250	1,948	893	1,539
2007	3,153	1,824	851	1,543
2008	3,055	1,745	832	1,579
2009	2,901	1,773	830	1,714
2010	2,825	1,668	832	1,753
2011	2,772	1,628	812	1,681
2012	2,633	1,561	791	1,703
2013	2,568	1,559	793	1,676
2014	2,511	1,641	786	1,638
2015	2,477	1,663	776	1,643
<i>Average annual percentage change^d</i>				
1970–2015	-3.1%	-1.7%	0.2%	-0.3%
2005–2015	-3.0%	-2.0%	-1.7%	-0.1%

Source:

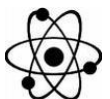
See Appendix A, Section 5. Nonhighway Passenger Mode Energy Intensities.

^a Only end-use energy was counted for electricity. Previous editions included primary energy use for electricity which included generation and distribution losses.

^b These data differ from the data on Table 2.14 because they include half of international services. These energy intensities may be inflated because all energy use is attributed to passengers—cargo energy use is not taken into account.

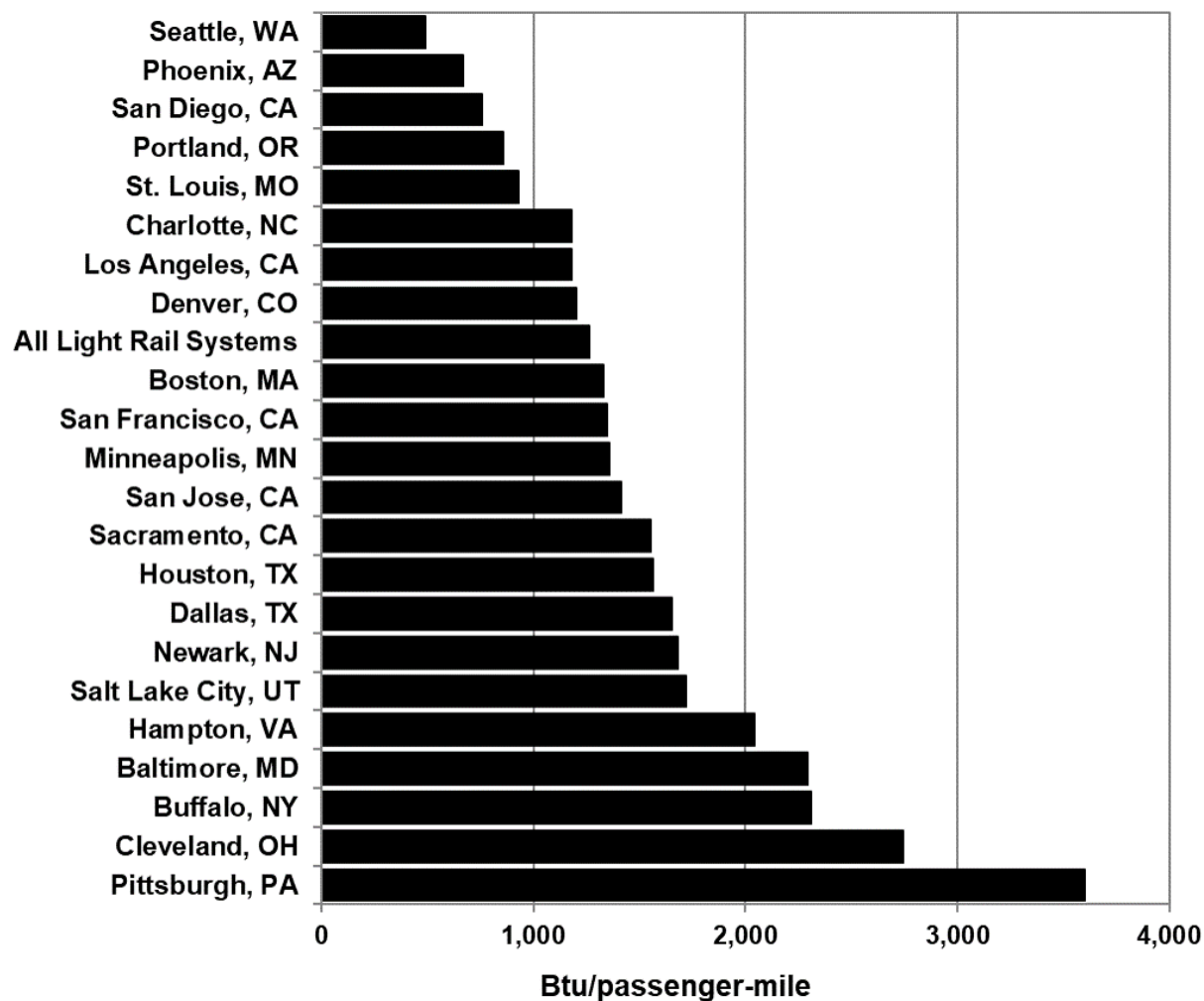
^c Data are not available.

^d Average annual percentage calculated to earliest year possible.



The energy intensity of light rail systems, measured in Btu per passenger-mile varies greatly. The weighted average of all light rail systems in 2015 is 3,823 Btu/passenger-mile.

Figure 2.7. Energy Intensity of Light Rail Transit Systems^a, 2015



Source:

U.S. Department of Transportation, *National Transit Database*, August 2017. (Additional resources: www.transit.dot.gov/ntd)

^a Typically an electric railway with a light volume traffic capacity with power drawn from an overhead electric line. Only end-use energy was counted for electricity. Previous editions included primary energy use for electricity which included generation and distribution losses.

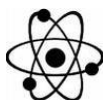
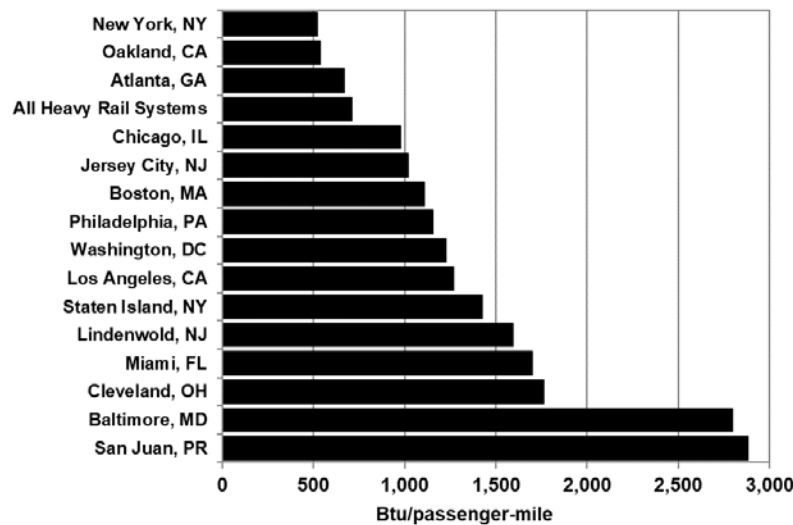
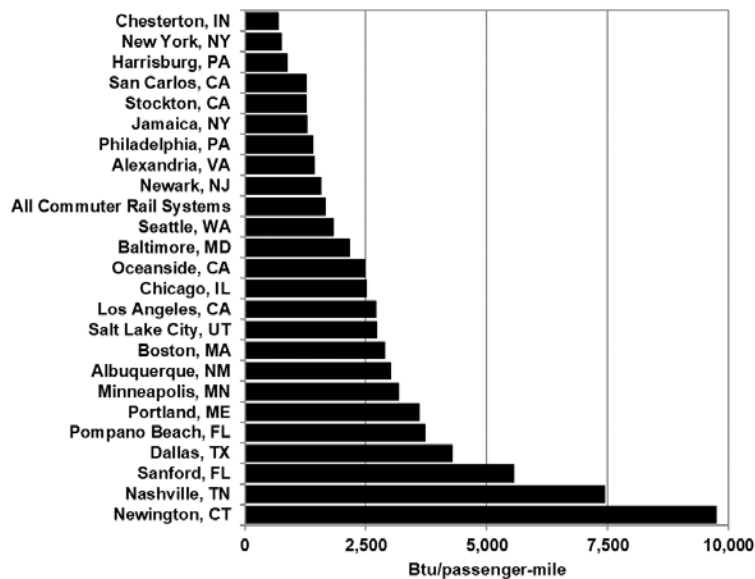


Figure 2.8. Energy Intensity of Heavy Rail Systems^a, 2015**Source:**

U.S. Department of Transportation, *National Transit Database*, August 2017. (Additional resources: www.transit.dot.gov/ntd)

Figure 2.9. Energy Intensity of Commuter Rail Systems^b, 2015

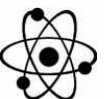
Note: Does not include systems classified as hybrid rail.

Source:

U.S. Department of Transportation, *2015 National Transit Database*, August 2017. (Additional resources: www.transit.dot.gov/ntd)

^a An electric railway with the capacity for a heavy volume of traffic. Only end-use energy was counted for electricity. Previous editions included primary energy use for electricity which included generation and distribution losses.

^b Electric car or diesel-propelled railway for urban passenger train service between a central city and adjacent suburbs. Only end-use energy was counted for electricity. Previous editions included primary energy use for electricity which included generation and distribution losses.



Great care should be taken when comparing modal energy intensity data among modes. Because of the inherent differences between the transportation modes in the nature of services, routes available, and many additional factors, it is not possible to obtain truly comparable national energy intensities among modes.

Table 2.17
Energy Intensities of Freight Modes, 1970–2015

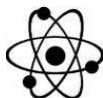
Year	Heavy single-unit and combination trucks (Btu per vehicle-mile)	Class I freight railroad		Waterborne commerce on taxable waterways (Btu per ton-mile)
		(Btu per freight car-mile)	(Btu per ton-mile)	
1970	24,960	17,669	691	a
1975	24,631	18,739	687	a
1980	24,758	18,742	597	a
1981	25,059	18,629	572	a
1982	24,297	18,404	553	a
1983	23,853	17,864	525	a
1984	23,585	17,795	510	a
1985	23,343	17,500	497	a
1986	23,352	17,265	486	a
1987	22,923	16,790	456	a
1988	22,596	16,758	443	a
1989	22,411	16,894	437	a
1990	22,795	16,619	420	a
1991	22,749	15,835	391	a
1992	22,609	16,043	393	a
1993	22,373	16,056	389	a
1994	22,193	16,340	388	a
1995	22,097	15,992	372	a
1996	22,109	15,747	368	a
1997	21,340	15,784	370	266
1998	21,516	15,372	365	256
1999	22,884	15,363	363	266
2000	23,449	14,917	352	270
2001	23,024	15,108	346	253
2002	23,462	15,003	345	253
2003	22,461	15,016	344	251
2004	20,540	15,274	341	241
2005	22,866	15,152	337	241
2006	23,340 ^b	14,990	330	235
2007	21,238	14,846	320	225
2008	21,008	14,573	305	252
2009	21,024	13,907	291	225
2010	21,499	13,733	289	217
2011	21,677	14,043	298	211
2012	21,524	13,800	294	211
2013	21,540	14,607	296	233
2014	21,573	14,533	292	214
2015	21,382	14,401	296	a
<i>Average annual percentage change</i>				
1970–2015	-0.3%	-0.4%	-1.9%	a
2005–2015	-0.7%	-0.5%	-1.3%	a

Source:

See Appendix A, Section 6. Freight Mode Energy Intensities.

^a Data are not available.

^b Due to changes in the FHWA fuel use methodology, truck data are not comparable with data before the year 2007.



Chapter 3

All Highway Vehicles and Characteristics

Summary Statistics from Tables in this Chapter

Source		
Table 3.2	U.S. share of world car registrations, 2015	13.6%
Table 3.3	U.S. share of world truck & bus registrations, 2015	43.3%
Table 3.4	Number of U.S. cars, 2015 (thousands)	112,864
Table 3.4	Number of U.S. trucks, 2015 (thousands)	141,256
Table 3.7	Vehicle miles traveled, 2015 (million miles)	3,104,179
	<i>Cars</i>	46.6%
	<i>Two-axle, four-tire trucks</i>	43.3%
	<i>Combination trucks</i>	5.5%
	<i>Other single-unit trucks</i>	3.5%
	<i>Motorcycles</i>	0.6%
	<i>Buses</i>	0.5%
Table 3.10	Average age of vehicles, 2016	
	<i>Cars (years)</i>	11.6
	<i>Light trucks (years)</i>	11.6
	<i>All light vehicles (years)</i>	11.6



The top countries producing the world's cars and trucks have changed over the last ten years. In 2015, China was the largest producer of cars and trucks. In 2000, Japan produced the most cars and the United States produced the most trucks (includes light trucks).

Table 3.1
World Production of Cars and Trucks, 2000 and 2015
(thousands)

Cars	2000	2015	Percent change 2000-2015
China	605	11,991	1,883%
Japan	8,363	7,831	-6%
Germany	5,132	5,708	11%
U.S.	5,542	4,163	-25%
Brazil	1,362	2,018	48%
India	605	2,529	318%
Russia	969	1,216	25%
Mexico	1,130	1,968	74%
Spain	2,366	2,219	-6%
UK	1,641	1,588	-3%
France	2,880	1,564	-46%
Czech Republic	428	1,297	203%
All Other Countries	10,205	11,668	14%
Total World	41,229	55,760	35%

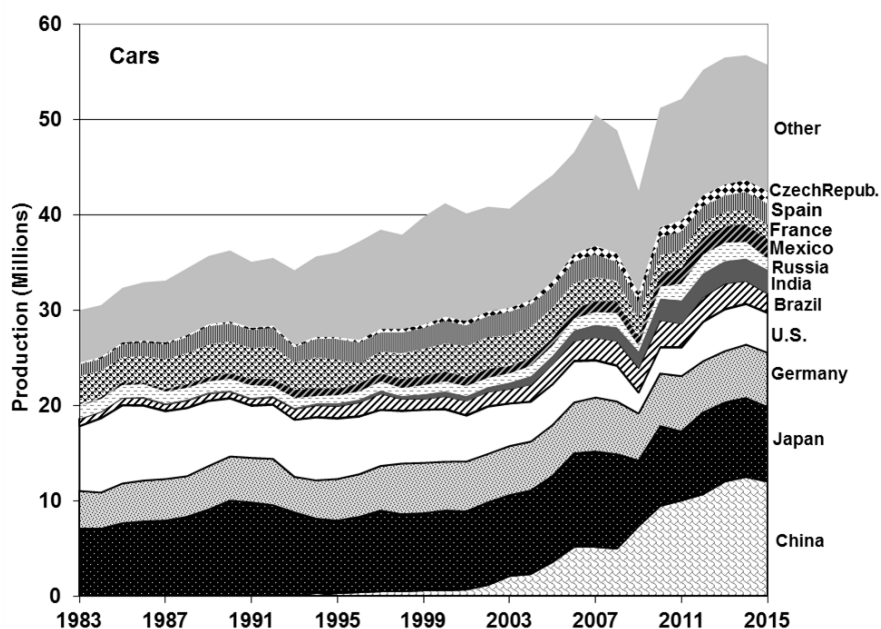
Trucks ^a	2000	2015	Percent change 2000-2015
China	1,464	12,512	754%
U.S.	7,263	7,943	9%
South Korea	513	2,181	325%
India	283	1,597	463%
Japan	1,781	1,448	-19%
Canada	1,411	1,397	-1%
Thailand	315	1,152	266%
All Other Countries	4,685	6,172	32%
Total World	17,717	34,402	94%

Source:

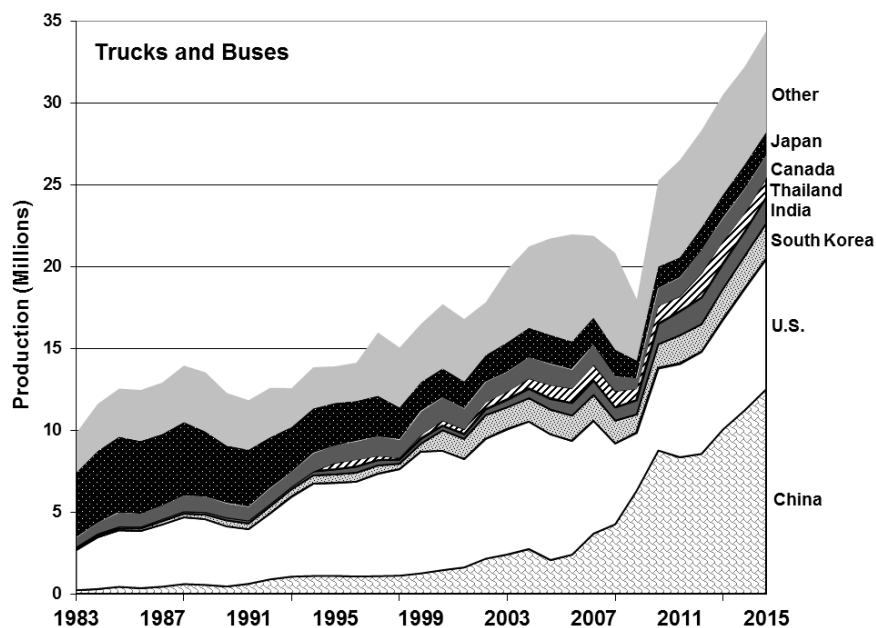
Ward's Communications, www.wardsauto.com

^a Includes light trucks, heavy trucks, and buses.



Figure 3.1. World Car Production, 1983–2015^a

Source:
See Table 3.1.

Figure 3.2. World Truck and Bus Production, 1983–2015^a

Source:
See Table 3.1.

^a The sharp decrease in 2009 coincides with the recession. Note that the scales of the two figures differ.



Use caution comparing historical data because of disconnects in data series. Also, the United States is unique in how many light trucks (SUVs, minivans, pickups) are used for personal travel. Those light trucks are not included on this table. The U.S. share of world cars continues to decline. The growth in the World total comes mainly from developing countries, like China, Indonesia, India, and South Korea.

Table 3.2
Car Registrations for Selected Countries, 1960–2015
(thousands)

Country	1960	1970	1980	1990	2000	2005	2010	2014	2015	Average annual percentage change 1990-2015
Argentina	474	1,482	3,112	4,284	5,060	5,340	7,605	10,092	11,003	3.8%
Brazil	a	a	a	12,127	15,393	18,370	25,541	32,715	33,566	4.2%
Canada ^b	4,104	6,602	10,256	12,622	16,832	18,124	20,121	21,730	22,068	2.3%
China	a	a	351	1,897	3,750	8,900	34,430	120,724	135,119	18.6%
France	4,950	11,860	18,440	23,550	28,060	30,100	31,300	31,800	32,000	1.2%
Germany ^c	4,856	14,376	23,236	35,512	43,772	46,090	42,302	44,403	45,071	1.0%
India	a	a	a	2,300	5,150	7,654	13,300	27,174	30,570	10.9%
Indonesia	a	a	a	1,200	a	3,850	8,891	12,595	13,846	10.3%
Japan	457	8,779	23,660	34,924	52,437	57,091	58,347	60,668	61,873	2.3%
Malaysia	a	a	a	1,811	4,213	6,402	9,115	11,149	11,279	7.6%
Pakistan	a	a	a	738	375	411	1,726	2,316	2,470	5.0%
Russia	a	a	a	a	20,353	25,285	34,350	40,850	41,000	4.8% ^d
South Korea	a	a	a	2,075	8,084	11,122	13,632	15,747	16,561	8.7%
United Kingdom	5,650	11,802	15,438	22,528	27,185	30,652	31,258	32,613	33,542	1.6%
United States	61,671	89,244	121,601	143,550	127,721	132,909	129,053	120,984	126,014	-0.5%
U.S. percentage of world	62.7%	46.1%	38.0%	32.3%	23.3%	21.5%	17.8%	13.7%	13.6%	
World total	98,305	193,479	320,390	444,900	548,558	617,914	723,567	884,506	923,590	3.0%

Source:

Ward's Communications, www.wardsauto.com.

^a Data are not available.

^b Data from 2000 and later are not comparable to prior data. Canada reclassified autos and trucks prior to 2000.

^c Data for 1990 and prior include West Germany only. Kraftwagen are included with automobiles.

^d Data for earliest year available.



The United States totals include SUVs, minivans, and light trucks, many of which are used for personal travel. Thus, countries that only use trucks for freight movement will not be comparable to the United States.

Table 3.3
Truck and Bus Registrations for Selected Countries, 1960–2015
(thousands)

Country	1960	1970	1980	1990	2000	2005	2010	2015	Average annual percentage change 1990-2015
Argentina	392	788	1,217	1,501	1,554	1,730	2,511	3,305	3.2%
Brazil	a	a	a	936	3,917	4,653	6,524	8,959	9.5%
Canada ^b	1,056	1,481	2,955	3,931	739	786	933	1,147	-4.8%
China	a	a	1,480	4,314	9,650	21,750	43,590	23,191	7.0%
France	1,650	1,850	2,550	4,910	5,733	6,198	6,444	6,652	1.2%
Germany ^c	786	1,228	1,617	2,764	3,534	3,133	2,960	3,356	0.8%
India	a	a	a	2,050	2,390	4,145	9,500	11,230	7.0%
Indonesia	a	a	a	1,391	2,373	2,950	6,938	9,237	7.9%
Japan	896	8,803	14,197	22,773	20,211	16,734	15,512	14,981	-1.7%
Malaysia	a	a	a	616	1,030	1,323	1,138	1,335	3.1%
Pakistan	a	a	a	172	385	414	538	678	5.6%
Russia	a	a	a	7,200	5,041	5,705	6,304	8,000	0.4%
South Korea	a	a	a	1,320	3,956	4,275	4,310	4,428	5.0%
United Kingdom	1,534	1,769	1,920	3,774	3,361	3,943	4,220	4,677	0.9%
United States	12,186	19,175	34,195	45,106	85,579	104,788	119,179	146,154	4.8%
U.S. percentage of world	42.6%	36.2%	37.7%	32.7%	42.1%	42.6%	38.5%	43.3%	
World total	28,583	52,899	90,592	138,082	203,272	245,798	309,395	337,250	3.6%

Source:

Ward's Communications, www.wardsauto.com.

^a Data are not available.

^b Data from 2000 and later are not comparable to prior data. Canada reclassified autos and trucks prior to 2000.

^c Data for 1990 and prior include West Germany only. Kraftwagen are included with automobiles.



VEHICLES IN USE

Both the Federal Highway Administration (FHWA) and IHS Automotive report figures on the car and truck population each year. The two estimates, however, differ by as much as 11.2% (1981). The differences can be attributed to several factors:

- 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 in different states or the same states to different owners. IHS Automotive data include only those vehicles which are registered on July 1 of the given year.
- The classification of mini-vans, station wagons on truck chassis, and utility vehicles as cars or trucks causes important differences in the two estimates. IHS Automotive data included passenger vans in the car count until 1980; since 1980 all vans have been counted as trucks.
- Starting in 1993, the FHWA reclassified some minivans and sport utility vehicles into the truck category which were previously included with cars. This change produced a dramatic change in the individual percentage differences of cars and trucks. The difference in total vehicles has been less than 5% each year since 1990 and does not appear to be significantly affected by the FHWA reclassifications. Beginning with 2009, the FHWA discontinued the car/2-axle, 4-tire truck designations on Table VM-1. The data since 2009 come from Tables MV-1 and MV-9.
- The FHWA data include all non-military Federal vehicles, while IHS Automotive data include only those Federal vehicles which are registered within a state. Federal vehicles are not required to have State registrations, and, according to the General Services Administration, most Federal vehicles are not registered.
- In 2012 both IHS Automotive and FHWA changed their methodologies for the car/light truck split which created a significant decrease in the number of cars reported and a corresponding increase in the number of light trucks.



In the early 1980's, researchers had to make a conscious choice of which data series to use, since they differed by as much as 11%. In 2005 the two sources differed by less than 1%. Both sources changed their methodologies for the car/light truck split causing significant decreases to the number of cars in 2012.

Table 3.4
U.S. Cars and Trucks in Use, 1970–2015
(thousands)

Year	Cars			Trucks			Total		
	FHWA	IHS Automotive	Percentage difference	FHWA	IHS Automotive	Percentage difference	FHWA	IHS Automotive	Percentage difference
1970	89,243	80,448	10.9%	18,797	17,688	6.3%	108,040	98,136	10.1%
1975	106,706	95,241	12.0%	25,781	24,813	3.9%	132,487	120,054	10.4%
1980	121,601	104,564	16.3%	33,667	35,268	-4.5%	155,267	139,832	11.0%
1981	123,098	105,839	16.3%	34,644	36,069	-4.0%	157,743	141,908	11.2%
1982	123,702	106,867	15.8%	35,382	36,987	-4.3%	159,084	143,854	10.6%
1983	126,444	108,961	16.0%	36,723	38,143	-3.7%	163,166	147,104	10.9%
1984	128,158	112,019	14.4%	37,507	40,143	-6.6%	165,665	152,162	8.9%
1985	127,885	114,662	11.5%	43,210	42,387	1.9%	171,095	157,049	8.9%
1986	130,004	117,268	10.9%	45,103	44,826	0.6%	175,106	162,094	8.0%
1987	131,482	119,849	9.7%	46,826	47,344	-1.1%	178,308	167,193	6.6%
1988	133,836	121,519	10.1%	49,941	50,221	-0.6%	183,777	171,740	7.0%
1989	134,559	122,758	9.6%	52,172	53,202	-1.9%	186,731	175,960	6.1%
1990	133,700	123,276	8.5%	54,470	56,023	-2.8%	188,171	179,299	4.9%
1991	128,300	123,268	4.1%	59,206	58,179	1.8%	187,505	181,447	3.3%
1992	126,581	120,347	5.2%	63,136	61,172	3.2%	189,717	181,519	4.5%
1993	127,327	121,055	5.2%	66,082	65,260	1.3%	193,409	186,315	3.8%
1994	127,883	121,997	4.8%	69,491	66,717	4.2%	197,375	188,714	4.6%
1995	128,387	123,242	4.2%	72,458	70,199	3.2%	200,845	193,441	3.8%
1996	129,728	124,613	4.1%	75,940	73,681	3.1%	205,669	198,294	3.7%
1997	129,749	124,673	4.1%	77,307	76,398	1.2%	207,056	201,071	3.0%
1998	131,839	125,966	4.7%	79,062	79,077	0.0%	210,901	205,043	2.9%
1999	132,432	126,869	4.4%	83,148	82,640	0.6%	215,580	209,509	2.9%
2000	133,621	127,721	4.6%	87,108	85,579	1.8%	220,729	213,300	3.5%
2001	137,633	128,714	6.9%	92,045	87,969	4.6%	229,678	216,683	6.0%
2002	135,921	129,907	4.6%	92,939	91,120	2.0%	228,860	221,027	3.5%
2003	135,670	131,072	3.5%	94,944	94,810	0.1%	230,614	225,882	2.1%
2004	136,431	132,469	3.0%	100,016	99,698	0.3%	236,447	232,167	1.8%
2005	136,568	132,909	2.8%	103,819	105,475	-1.6%	240,387	238,384	0.8%
2006	135,400	135,047	0.3%	107,944	109,596	-1.5%	243,344	244,643	-0.5%
2007	135,933	135,222	0.5%	110,498	113,479	-2.6%	246,431	248,701	-0.9%
2008	137,080	135,882	0.9%	110,242	113,931	-3.2%	247,322	249,813	-1.0%
2009	134,880	132,500	1.8%	110,561	116,472	-5.1%	245,441	248,972	-1.4%
2010	130,892	129,053	1.4%	110,322	119,179	-7.4%	241,214	248,232	-2.8%
2011	125,657	127,577	-1.5%	118,483	121,355	-2.4%	244,140	248,932	-1.9%
2012	111,290	120,902	-8.0%	133,130	130,595	1.9%	244,420	251,497	-2.8%
2013	113,676	120,214	-5.4%	132,931	132,501	0.3%	246,607	252,715	-2.4%
2014	113,899	120,984	-5.9%	137,531	137,043	0.4%	251,430	258,027	-2.6%
2015	112,864	122,322	-7.7%	141,256	141,872	-0.4%	254,120	264,194	-3.8%

Source:

FHWA - U.S. Department of Transportation, Federal Highway Administration, 1970-2008, *Highway Statistics 2008* and earlier, Washington, DC, 2009, Table VM-1 and annual. 2009-2015 data from Tables MV-1 and MV-9, *Highway Statistics 2015*. (Additional resources: www.fhwa.dot.gov)

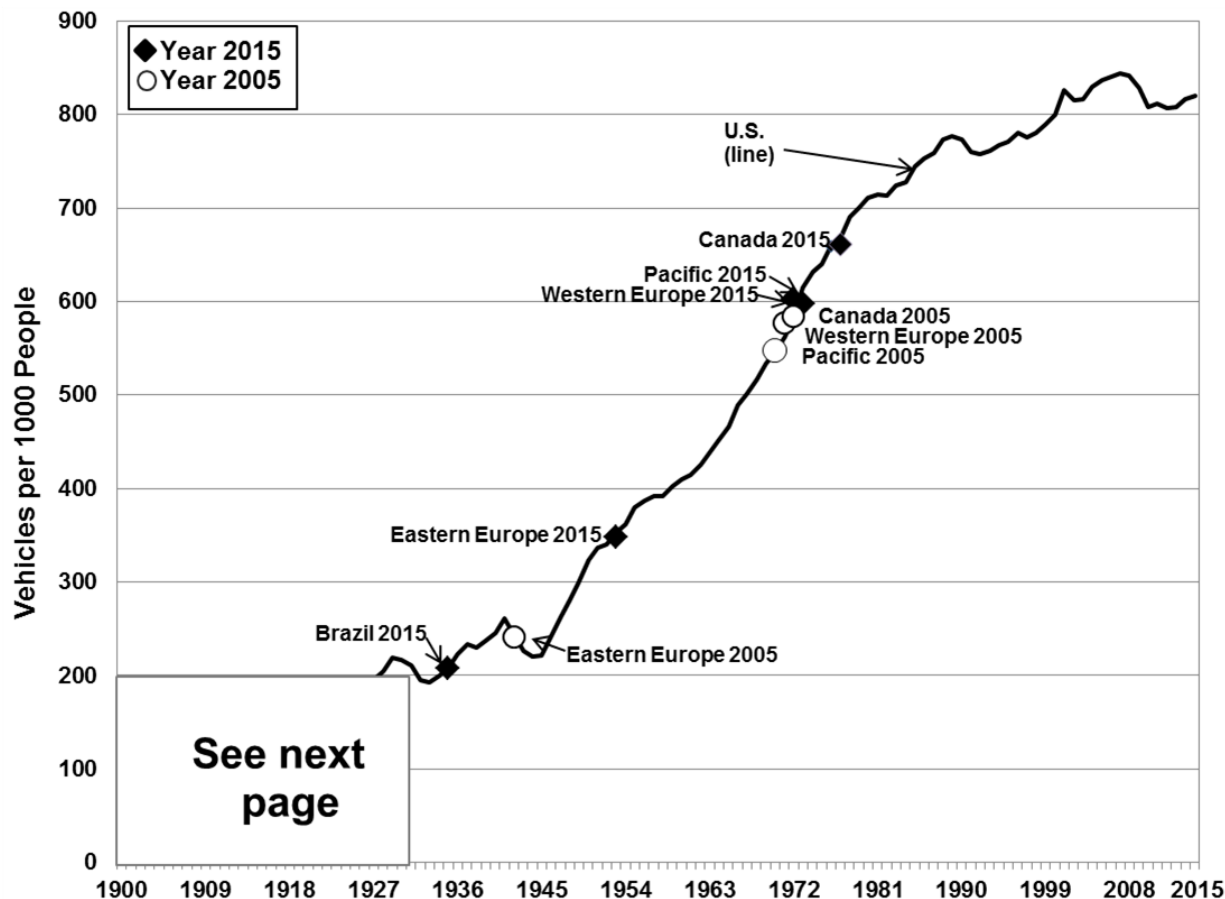
IHS Automotive - IHS Automotive, Detroit, Michigan. **FURTHER REPRODUCTION PROHIBITED.**

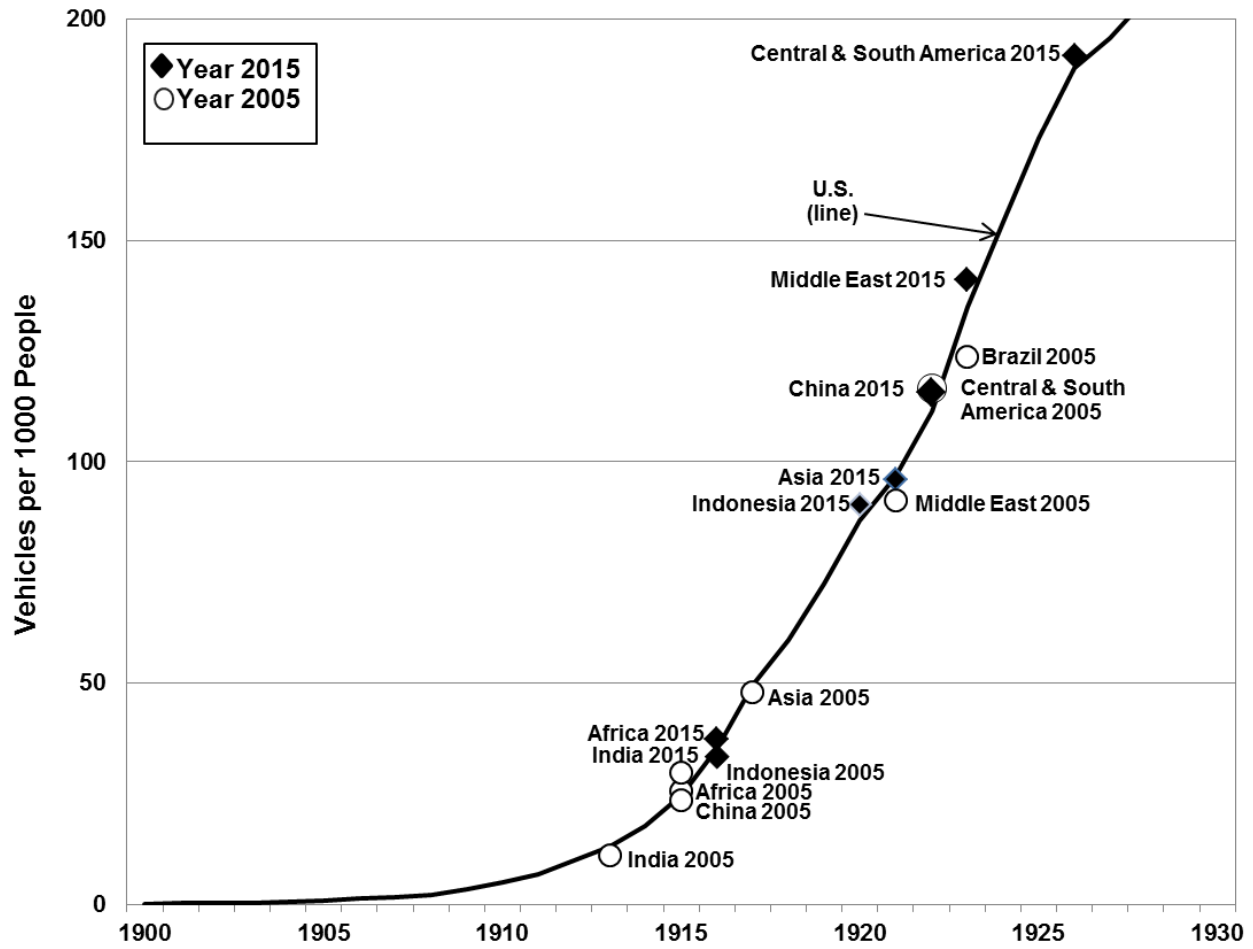
(Additional resources: <https://www.ihs.com/industry/automotive.html>)



The graphs below show the number of motor vehicles per thousand people for various countries. The data for the United States are displayed in the line which goes from 1900 to 2015. The points labeled on that line show data for the other countries/regions around the world and how their vehicles per thousand people compare to the United States at two different points in time, 2005 and 2015. For instance, the graph shows that in 2005, Eastern Europe's vehicles per thousand people was about where the United States was in 1942, but by 2015 it is about where the United States was in 1953. The lower part of the graph (1900-1930) is shown enlarged on the facing page.

Figure 3.3. Vehicles per Thousand People: U.S. (Over Time) Compared to Other Countries (in 2005 and 2015)





Source:
See Tables 3.5 and 3.6.



Though some countries are listed separately in this table, those countries are also included in the regional total. For instance, China is listed separately, but is also included in the Asia, Far East region.

Table 3.5
Vehicles per Thousand People in Selected Countries/Regions, 2005 and 2015

Country/Region	Vehicles per 1,000 people	
	2005	2015
Africa	25.5	37.4
Asia, Far East	47.9	95.9
Asia, Middle East	91.2	141.2
Brazil	123.8	208.2
Canada	583.9	661.4
Central & South America	116.5	191.7
China	23.5	115.8
Europe, East	241.3	348.0
Europe, West	577.8	597.6
India	11.1	33.4
Indonesia	29.7	90.2
Pacific	548.2	602.4
United States	837.2	820.1

Sources:

Population – U.S. Census Bureau, Population Division, International Data Base (IDB) World, July 21, 2017.
(Additional resources: www.census.gov/population/international)

Vehicles – United States: See Table 3.6. All other countries: Ward's Communications, www.wardsauto.com.



The number of vehicles per thousand people in the United States has grown tremendously since 1900. After a peak in 2007 at 844.5, the number has declined and in 2015 was 820.2.

Table 3.6
Vehicles per Thousand People in the United States, 1990–2015

Year	U.S. vehicles per 1,000 people	Year	U.S. vehicles per 1,000 people	Year	U.S. vehicles per 1,000 people	Year	U.S. vehicles per 1,000 people	Year	U.S. vehicles per 1,000 people
1900	0.1	1924	154.4	1948	280.2	1972	585.6	1996	781.2
1901	0.2	1925	173.3	1949	299.6	1973	615.2	1997	776.0
1902	0.3	1926	189.1	1950	323.7	1974	632.3	1998	781.2
1903	0.4	1927	195.8	1951	337.1	1975	640.1	1999	790.1
1904	0.7	1928	204.9	1952	340.6	1976	659.5	2000	800.3
1905	0.9	1929	219.3	1953	353.7	1977	669.0	2001	825.8
1906	1.3	1930	217.3	1954	361.4	1978	690.2	2002	815.7
1907	1.7	1931	210.4	1955	379.8	1979	700.4	2003	816.1
1908	2.2	1932	195.4	1956	387.6	1980	710.7	2004	829.9
1909	3.5	1933	192.4	1957	392.1	1981	715.2	2005	837.3
1910	5.1	1934	199.9	1958	392.2	1982	714.0	2006	840.7
1911	6.8	1935	208.6	1959	402.8	1983	724.3	2007	844.5
1912	9.9	1936	222.6	1960	410.4	1984	728.2	2008	841.6
1913	12.9	1937	233.3	1961	415.1	1985	744.5	2009	828.7
1914	17.8	1938	229.7	1962	426.1	1986	753.3	2010	808.4
1915	24.8	1939	236.9	1963	438.8	1987	758.6	2011	812.7
1916	35.5	1940	245.6	1964	451.6	1988	772.9	2012	808.0
1917	49.6	1941	261.6	1965	466.9	1989	777.0	2013	808.6
1918	59.7	1942	244.7	1966	489.3	1990	773.4	2014	816.4
1919	72.5	1943	225.9	1967	500.7	1991	760.2	2015	820.2
1920	86.8	1944	220.2	1968	516.5	1992	758.0		
1921	96.7	1945	221.8	1969	533.4	1993	761.9		
1922	111.5	1946	243.1	1970	545.4	1994	766.9		
1923	134.9	1947	262.6	1971	562.5	1995	771.0		

Sources:

Population – U.S. Census Bureau, Population Division, International Data Base (IDB) World, July 19, 2017.

(Additional resources: www.census.gov/ipc/www/idb/)

Vehicles – U.S. Department of Transportation, Federal Highway Administration, *Highway Statistics 2015*, Washington, DC, 2016.



Total vehicle-miles traveled increased each year from 2011 to 2015. The trend of using two-axle, four-tire trucks, such as pickups, vans, and sport-utility vehicles, for personal travel is evident in these data; two-axle, four-tire trucks account for 32.0% more travel in 2015 than in 1970, and cars account for 35.9% less travel in that time period.

Table 3.7
Shares of Highway Vehicle-Miles Traveled by Vehicle Type, 1970–2015

Year	Cars	Motorcycles	Two-axle, four-tire trucks	Other single-unit trucks	Combination trucks	Buses	Total vehicle-miles traveled (million miles)
1970	82.6%	0.3%	11.1%	2.4%	3.2%	0.4%	1,109,724
1975	77.9%	0.4%	15.1%	2.6%	3.5%	0.5%	1,327,664
1980	72.8%	0.7%	19.0%	2.6%	4.5%	0.4%	1,527,295
1985	70.2%	0.5%	22.0%	2.6%	4.4%	0.3%	1,774,826
1986	69.2%	0.5%	23.1%	2.5%	4.4%	0.3%	1,834,872
1987	68.5%	0.5%	23.8%	2.5%	4.5%	0.3%	1,921,204
1988	67.6%	0.5%	24.8%	2.4%	4.4%	0.3%	2,025,962
1989	66.8%	0.5%	25.6%	2.4%	4.4%	0.3%	2,096,487
1990	65.7%	0.4%	26.8%	2.4%	4.4%	0.3%	2,144,362
1991	62.5%	0.4%	29.9%	2.4%	4.4%	0.3%	2,172,050
1992	61.0%	0.4%	31.5%	2.4%	4.4%	0.3%	2,247,151
1993	59.9%	0.4%	32.5%	2.5%	4.5%	0.3%	2,296,378
1994	59.6%	0.4%	32.4%	2.6%	4.6%	0.3%	2,357,588
1995	59.4%	0.4%	32.6%	2.6%	4.8%	0.3%	2,422,696
1996	59.1%	0.4%	32.8%	2.6%	4.8%	0.3%	2,485,848
1997	58.7%	0.4%	33.2%	2.6%	4.9%	0.3%	2,561,695
1998	58.9%	0.4%	33.0%	2.6%	4.9%	0.3%	2,631,522
1999	58.3%	0.4%	33.5%	2.6%	4.9%	0.3%	2,691,056
2000	58.3%	0.4%	33.6%	2.6%	4.9%	0.3%	2,746,925
2001	58.2%	0.3%	33.7%	2.6%	4.9%	0.3%	2,797,287
2002	58.1%	0.3%	33.8%	2.7%	4.9%	0.2%	2,855,508
2003	57.8%	0.3%	34.0%	2.7%	4.8%	0.2%	2,890,412
2004	57.3%	0.3%	34.6%	2.6%	4.8%	0.2%	2,964,788
2005	57.1%	0.3%	34.8%	2.6%	4.8%	0.2%	2,989,430
2006	56.1%	0.4%	35.9%	2.7%	4.7%	0.2%	3,014,369 ^a
2007	55.2%	0.4%	36.7%	2.7%	4.8%	0.2%	3,032,399
2008	54.3%	0.5%	37.3%	2.8%	4.8%	0.2%	2,973,509
2009	53.0%	0.7%	36.1%	4.1%	5.7%	0.5%	2,956,764
2010	50.4%	0.6%	38.8%	3.7%	5.9%	0.5%	2,967,266
2011	49.4%	0.6%	40.4%	3.5%	5.6%	0.5%	2,950,401
2012	48.4%	0.7%	41.3%	3.6%	5.5%	0.5%	2,969,433
2013	48.4%	0.7%	41.2%	3.6%	5.6%	0.5%	2,988,281
2014	47.5%	0.7%	42.1%	3.6%	5.6%	0.5%	3,025,656
2015	46.7%	0.6%	43.1%	3.5%	5.5%	0.5%	3,095,372
<i>Average annual percentage change</i>							
1970–2015							2.3%
2005–2015							0.3%

Source:

U.S. Department of Transportation, Federal Highway Administration, *Highway Statistics 2015*, Washington, DC, 2016, Table VM-1 and annual. (Additional resources: www.fhwa.dot.gov). 2009–2015 cars and 2-axle 4-tire trucks – see Section 7 in Appendix A.

^a Due to FHWA methodology changes, data from 2007-on are not comparable with previous data.



In 1970 only 2.9% of the car population was 15 years old or older; by 2013 that number rose to nearly 20%.

Table 3.8
Cars in Operation by Age, 1970, 2000, and 2013

Age (years)	1970			2000			2013		
	Vehicles (thousands)	Percentage ^a	Cumulative percentage ^a	Vehicles (thousands)	Percentage ^a	Cumulative percentage ^a	Vehicles (thousands)	Percentage ^a	Cumulative percentage ^a
Under 1 ^b	6,288	7.8%	7.8%	6,665	5.2%	5.2%	9,287	7.1%	7.1%
1	9,299	11.6%	19.4%	8,177	6.4%	11.6%	7,700	5.9%	13.1%
2	8,816	11.0%	30.3%	7,655	6.0%	17.6%	5,957	4.6%	17.6%
3	7,878	9.8%	40.1%	7,906	6.2%	23.8%	6,159	4.7%	22.4%
4	8,538	10.6%	50.8%	7,413	5.8%	29.6%	5,484	4.2%	26.6%
5	8,506	10.6%	61.3%	8,675	6.8%	36.4%	7,226	5.6%	32.1%
6	7,116	8.8%	70.2%	7,628	6.0%	42.4%	7,896	6.1%	38.2%
7	6,268	7.8%	78.0%	7,650	6.0%	48.4%	7,706	5.9%	44.1%
8	5,058	6.3%	84.3%	7,021	5.5%	53.9%	7,843	6.0%	50.2%
9	3,267	4.1%	88.3%	7,109	5.6%	59.4%	6,924	5.3%	55.5%
10	2,776	3.5%	91.8%	7,071	5.5%	65.0%	7,237	5.6%	61.1%
11	1,692	2.1%	93.9%	7,338	5.7%	70.7%	7,167	5.5%	66.6%
12	799	1.0%	94.9%	6,876	5.4%	76.1%	6,660	5.1%	71.7%
13	996	1.2%	96.1%	6,084	4.8%	80.9%	6,889	5.3%	77.0%
14	794	1.0%	97.1%	5,334	4.2%	85.0%	5,487	4.2%	81.2%
15 and older	2,336	2.9%	100.0%	19,119	15.0%	100.0%	24,457	18.8%	100.0%
Subtotal	80,427	100.0%		127,721	100.0%		130,078	100.0%	
Age not given	22			0			0		
Total	80,449			121,721			130,078		

Source:

IHS Automotive, Detroit, MI. **FURTHER REPRODUCTION PROHIBITED.**

^a Percentages may not sum to totals due to rounding.

^b Includes cars which were sold prior to July 1, 1970, and similarly, sold prior to July 1, 2000. For 2013, cars sold prior to December 31, 2013 were included.



The number of trucks in the United States has grown significantly since 1970, some of it due to the use of light trucks (pickups, vans, sport utility vehicles) as personal passenger vehicles. Those light trucks, as well as medium and heavy trucks, are included in the data. In 1970 about 15% of trucks were age 15 or older; by 2013, that increased to 20.8%.

Table 3.9
Trucks in Operation by Age, 1970, 2000, and 2013

Age (years)	1970			2000			2013		
	Vehicles (thousands)	Percentage ^a	Cumulative percentage ^a	Vehicles (thousands)	Percentage ^a	Cumulative percentage ^a	Vehicles (thousands)	Percentage ^a	Cumulative percentage ^a
Under 1 ^b	1,262	7.1%	7.1%	6,439	7.5%	7.5%	8,097	6.5%	6.5%
1	1,881	10.6%	17.8%	7,726	9.0%	16.6%	6,391	5.1%	11.6%
2	1,536	8.7%	26.5%	6,630	7.7%	24.3%	6,417	5.2%	16.8%
3	1,428	8.1%	34.6%	6,313	7.4%	31.7%	4,972	4.0%	20.8%
4	1,483	8.4%	43.0%	5,300	6.2%	37.9%	3,991	3.2%	24.0%
5	1,339	7.6%	50.5%	5,818	6.8%	44.7%	6,927	5.6%	29.5%
6	1,154	6.5%	57.1%	5,206	6.1%	50.8%	7,587	6.1%	35.6%
7	975	5.5%	62.6%	4,335	5.1%	55.8%	7,580	6.1%	41.7%
8	826	4.7%	67.3%	3,547	4.1%	60.0%	7,585	6.1%	47.8%
9	621	3.5%	70.8%	3,411	4.0%	63.9%	7,978	6.4%	54.2%
10	658	3.7%	74.5%	3,258	3.8%	67.8%	7,201	5.8%	60.0%
11	583	3.3%	77.8%	3,665	4.3%	72.0%	6,850	5.5%	65.5%
12	383	2.2%	80.0%	3,421	4.0%	76.0%	6,163	4.9%	70.4%
13	417	2.4%	82.3%	2,860	3.3%	79.4%	5,673	4.6%	75.0%
14	414	2.3%	84.7%	2,812	3.3%	82.7%	5,217	4.2%	79.2%
15 and older	2,710	15.3%	100.0%	14,838	17.3%	100.0%	25,917	20.8%	100.0%
Subtotal	17,670	100.0%		85,579	100.0%		124,545	100.0%	
Age note given	15			0			0		
Total	17,685			85,579			124,545		

Source:

IHS Automotive, Detroit, MI. **FURTHER REPRODUCTION PROHIBITED.**

^a Percentages may not sum to totals due to rounding.

^b Includes trucks which were sold prior to July 1, 1970, and similarly, sold prior to July 1, 2000. For 2013, trucks sold prior to December 31, 2013 were included.



The average age of cars and light trucks has grown to a record level in 2016—11.6 years. Light trucks, which include pickups, vans, and sport utility vehicles, previously had a lower average age than cars. In 2014 through 2016, however, there is no difference in their ages.

Table 3.10
U.S. Average Vehicle Age, 1995–2016

Calendar Year	Passenger cars	Light trucks	All light vehicles
1995	8.4	8.3	8.4
1996	8.5	8.3	8.5
1997	8.7	8.5	8.6
1998	8.9	8.5	8.8
1999	9.1	8.5	8.8
2000	9.1	8.4	8.9
2001	9.3	8.4	8.9 ^a
2002	9.8	9.4	9.6
2003	9.9	9.0	9.7
2004	10.0	9.5	9.8
2005	10.1	9.5	9.8
2006	10.2	9.5	9.9
2007	10.3	9.6	10.0
2008	10.4	9.8	10.1
2009	10.5	10.1	10.3
2010	10.8	10.5	10.6
2011	11.1	10.8	10.9
2012	11.3	11.1	11.2
2013	11.4	11.3	11.4
2014	11.4	11.4	11.4
2015	11.5	11.5	11.5
2016	11.6	11.6	11.6

Source:

IHS Automotive, Detroit, MI. **FURTHER REPRODUCTION PROHIBITED.** (Additional resources: <https://www.ihs.com/industry/automotive.html>)

^a In 2013, IHS Automotive published a data series showing vehicle age from 2002-2013. These data did not match the previous data published by IHS Automotive. The data prior to 2002 came from earlier IHS Automotive news releases and is not comparable to the revised data.



Table 3.11
New Retail Vehicle Sales, 1970–2016
 (thousands)

Calendar Year	Cars	Light Trucks ^a	Subtotal Light Vehicles	Heavy Trucks	Total Vehicle Sales
1970	8,399	1,457	9,856	334	10,190
1975	8,624	2,053	10,677	298	10,975
1976	10,110	2,719	12,829	324	13,153
1977	11,183	3,109	14,292	376	14,668
1978	11,314	3,474	14,788	441	15,229
1979	10,673	2,845	13,518	391	13,909
1980	8,949	1,960	10,909	271	11,180
1981	8,489	1,746	10,235	226	10,461
1982	7,956	2,063	10,019	184	10,203
1983	9,148	2,521	11,669	189	11,858
1984	10,324	3,255	13,579	282	13,861
1985	10,979	3,688	14,667	295	14,962
1986	11,404	4,594	15,998	277	16,275
1987	10,192	4,610	14,802	302	15,104
1988	10,547	4,800	15,347	348	15,695
1989	9,779	4,610	14,389	330	14,719
1990	9,303	4,548	13,851	297	14,148
1991	8,185	4,122	12,307	242	12,549
1992	8,213	4,629	12,842	276	13,118
1993	8,518	5,351	13,869	330	14,199
1994	8,991	6,033	15,024	387	15,411
1995	8,620	6,053	14,673	428	15,101
1996	8,479	6,519	14,998	411	15,409
1997	8,217	6,797	15,014	430	15,444
1998	8,085	7,299	15,384	526	15,910
1999	8,638	8,073	16,711	641	17,352
2000	8,778	8,386	17,164	579	17,743
2001	8,352	8,598	16,950	452	17,402
2002	8,042	8,633	16,675	402	17,077
2003	7,556	8,938	16,494	420	16,914
2004	7,483	9,254	16,737	538	17,275
2005	7,660	9,114	16,774	664	17,438
2006	7,762	8,574	16,336	694	17,030
2007	7,562	8,305	15,867	537	16,404
2008	6,769	6,246	13,015	432	13,447
2009	5,402	4,834	10,236	312	10,548
2010	5,636	5,758	11,394	378	11,772
2011	6,093	6,449	12,542	500	13,042
2012	7,245	6,975	14,220	569	14,789
2013	7,586	7,693	15,279	606	15,884
2014	7,708	8,484	16,192	671	16,862
2015	7,517	9,578	17,095	732	17,827
2016	6,873	10,296	17,169	697	17,866
<i>Average annual percentage change</i>					
1970–2016	-0.4%	4.3%	1.2%	1.6%	1.2%
2006–2016	-1.2%	1.8%	0.5%	0.0%	0.5%

Source:

Ward's Communications, www.wardsauto.com.

^a Includes light trucks of 10,000 lb. gross vehicle weight and less.



The Environmental Protection Agency estimated the survival rates for cars and light trucks for the mid-term evaluation of the Light Vehicle Greenhouse Gas Emissions Standards and Corporate Average Fuel Economy Standards.

Table 3.12
Survival Rates for Cars and Light Trucks by Vehicle Age

Vehicle age (years)	Estimated survival rate for cars	Estimated survival rate for light trucks
0	1.000	1.000
1	0.997	0.991
2	0.994	0.982
3	0.991	0.973
4	0.984	0.960
5	0.974	0.941
6	0.961	0.919
7	0.942	0.891
8	0.920	0.859
9	0.893	0.823
10	0.862	0.784
11	0.826	0.741
12	0.788	0.697
13	0.718	0.651
14	0.613	0.605
15	0.510	0.553
16	0.415	0.502
17	0.332	0.453
18	0.261	0.407
19	0.203	0.364
20	0.157	0.324
21	0.120	0.288
22	0.092	0.255
23	0.070	0.225
24	0.053	0.198
25	0.040	0.174
26	0.030	0.153
27	0.023	0.133
28	0.013	0.117
29	0.010	0.102
30	0.007	0.089
31	0.002	0.027

Source:

U.S. Environmental Protection Agency, *Draft Technical Assessment Report: Midterm Evaluation of Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards for Model Years 2022-2025*, EPA-420-D-16-900, July 2016. (Additional resources: <https://www.epa.gov/regulations-emissions-vehicles-and-engines/midterm-evaluation-light-duty-vehicle-greenhouse-gas-ghg#TAR>)



The Environmental Protection Agency estimated the annual vehicle miles of travel for cars and light trucks up to 30 years old for the mid-term evaluation of the Light Vehicle Greenhouse Gas Emissions Standards and Corporate Average Fuel Economy Standards. The “Total” row represents the number of miles a car or light truck would travel if it is in operation for 30 years. Typical lifetime miles from a 2006 study by the National Highway Traffic Safety Administration (NHTSA) are shown below the total.

Table 3.13
Annual Mileage for Cars and Light Trucks by Vehicle Age

Vehicle age (years)	Estimated annual vehicle miles of travel for cars	Estimated annual vehicle miles of travel for light trucks
0	13,843	15,962
1	13,580	15,670
2	13,296	15,320
3	12,992	15,098
4	12,672	14,528
5	12,337	14,081
6	11,989	13,548
7	11,630	13,112
8	11,262	12,544
9	10,887	12,078
10	10,509	11,595
11	10,129	11,131
12	9,748	10,641
13	9,370	10,153
14	8,997	9,691
15	8,629	9,239
16	8,270	8,797
17	7,922	8,383
18	7,586	8,009
19	7,265	7,666
20	6,962	7,358
21	6,679	7,089
22	6,416	6,862
23	6,177	6,684
24	5,963	6,556
25	5,778	6,481
26	5,623	6,466
27	5,499	6,466
28	5,410	6,466
29	5,358	6,466
30	5,358	6,466
Total	278,134	310,610
NHTSA 2006 study – typical lifetime miles	152,137	179,954

Sources:

U.S. Environmental Protection Agency, *Draft Technical Assessment Report: Midterm Evaluation of Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards for Model Years 2022-2025*, EPA-420-D-16-900, July 2016. (Additional resources: <https://www.epa.gov/regulations-emissions-vehicles-and-engines/midterm-evaluation-light-duty-vehicle-greenhouse-gas-ghg#TAR>)

U.S. Department of Transportation, National Highway Traffic Safety Administration, *Vehicle Survivability and Travel Mileage Schedules*, January 2006.



Using current registration data and a scrappage model by Greenspan and Cohen [1996 paper: www.federalreserve.gov/pubs/feds/1996/199640/199640pap.pdf], ORNL calculated heavy truck (trucks over 26,000 lb gross vehicle weight) scrappage rates. The expected median lifetime for a 1990 model year heavy truck is 29 years. These data are fitted model values which assume constant economic conditions.

Table 3.14
Heavy Truck^a Scrappage and Survival Rates
1970, 1980, and 1990 Model Years

Vehicle age ^b (years)	1970 model year		1980 model year		1990 model year	
	Survival rate ^c	Scrappage rate ^d	Survival rate ^c	Scrappage rate ^d	Survival rate ^c	Scrappage rate ^d
4	98.8	1.2	98.5	1.5	99.4	0.6
5	97.2	1.6	96.7	1.9	98.6	0.8
6	95.3	1.9	94.5	2.3	97.6	1.0
7	93.2	2.3	92.0	2.7	96.5	1.2
8	90.7	2.6	89.1	3.1	95.2	1.3
9	88.1	3.0	86.0	3.5	93.8	1.5
10	85.2	3.3	82.7	3.9	92.2	1.7
11	82.1	3.6	79.1	4.3	90.5	1.9
12	78.8	4.0	75.4	4.7	88.6	2.0
13	75.4	4.3	71.6	5.1	86.7	2.2
14	71.9	4.7	67.7	5.5	84.6	2.4
15	68.3	5.0	63.7	5.9	82.4	2.6
16	64.6	5.3	59.7	6.3	80.2	2.7
17	61.0	5.7	55.7	6.7	77.9	2.9
18	57.3	6.0	51.8	7.1	75.5	3.1
19	53.7	6.3	47.9	7.4	73.0	3.3
20	50.1	6.7	44.2	7.8	70.5	3.4
21	46.6	7.0	40.6	8.2	68.0	3.6
22	43.2	7.3	37.1	8.6	65.4	3.8
23	39.9	7.6	33.7	9.0	62.8	3.9
24	36.7	8.0	30.6	9.4	60.3	4.1
25	33.7	8.3	27.6	9.7	57.7	4.3
26	30.8	8.6	24.8	10.1	55.1	4.5
27	28.0	8.9	22.2	10.5	52.6	4.6
28	25.4	9.3	19.8	10.9	50.0	4.8
29	23.0	9.6	17.6	11.2	47.6	5.0
30	20.7	9.9	15.5	11.6	45.1	5.1
Median lifetime	20.0 years		18.5 years		28.0 years	

Source:

Schmoyer, Richard L., unpublished study on scrappage rates, Oak Ridge National Laboratory, Oak Ridge, TN, 2001.

^a Heavy trucks are trucks over 26,000 lb gross vehicle weight.

^b It was assumed that scrappage for vehicles less than 4 years old is 0.

^c The percentage of heavy trucks which will be in use at the end of the year.

^d The percentage of heavy trucks which will be retired from use during the year.





Chapter 4

Light Vehicles and Characteristics

Summary Statistics from Tables in this Chapter

Source		
Table 4.1	Cars, 2015	
	<i>Registrations (thousands)</i>	112,864
	<i>Vehicle miles (billion miles)</i>	1,445.4
	<i>Fleet average fuel economy (miles per gallon)</i>	26.2
Table 4.2	Two-axle, four-tire trucks, 2015	
	<i>Registrations (thousands)</i>	128,553
	<i>Vehicle miles (billion miles)</i>	1,343.1
	<i>Fleet average fuel economy (miles per gallon)</i>	18.8
Table 4.7	Light truck share of total light vehicle sales	
	<i>1970 calendar year</i>	14.8%
	<i>2016 calendar year</i>	60.0%
Table 4.8	Cars, 2015 model year	
	<i>Production (thousands)</i>	7,899
	<i>New car fuel economy (miles per gallon)</i>	29.4
Table 4.8	Car SUVs, 2015 model year	
	<i>Production (thousands)</i>	1,701
	<i>New car SUV fuel economy (miles per gallon)</i>	25.3
Table 4.8	Truck SUVs, 2015 model year	
	<i>Production (thousands)</i>	4,697
	<i>New truck SUV fuel economy (miles per gallon)</i>	22.6
Table 4.8	Pickups, 2015 model year	
	<i>Production (thousands)</i>	1,786
	<i>New pickup fuel economy (miles per gallon)</i>	18.8
Table 4.8	Vans, 2015 model year	
	<i>Production (thousands)</i>	655
	<i>New van fuel economy (miles per gallon)</i>	21.9
Table 4.29	Average fuel economy loss from 50 to 70 mph	24.5%

The definition of light truck can change from table to table in this document due to differing definitions among federal government regulations and public nomenclature. See page 4-2 for additional information.



Definition of Light Truck

Often for regulatory purposes, agencies within the federal government have differing definitions for the term “light truck.” Private data collectors, such as Ward’s Communications or IHS Automotive/Polk, have their own definitions as well. The paragraphs below are intended as a guide to the different definitions which are used in this document.

The data on Table 4.2 are from the Federal Highway Administration (FHWA). From 1970 to 2008 the FHWA defined light trucks as two-axle, four-tire trucks, including pickups, vans, SUVs, and other two-axle, four-tire trucks under 10,000 lb gross vehicle weight rating (GVWR). In 2009, the FHWA changed methodologies and no longer publishes vehicle miles, fuel use, and fuel economy of light trucks separately from cars. They continue to publish vehicle registrations for pickups, vans, SUVs and other two-axle, four tire trucks under 10,000 lb. The methodology used by Oak Ridge National Laboratory (ORNL) to continue the data series on Table 4.2 after 2008 is based on the FHWA data for all light vehicles, thus uses the same definition of light trucks. See Section 7.2 in Appendix A for the methodology of light truck data on Table 4.2 after 2008. Data on energy use in Tables 2.7 through 2.9 also use the FHWA definition of light truck.

Tables 3.11, 4.4, 4.5, and 4.7 are light truck sales based on Ward’s Communications data. Ward’s definition of light trucks includes pickups, vans, SUVs, and specialty purpose vehicles up to 14,000 lb GVWR. However, in most cases, data are available by individual GVWR and ORNL summarized only light trucks that were 10,000 lb GVWR or less and did not include the heavier trucks. Thus, the definition on these tables is nearly identical to the FHWA definition.

The Environmental Protection Agency (EPA) and the Department of Transportation, National Highway Traffic Safety Administration (NHTSA), issued joint rulemaking to establish Corporate Average Fuel Economy (CAFE) standards and greenhouse gas emissions standards beginning with model year 2012. The rulemaking established new definitions of cars and light trucks. Before the rule, CAFE standards applied to cars and light trucks (pickups, vans, SUVs, and other trucks) less than 8,500 lb GVWR. After the rule, some two-wheel drive SUVs are considered cars instead of light trucks, and personal passenger vehicles (vans and SUVs) up to 10,000 lb GVWR are considered light trucks. Thus, data are now categorized as cars, car SUVs, truck SUVs, pickups and vans. Table 4.9 gives a listing of which SUVs are considered car SUVs for model year 2016. The EPA revised their data series back to 1975, so the definitions are consistent historically. Data on tables 4.8 through 4.15 are based on EPA data and thus use this definition of cars and light trucks. The CAFE data on Table 4.21 apply to cars only through 2011 and cars plus car SUVs after that. The CAFE data on Table 4.22 are for trucks up to 8,500 lb GVWR through 2011 and after that are for truck SUVs and vans up to 10,000 lb GVWR, and pickup trucks up to 8,500 lb GVWR.

Because of these different definitions, caution is advised when comparing light truck data from different sources.



The data in this table from 1985–on DO NOT include minivans, pickups, or sport utility vehicles. Much of the data for 2009–on were estimated; the FHWA no longer publishes travel and fuel data for cars. A methodology change for the number of cars registered affected the series in 2012.

Table 4.1
Summary Statistics for Cars, 1970–2015

Year	Registrations ^a (thousands)	Vehicle travel (billion miles)	Miles (per vehicle)	Fuel use (million gallons)	Fuel economy ^b (miles per gallon)
1970	89,244	916.7	10,272	67,820	13.5
1975	106,706	1,034.0	9,690	74,140	13.9
1980	121,601	1,111.6	9,141	69,981	15.9
1985 ^c	127,885	1,246.8	9,749	71,518	17.4
1986	130,004	1,270.2	9,770	73,174	17.4
1987	131,482	1,316.0	10,009	73,308	18.0
1988	133,836	1,370.3	10,238	73,345	18.7
1989	134,559	1,401.2	10,413	73,913	19.0
1990	133,700	1,408.3	10,533	69,568	20.2
1991	128,300	1,358.2	10,586	64,318	21.1
1992	126,581	1,371.6	10,836	65,436	21.0
1993	127,327	1,374.7	10,797	67,047	20.5
1994	127,883	1,406.1	10,995	67,874	20.7
1995	128,387	1,438.3	11,203	68,072	21.1
1996	129,728	1,469.9	11,330	69,221	21.2
1997	129,749	1,502.6	11,580	69,892	21.5
1998	131,839	1,549.6	11,754	71,695	21.6
1999	132,432	1,569.1	11,848	73,283	21.4
2000	133,621	1,600.3	11,976	73,065	21.9
2001	137,633	1,628.3	11,831	73,559	22.1
2002	135,921	1,658.5	12,202	75,471	22.0
2003	135,670	1,672.1	12,325	74,590	22.4
2004	136,431	1,699.9	12,460	75,402	22.5
2005	136,568	1,708.4	12,510	77,418	22.1
2006	135,400	1,690.5	12,485	75,009	22.5
2007	135,933	1,672.5	12,304	74,377	22.5
2008	137,080	1,615.9	11,788	71,497	22.6 ^d
2009	134,880	1,566.8	11,616	66,587	23.5
2010	130,892	1,496.4	11,432	62,245	24.0
2011	125,657	1,457.8	11,601	59,646	24.4
2012	111,290	1,438.6	12,928	57,899	24.9
2013	113,676	1,446.0	12,720	57,290	25.2
2014	113,899	1,436.6	12,613	56,470	25.4
2015	112,864	1,445.4	12,807	55,212	26.2
<i>Average annual percentage change</i>					
1970–2015	0.5%	1.0%	0.5%	-0.5%	1.5%
2005–2015	-1.9%	-1.7%	0.2%	-3.3%	1.7%

Source:

1970–2008: U.S. Department of Transportation, Federal Highway Administration, *Highway Statistics 2009*, Washington, DC, 2011, Table VM-1 and annual. 2009–on: See Section 7.1 in Appendix A. (Additional resources: www.fhwa.dot.gov)

^a This number differs from IHS Automotive’s estimates of “number of cars in use.” See Table 3.4.

^b Fuel economy for car population.

^c Beginning in this year the data were revised to exclude minivans, pickups and sport utility vehicles which may have been previously included.

^d Due to FHWA methodology changes, data from 2009–on are not comparable with previous data.



Much of the data for 2009-on were estimated; the FHWA no longer publishes travel and fuel use data for two-axle, four-tire trucks. A methodology change for the number of registrations affected the data series in 2012.

Table 4.2
Summary Statistics for Two-Axle, Four-Tire Trucks, 1970–2015

Year	Registrations (thousands)	Vehicle travel (billion miles)	Miles (per vehicle)	Fuel use (million gallons)	Fuel economy (miles per gallon)
1970	14,211	123.3	8,675	12,313	10.0
1975	20,418	200.7	9,830	19,081	10.5
1980	27,876	290.9	10,437	23,796	12.2
1985 ^a	37,214	391.0	10,506	27,363	14.3
1986	39,382	423.9	10,764	29,074	14.6
1987	41,107	456.9	11,114	30,598	14.9
1988	43,805	502.2	11,465	32,653	15.4
1989	45,945	536.5	11,676	33,271	16.1
1990	48,275	574.6	11,902	35,611	16.1
1991	53,033	649.4	12,245	38,217	17.0
1992	57,091	706.9	12,381	40,929	17.3
1993	59,994	745.8	12,430	42,851	17.4
1994	62,904	764.6	12,156	44,112	17.3
1995	65,738	790.0	12,018	45,605	17.3
1996	69,134	816.5	11,811	47,354	17.2
1997	70,224	850.7	12,115	49,389	17.2
1998	71,330	868.3	12,173	50,462	17.2
1999	75,356	901.0	11,957	52,859	17.0
2000	79,085	923.1	11,672	52,939	17.4
2001	84,188	943.2	11,204	53,522	17.6
2002	85,011	966.0	11,364	55,220	17.5
2003	87,187	984.1	11,287	60,758	16.2
2004	91,845	1,027.2	11,184	63,417	16.2
2005	95,337	1,041.1	10,920	58,869	17.7
2006	99,125	1,082.5	10,920	60,685	17.8
2007	101,470	1,112.3	10,962	61,836	18.0
2008	101,235	1,108.6	10,951	61,199	18.1 ^b
2009	100,154	1,066.5	10,649	61,824	17.3
2010	102,702	1,152.1	11,218	64,687	17.8
2011	105,571	1,192.7	11,298	65,786	18.1
2012	120,847	1,225.5	10,142	66,395	18.5
2013	120,523	1,231.8	10,220	65,555	18.8
2014	124,681	1,274.0	10,218	69,012	18.5
2015	128,553	1,334.3	10,448	67,730	18.8
<i>Average annual percentage change</i>					
1970–2015	5.0%	5.5%	0.4%	3.9%	1.4%
2005–2015	3.0%	2.6%	-0.4%	1.4%	0.6%

Source:

1970-2008: U.S. Department of Transportation, Federal Highway Administration, *Highway Statistics 2009*, Washington, DC, 2011, Table MV-9. Previous years Table VM-1. 2009-on: See Section 7.2 in Appendix A. (Additional resources: www.fhwa.dot.gov)

^a Beginning in this year the data were revised to include all vans (including mini-vans), pickups and sport utility vehicles.

^b Due to FHWA methodology changes, data from 2009-on are not comparable with previous data.



These data are the combination of the car and two-axle, four-tire truck data from Tables 4.1 and 4.2 thus the data may not match exactly with the FHWA VM-1 table's light-duty vehicle data. The methodology change after 2008 affects these data as well.

Table 4.3
Summary Statistics for Light Vehicles, 1970–2015

Year	Registrations (thousands)	Vehicle travel (billion miles)	Miles (per vehicle)	Fuel use (million gallons)	Fuel economy (miles per gallon)
1970	103,455	1,040	10,053	80,133	13.0
1975	127,124	1,235	9,712	93,221	13.2
1980	149,477	1,403	9,383	93,777	15.0
1981	152,026	1,430	9,404	92,809	15.4
1982	153,494	1,468	9,563	91,818	16.0
1983	157,658	1,523	9,658	94,267	16.2
1984	160,264	1,585	9,890	96,267	16.5
1985 ^a	165,099	1,638	9,920	98,881	16.6
1986	169,386	1,694	10,001	102,248	16.6
1987	172,589	1,773	10,272	103,906	17.1
1988	177,641	1,872	10,541	105,998	17.7
1989	180,504	1,938	10,735	107,184	18.1
1990	181,975	1,983	10,896	105,179	18.9
1991	181,333	2,008	11,071	102,535	19.6
1992	183,672	2,078	11,316	106,365	19.5
1993	187,321	2,120	11,320	109,898	19.3
1994	190,787	2,171	11,378	111,986	19.4
1995	194,125	2,228	11,479	113,677	19.6
1996	198,862	2,286	11,497	116,575	19.6
1997	199,973	2,353	11,768	119,281	19.7
1998	203,169	2,418	11,901	122,157	19.8
1999	207,788	2,470	11,888	126,142	19.6
2000	212,706	2,523	11,863	126,004	20.0
2001	221,821	2,572	11,593	127,081	20.2
2002	220,932	2,625	11,879	130,691	20.1
2003	222,857	2,656	11,919	135,348	19.6
2004	228,276	2,727	11,946	138,819	19.6
2005	231,905	2,749	11,856	136,287	20.2
2006	234,525	2,773	11,824	135,694	20.4
2007	237,403	2,785	11,730	136,213	20.4
2008	238,315	2,724	11,432	132,696	20.5 ^b
2009	235,034	2,633	11,204	128,411	20.5
2010	233,594	2,648	11,338	126,932	20.9
2011	231,228	2,650	11,463	125,432	21.1
2012	232,137	2,664	11,476	124,294	21.4
2013	234,199	2,678	11,434	122,845	21.8
2014	238,580	2,711	11,361	125,482	21.6
2015	241,417	2,780	11,514	122,940	22.6
<i>Average annual percentage change</i>					
1970–2015	1.9%	2.2%	0.3%	1.0%	1.2%
2005–2015	0.4%	0.1%	-0.3%	-1.0%	1.1%

Sources:

Tables 4.1 and 4.2.

^a Beginning in this year the data were revised to include all vans (including mini-vans), pickups and sport utility vehicles.

^b Due to FHWA methodology changes, data from 2009-on are not comparable with previous data.



Because data on Class 2b trucks are scarce, the U.S. DOE funded a study to investigate available sources of data. In the final report, four methodologies are described to estimate the sales of Class 2b trucks. Until another study is funded, the 1999 data are the latest available.

Table 4.4
Summary Statistics on Class 1, Class 2a, and Class 2b Light Trucks

	CY 1999 truck sales (millions)	2000 truck population (millions)	Percent diesel trucks in population	Average age (years)	Estimated annual miles ^a (billions)	Estimated fuel use (billion ^a gallons)	Estimated fuel economy (miles per gallon)
Class 1	5.7	49.7	0.3%	7.3	672.7	37.4	18.0
Class 2a	1.8	19.2	2.5%	7.4	251.9	18.0	14.0
Class 2b	0.5	5.8	24.0%	8.6	76.7	5.5	13.9

Note: CY - calendar year.

Source:

Davis, S.C. and L.F. Truett, *Investigation of Class 2b Trucks (Vehicles of 8,500 to 10,000 lbs GVWR)*, ORNL/TM-2002/49, March 2002, Table 16.

Table 4.5
Sales Estimates of Class 1, Class 2a, and Class 2b Light Trucks, 1989–1999

Calendar year	Sales estimates (thousands)			Total
	Class 1 (6,000 lb and under)	Class 2a (6,001-8,500 lb)	Class 2b (8,501-10,000 lb)	
1989	3,313	918	379	4,610
1990	3,451	829	268	4,548
1991	3,246	670	206	4,122
1992	3,608	827	194	4,629
1993	4,119	975	257	5,351
1994	4,527	1,241	265	6,033
1995	4,422	1,304	327	6,053
1996	4,829	1,356	334	6,519
1997	5,085	1,315	397	6,797
1998	5,263	1,694	342	7,299
1999	5,707	1,845	521	8,073
<i>Percent change</i>				
1989–1999	72.3%	101.0%	37.5%	75.1%

Note: These data were calculated using Methodology 4 from the report.

Source:

Davis, S.C. and L.F. Truett, *Investigation of Class 2b Trucks (Vehicles of 8,500 to 10,000 lbs GVWR)*, ORNL/TM-2002/49, March 2002, Table 1.

^a Estimates derived using 2000 population data and 1997 usage data. See source for details.



Car sales in 2009 and 2010 were below 6 million but increased to more than 7.7 million by 2014 before declining in both 2015 and 2016. In 1980, Chrysler/FCA, Ford and General Motors held 73.8% of the market; by 2016, that had dropped to 27.9%.

Table 4.6
New Retail Car Sales in the United States, 1970–2016

Calendar year	Domestic ^a	Import ^b (thousands)	Total ^c	Percentage imports	Percentage FCA/Ford/GM sales ^d	Percentage diesel
1970	7,119	1,280	8,399	15.2%	^e	0.07%
1975	7,053	1,571	8,624	18.2%	^e	0.31%
1980	6,580	2,369	8,949	26.5%	73.8%	4.32%
1985	8,205	2,775	10,979	25.3%	72.9%	0.83%
1990	6,919	2,384	9,303	25.6%	65.7%	0.08%
1991	6,162	2,023	8,185	24.7%	64.2%	0.10%
1992	6,286	1,927	8,213	23.5%	65.8%	0.06%
1993	6,742	1,776	8,518	20.9%	67.3%	0.04%
1994	7,255	1,735	8,991	19.3%	65.9%	0.04%
1995	7,114	1,506	8,620	17.5%	65.3%	0.03%
1996	7,206	1,272	8,479	15.0%	64.1%	0.09%
1997	6,862	1,355	8,217	16.5%	62.2%	0.09%
1998	6,705	1,380	8,085	17.1%	59.7%	0.14%
1999	6,919	1,719	8,638	19.9%	58.3%	0.16%
2000	6,762	2,016	8,778	23.0%	55.0%	0.26%
2001	6,254	2,098	8,352	25.1%	51.4%	0.18%
2002	5,817	2,226	8,042	27.7%	48.4%	0.39%
2003	5,473	2,083	7,556	27.6%	47.1%	0.52%
2004	5,333	2,149	7,483	28.7%	44.9%	0.40%
2005	5,473	2,187	7,660	28.5%	43.1%	0.63%
2006	5,417	2,345	7,762	30.2%	40.5%	0.82%
2007	5,197	2,365	7,562	31.3%	36.9%	0.10%
2008	4,491	2,278	6,769	33.7%	34.2%	0.11%
2009	3,558	1,843	5,402	34.1%	31.3%	2.93%
2010	3,791	1,844	5,636	32.7%	31.7%	2.69%
2011	4,146	1,947	6,093	32.0%	33.3%	1.47%
2012	5,120	2,125	7,245	29.3%	31.6%	2.69%
2013	5,433	2,153	7,586	28.4%	32.4%	2.45%
2014	5,610	2,098	7,708	27.2%	31.2%	2.41%
2015	5,595	1,922	7,517	25.6%	29.7%	1.14%
2016	5,169	1,703	6,873	24.8%	27.9%	0.12%
<i>Average annual percentage change</i>						
1970–2016	-0.7%	0.6%	-0.4%			
2006–2016	-0.5%	-3.1%	-1.2%			

Source:

Domestic and import data - 1970–97: American Automobile Manufacturers Association, *Motor Vehicle Facts and Figures 1998*, Detroit, MI, 1998, p. 15, and annual. 1997 data from *Economic Indicators, 4th Quarter 1997*.

1998–2016: Ward's Communication, www.wardsauto.com.

Diesel data - Ward's Communications, www.wardsauto.com.

^a Any vehicle built in North America regardless of manufacturer.

^b Any vehicle built outside of North America regardless of manufacturer. Does not include import tourist deliveries.

^c Sums may not add to totals due to rounding.

^d Big 3 includes Ford, General Motors, and Fiat-Chrysler (and predecessor entities).

^e Data are not available.



Light trucks, which include pick-ups, minivans, sport-utility vehicles, and other trucks less than 10,000 pounds gross vehicle weight (GVW), accounted for more than half of light vehicle sales from 2001 to 2007 and again in 2010, 2011, and from 2013 to 2016.

Table 4.7
New Retail Sales of Trucks 10,000 Pounds GVW and Less in the United States, 1970–2016

Calendar year	Light truck sales ^a (thousands)	Percentages			Light trucks of light-duty vehicle sales ^e	Light trucks of total truck sales
		Import ^b	FCA/Ford/GM sales ^c	Diesel ^d		
1970	1,457	4.5%	Not available	^f	14.8%	80.5%
1975	2,053	10.0%	Not available	^f	20.9%	82.8%
1980	1,960	24.4%	Not available	4.0%	17.5%	78.6%
1985	3,688	22.6%	78.2%	4.0%	25.1%	77.7%
1990	4,548	13.5%	80.9%	2.3%	32.8%	93.8%
1991	4,122	13.1%	79.4%	3.2%	33.5%	94.4%
1992	4,629	8.8%	83.1%	2.5%	36.0%	94.4%
1993	5,351	7.1%	83.4%	2.3%	38.6%	94.2%
1994	6,033	6.8%	82.9%	2.5%	40.2%	94.0%
1995	6,053	6.6%	83.4%	3.8%	41.3%	93.2%
1996	6,519	6.7%	83.8%	3.1%	43.5%	93.4%
1997	6,797	8.5%	81.9%	2.7%	45.3%	93.4%
1998	7,299	9.0%	80.5%	2.6%	47.4%	92.6%
1999	8,073	9.6%	78.0%	2.9%	48.3%	92.0%
2000	8,386	10.2%	76.1%	3.4%	48.9%	92.8%
2001	8,598	11.4%	75.3%	2.9%	50.7%	94.3%
2002	8,633	12.4%	74.7%	2.7%	51.8%	94.9%
2003	8,938	13.7%	72.4%	2.9%	54.2%	95.0%
2004	9,254	13.5%	70.1%	2.8%	55.3%	94.3%
2005	9,114	13.3%	68.2%	2.7%	54.3%	93.1%
2006	8,574	15.7%	63.9%	2.8%	52.5%	92.3%
2007	8,305	16.7%	61.9%	3.2%	52.3%	93.3%
2008	6,246	17.6%	61.2%	3.4%	48.0%	92.9%
2009	4,834	18.3%	57.8%	4.2%	47.2%	93.0%
2010	5,758	15.6%	57.6%	4.9%	50.5%	93.8%
2011	6,449	15.2%	59.4%	5.4%	51.4%	92.7%
2012	6,975	15.2%	57.7%	5.5%	49.0%	92.6%
2013	7,693	16.1%	57.3%	5.3%	50.3%	92.7%
2014	8,484	16.0%	57.6%	5.4%	52.4%	92.7%
2015	9,578	18.6%	57.0%	5.5%	56.0%	92.7%
2016	10,296	20.7%	55.6%	^g	60.0%	93.7%
Average annual percentage change						
1970–2016	4.3%					
2006–2016	1.8%					

Source:

Ward's Communications, www.wardsauto.com.

^a Includes all trucks of 10,000 pounds gross vehicle weight and less sold in the United States.

^b Excluding transplants.

^c Includes Ford, General Motors, and Fiat-Chrysler (and predecessor entities).

^d Based on model year factory installations.

^e Light-duty vehicles include cars and light trucks.

^f Indicates less than 1 percent.

^g Not available.



The production-weighted fuel economy of cars increased dramatically from 1975 (13.5 mpg) to 1985 (23.0 mpg), but rose only 0.5 mpg from 1985 to 2005. Since 2005, fuel economy rose 5.8 mpg—from 23.5 mpg in 2005 to 29.8 mpg in 2016. The fuel economy values have been adjusted to provide the best estimate of real world performance.

Table 4.8
Production, Production Shares, and Production-Weighted Fuel Economies of New Domestic and Import Cars, Model Years 1975-2016^a

Model year	Car			Car SUV		
	Production (thousands)	Production share (%) ^b	Fuel economy (mpg)	Production (thousands)	Production share (%) ^b	Fuel economy (mpg)
1975	8,237	99.9%	13.5	10	0.1%	11.1
1980	9,443	100.0%	20.0	0	0.0%	14.6
1990	8,810	99.3%	23.3	65	0.7%	18.8
1991	8,524	97.4%	23.4	224	2.6%	18.2
1992	8,108	97.1%	23.1	243	2.9%	17.8
1993	8,456	94.7%	23.5	473	5.3%	17.0
1994	8,415	96.2%	23.3	332	3.8%	18.0
1995	9,396	97.7%	23.4	220	2.3%	17.8
1996	7,890	96.5%	23.3	287	3.5%	18.4
1997	8,334	95.8%	23.4	361	4.2%	19.2
1998	7,971	94.6%	23.4	454	5.4%	18.2
1999	8,376	94.5%	23.0	488	5.5%	18.5
2000	9,125	93.7%	22.9	617	6.3%	17.9
2001	8,405	91.9%	23.0	743	8.1%	18.8
2002	8,301	93.2%	23.1	603	6.8%	19.3
2003	7,921	93.2%	23.3	575	6.8%	19.9
2004	7,537	92.2%	23.1	639	7.8%	20.0
2005	8,027	90.8%	23.5	813	9.2%	20.2
2006	7,993	91.4%	23.3	751	8.6%	20.5
2007	8,082	89.8%	24.1	919	10.2%	20.6
2008	7,319	88.8%	24.3	924	11.2%	21.2
2009	5,636	90.3%	25.3	608	9.7%	22.0
2010	6,061	86.9%	26.2	915	13.1%	23.0
2011	5,743	82.6%	26.1	1,207	17.4%	23.7
2012	7,392	85.4%	27.9	1,265	14.6%	23.4
2013	8,226	84.5%	28.6	1,514	15.5%	24.5
2014	7,639	83.0%	28.7	1,566	17.0%	24.6
2015	7,899	82.3%	29.4	1,701	17.7%	25.3
2016	^c	82.8%	29.8	^c	17.2%	25.6

Note: See Table 4.11 for all cars (car + car SUV). See Table 4.9 for car SUV listing.

Source:

U.S. Environmental Protection Agency, *Light-Duty Automotive Technology, Carbon Dioxide Emissions, and Fuel Economy Trends: 1975 Through 2016*, November 2016. (Additional resources: www.epa.gov/fueleconomy/light-duty-automotive-technology-carbon-dioxide-emissions-and-fuel-economy-trends-1975-0)

^a The fuel economy data on this table are adjusted to provide the best estimate of real world performance. See section 10 of the source document for details on adjustment methodology. These data are not directly comparable to Corporate Average Fuel Economy data.

^b Production share is based on total of cars plus car SUVs. Percentages may not sum to totals due to rounding.

^c Data are not available.



A vehicle classification was created to match the Corporate Average Fuel Economy (CAFE) methodology. Under CAFE, small, two-wheel drive sport utility vehicles will be held to the same standards as cars. The Environmental Protection Agency has defined these vehicles as “car SUVs.” The vehicles below make up this category.

Table 4.9
Definition of Car Sport Utility Vehicles in Model Year 2016

Acura RDX 2WD	Jeep Cherokee FWD
BMW X3 sDrive 28i	Jeep Compass FWD
Buick Encore	Jeep Patriot FWD
Cadillac SRX	Jeep Renegade 4x2
Cadillac SRX AWD	Kia Sorento AWD
Chevrolet Equinox AWD	Kia Sorento FWD
Chevrolet Equinox FWD	Kia Sportage FWD
Chevrolet Trax	Kia Sportage SX FWD
Dodge Journey	Lexus NX 200t
Fiat 500X	Lexus NX 200t AWD F Sport
Ford Edge FWD	Lexus NX 300h
Ford Escape FWD	Lexus RX 350
GMC Terrain AWD	Lexus RX 450h
GMC Terrain FWD	Lincoln MKC FWD
Honda CR-V 2WD	Lincoln MKX FWD
Honda HR-V 2WD	Mazda CX-5 2WD
Honda HR-V 4WD	Mercedes GLC 300
Hyundai Santa Fe Sport AWD	Mitsubishi Outlander Sport 2WD
Hyundai Santa Fe Sport FWD	Nissan Rogue FWD
Hyundai Santa Fe Sport Ultimate FWD	Tesla Model X AWD
Hyundai Tucson AWD	Toyota RAV4
Hyundai Tucson Eco AWD	Toyota RAV4 LE/XLE
Hyundai Tucson Eco FWD	Toyota RAV4 Limited AWD/SE AWD
Hyundai Tucson Fuel Cell ^a	Volvo XC60 FWD
Hyundai Tucson FWD	Volvo XC70 FWD
Infiniti QX70 RWD	VW Tiguan

Note: 2WD = Two-wheel drive. 4WD = Four-wheel drive. AWD = All-wheel drive. FWD = Front-wheel drive.

Source:

U.S. Environmental Protection Agency, *Light-Duty Automotive Technology, Carbon Dioxide Emissions, and Fuel Economy Trends: 1975 Through 2016*, November 2016. (Additional resources: www.epa.gov/fueleconomy/light-duty-automotive-technology-carbon-dioxide-emissions-and-fuel-economy-trends-1975-0)

^a Alternative fuel vehicle.



Production of sport utility vehicles (SUVs) has grown substantially since 1975. The production-weighted fuel economy of SUVs was more than 22 mpg in 2016. Almost 62% of all light trucks produced in 2016 were SUVs.

Table 4.10
Production, Production Shares, and Production-Weighted Fuel Economies of New Domestic and Import Light Trucks, Model Years 1975-2016^a

Model Year	Pickup			Van			Truck SUV		
	Production (Thousands)	Share (%) ^b	Fuel Economy (mpg)	Production (Thousands)	Share (%) ^b	Fuel Economy (mpg)	Production (Thousands)	Share (%) ^b	Fuel Economy (mpg)
1975	1,343	67.9%	11.9	457	23.1%	11.1	177	9.0%	11.0
1980	1,437	77.1%	16.5	242	13.0%	14.1	184	9.9%	13.2
1985	2,078	58.0%	18.2	855	23.9%	16.5	648	18.1%	16.5
1986	2,532	59.0%	18.9	1,044	24.3%	17.5	714	16.6%	17.0
1987	2,147	53.2%	19.0	1,114	27.6%	17.7	779	19.3%	17.3
1988	2,459	55.3%	18.1	1,133	25.5%	17.9	859	19.3%	17.0
1989	2,232	51.6%	17.8	1,278	29.5%	17.8	818	18.9%	16.6
1990	1,835	49.1%	17.4	1,262	33.7%	17.8	643	17.2%	16.4
1991	1,920	50.2%	18.2	1,034	27.0%	17.9	871	22.8%	16.7
1992	1,840	48.1%	17.5	1,221	31.9%	17.9	761	19.9%	16.2
1993	2,002	46.8%	17.6	1,441	33.7%	18.2	838	19.6%	16.3
1994	2,669	49.6%	17.4	1,418	26.4%	17.8	1,291	24.0%	16.0
1995	2,271	41.1%	16.9	1,662	30.1%	18.1	1,596	28.9%	16.0
1996	1,955	39.4%	17.1	1,409	28.4%	18.3	1,603	32.3%	16.2
1997	2,408	41.8%	16.8	1,265	22.0%	18.2	2,089	36.3%	16.1
1998	2,415	40.0%	17.0	1,489	24.7%	18.7	2,127	35.3%	16.2
1999	2,544	40.1%	16.3	1,463	23.0%	18.3	2,342	36.9%	16.1
2000	2,612	38.2%	16.7	1,691	24.8%	18.6	2,526	37.0%	16.0
2001	2,519	39.0%	16.0	1,232	19.1%	18.0	2,707	41.9%	16.4
2002	2,380	33.0%	15.8	1,243	17.2%	18.7	3,588	49.8%	16.3
2003	2,474	34.0%	16.1	1,232	16.9%	19.0	3,571	49.1%	16.4
2004	2,505	33.3%	15.7	953	12.7%	19.2	4,075	54.1%	16.5
2005	2,300	32.6%	15.8	1,481	21.0%	19.3	3,272	46.4%	16.7
2006	2,188	34.4%	16.1	1,166	18.3%	19.5	3,006	47.3%	17.2
2007	2,113	33.7%	16.2	847	13.5%	19.5	3,314	52.8%	17.7
2008	1,794	31.7%	16.5	790	14.0%	19.8	3,072	54.3%	18.2
2009	989	32.2%	16.9	368	12.0%	20.1	1,714	55.8%	19.3
2010	1,276	30.8%	16.9	559	13.5%	20.1	2,305	55.7%	19.7
2011	1,479	29.2%	17.2	521	10.3%	21.0	3,069	60.5%	19.8
2012	1,357	28.3%	17.2	661	13.8%	21.3	2,771	57.8%	20.0
2013	1,577	28.9%	17.4	571	10.5%	21.1	3,310	60.6%	20.9
2014	1,929	30.6%	18.0	672	10.7%	21.3	3,706	58.8%	21.7
2015	1,786	25.0%	18.8	655	9.2%	21.9	4,697	65.8%	22.6
2016	^c	28.5%	19.0	^c	9.5%	21.9	^c	61.7%	22.6

Note: Includes light trucks of 8,500 lb or less. See Table 4.11 for all light trucks (pickup + van + truck SUV).

Source:

U.S. Environmental Protection Agency, *Light-Duty Automotive Technology, Carbon Dioxide Emissions, and Fuel Economy Trends: 1975 Through 2016*, November 2016. (Additional resources: www.epa.gov/fueleconomy/light-duty-automotive-technology-carbon-dioxide-emissions-and-fuel-economy-trends-1975-0)

^a The fuel economy data on this table are adjusted to provide the best estimate of real world performance. See section 10 of the source document for details on adjustment methodology. These data are not directly comparable to Corporate Average Fuel Economy data.

^b Production share is based on the total of pickups, plus vans and truck SUVs. Percentages may not sum to totals due to rounding.

^c Data are not available.



The average fuel economy of cars more than doubled from 1975 to 2016 while the average fuel economy of light trucks grew by 84% in that same time period. This was not steady annual growth, but growth in the 1970's and early 1980's followed by a long period with little improvement. Growth resumed around 2008-2009.

Table 4.11
Production and Production-Weighted Fuel Economies of New Domestic and Import Cars, Light Trucks and Light Vehicles, Model Years 1975-2016^a

Model Year	All Cars		All Light Trucks		All Light Vehicles	
	Production (Thousands)	Fuel Economy (mpg)	Production (Thousands)	Fuel Economy (mpg)	Production (Thousands)	Fuel Economy (mpg)
1975	8,247	13.5	1,977	11.6	10,224	13.1
1980	9,444	20.0	1,863	15.8	11,307	19.2
1985	10,879	23.0	3,581	17.5	14,460	21.3
1986	11,074	23.7	4,291	18.2	15,365	21.8
1987	10,826	23.8	4,039	18.3	14,865	22.0
1988	10,845	24.1	4,450	17.8	15,295	21.9
1989	10,126	23.6	4,327	17.6	14,453	21.4
1990	8,875	23.3	3,740	17.4	12,615	21.2
1991	8,748	23.3	3,825	17.8	12,573	21.3
1992	8,350	22.9	3,822	17.3	12,172	20.8
1993	8,929	23.0	4,281	17.5	13,210	20.9
1994	8,747	23.0	5,378	17.2	14,125	20.4
1995	9,616	23.3	5,529	17.0	15,145	20.5
1996	8,177	23.1	4,967	17.2	13,144	20.4
1997	8,695	23.2	5,762	16.8	14,457	20.2
1998	8,425	23.0	6,030	17.1	14,455	20.1
1999	8,865	22.7	6,350	16.6	15,215	19.7
2000	9,742	22.5	6,829	16.8	16,571	19.8
2001	9,148	22.6	6,458	16.5	15,606	19.6
2002	8,904	22.8	7,211	16.5	16,115	19.5
2003	8,496	23.0	7,277	16.7	15,773	19.6
2004	8,176	22.9	7,533	16.5	15,709	19.3
2005	8,839	23.1	7,053	16.9	15,892	19.9
2006	8,744	23.0	6,360	17.2	15,104	20.1
2007	9,001	23.7	6,275	17.4	15,276	20.6
2008	8,243	23.9	5,656	17.8	13,898	21.0
2009	6,244	25.0	3,071	18.5	9,316	22.4
2010	6,976	25.7	4,141	18.8	11,116	22.6
2011	6,949	25.6	5,069	19.1	12,018	22.4
2012	8,658	27.1	4,790	19.3	13,448	23.7
2013	9,740	27.9	5,458	19.8	15,198	24.3
2014	9,205	27.9	6,307	20.4	15,512	24.3
2015	9,601	28.6	7,138	21.1	16,739	24.8
2016	^b	29.0	^b	21.4	^b	25.6

Source:

U.S. Environmental Protection Agency, *Light-Duty Automotive Technology, Carbon Dioxide Emissions, and Fuel Economy Trends: 1975 Through 2016*, November 2016. (Additional resources: www.epa.gov/fueleconomy/light-duty-automotive-technology-carbon-dioxide-emissions-and-fuel-economy-trends-1975-0)

^a The fuel economy data on this table are adjusted to provide the best estimate of real world performance. See section 10 of the source document for details on adjustment methodology. These data are not directly comparable to Corporate Average Fuel Economy data.

^b Data are not available, but 62.1% of all light vehicles were cars and 37.9% were light trucks in 2016.



Back in 1975 only 19.3% of new light vehicles produced were light trucks. Because of the boom in production of minivans, sport utility vehicles, and pick-up trucks, that number rose to over 40% in 1998. The car SUV category was almost 11% of production in 2016 and the truck SUVs were 23%.

Table 4.12
Light Vehicle Production Shares^a, Model Years 1975–2016

Model Year						Total Light Vehicles Produced (thousands)	Production Share	
	Car	Car SUV	Pickup	Van	Truck SUV		Cars ^b	Light Trucks
1975	80.6%	0.1%	13.1%	4.5%	1.7%	10,224	80.7%	19.3%
1980	83.5%	0.0%	12.7%	2.1%	1.6%	11,306	83.5%	16.5%
1985	74.6%	0.6%	14.4%	5.9%	4.5%	14,460	75.2%	24.8%
1986	71.7%	0.4%	16.5%	6.8%	4.6%	15,365	72.1%	27.9%
1987	72.2%	0.6%	14.4%	7.5%	5.2%	14,865	72.8%	27.2%
1988	70.2%	0.7%	16.1%	7.4%	5.6%	15,295	70.9%	29.1%
1989	69.3%	0.7%	15.4%	8.8%	5.7%	14,453	70.1%	29.9%
1990	69.8%	0.5%	14.5%	10.0%	5.1%	12,615	70.4%	29.6%
1991	67.8%	1.8%	15.3%	8.2%	6.9%	12,573	69.6%	30.4%
1992	66.6%	2.0%	15.1%	10.0%	6.2%	12,172	68.6%	31.4%
1993	64.0%	3.6%	15.2%	10.9%	6.3%	13,211	67.6%	32.4%
1994	59.6%	2.3%	18.9%	10.0%	9.1%	14,125	61.9%	38.1%
1995	62.0%	1.5%	15.0%	11.0%	10.5%	15,145	63.5%	36.5%
1996	60.0%	2.2%	14.9%	10.7%	12.2%	13,144	62.2%	37.8%
1997	57.6%	2.5%	16.7%	8.8%	14.5%	14,458	60.1%	39.9%
1998	55.1%	3.1%	16.7%	10.3%	14.7%	14,456	58.3%	41.7%
1999	55.1%	3.2%	16.7%	9.6%	15.4%	15,215	58.3%	41.7%
2000	55.1%	3.7%	15.8%	10.2%	15.2%	16,571	58.8%	41.2%
2001	53.9%	4.8%	16.1%	7.9%	17.3%	15,605	58.6%	41.4%
2002	51.5%	3.7%	14.8%	7.7%	22.3%	16,115	55.3%	44.7%
2003	50.2%	3.6%	15.7%	7.8%	22.6%	15,773	53.9%	46.1%
2004	48.0%	4.1%	15.9%	6.1%	25.9%	15,709	52.0%	48.0%
2005	50.5%	5.1%	14.5%	9.3%	20.6%	15,892	55.6%	44.4%
2006	52.9%	5.0%	14.5%	7.7%	19.9%	15,104	57.9%	42.1%
2007	52.9%	6.0%	13.8%	5.5%	21.7%	15,276	58.9%	41.1%
2008	52.7%	6.6%	12.9%	5.7%	22.1%	13,898	59.3%	40.7%
2009	60.5%	6.5%	10.6%	4.0%	18.4%	9,316	67.0%	33.0%
2010	54.5%	8.2%	11.5%	5.0%	20.7%	11,116	62.8%	37.3%
2011	47.8%	10.0%	12.3%	4.3%	25.5%	12,018	57.8%	42.2%
2012	55.0%	9.4%	10.1%	4.9%	20.6%	13,448	64.4%	35.6%
2013	54.1%	10.0%	10.4%	3.8%	21.8%	15,198	64.1%	35.9%
2014	49.2%	10.1%	12.4%	4.3%	23.9%	15,512	59.3%	40.7%
2015	47.2%	10.2%	10.7%	3.9%	28.1%	16,739	57.4%	42.6%
2016	51.4%	10.7%	10.8%	3.7%	23.4%	^c	62.1%	37.9%

Note: Includes light trucks of 8,500 lb or less.

Source:

U.S. Environmental Protection Agency, *Light-Duty Automotive Technology, Carbon Dioxide Emissions, and Fuel Economy Trends: 1975 Through 2016*, November 2016. (Additional resources: www.epa.gov/fueleconomy/light-duty-automotive-technology-carbon-dioxide-emissions-and-fuel-economy-trends-1975-0)

^a Percentages may not sum to totals due to rounding.

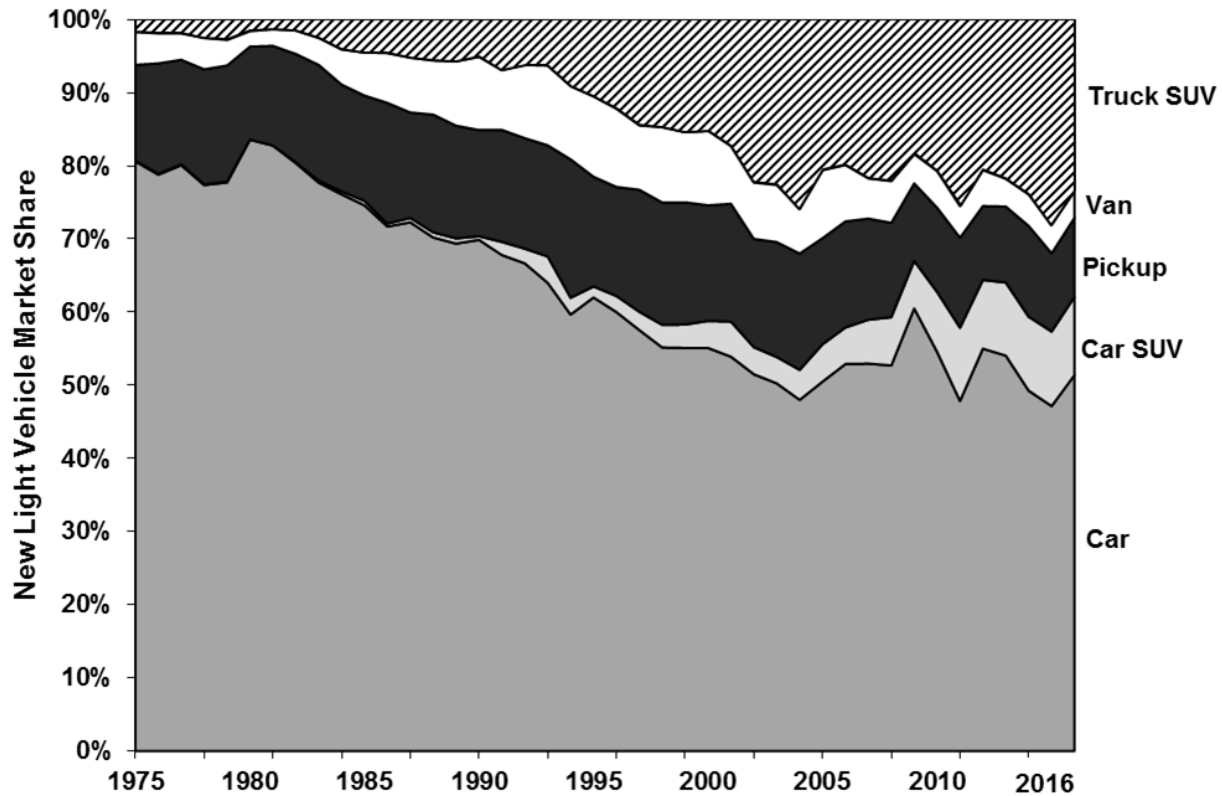
^b Cars include both car and car SUV categories.

^c Data are not available.



The effects of the Japanese earthquake/tsunami in 2011 are apparent in the large decline in car production for that year. Light trucks were gaining market share from the early 1980s until 2004, mainly due to increases in the market share of sport utility vehicles (SUVs) and pickup trucks. Car SUVs are two-wheel drive SUVs that are counted as cars in the Corporate Average Fuel Economy Standards for model years 2011-on. A listing of the makes/models of car SUVs is in Table 4.9.

Figure 4.1. Light Vehicle Production Shares, Model Years 1975–2016



Source:
See Table 4.12.



The production-weighted average engine displacement of cars in 1975 was 4.72 liters, but had declined to 2.34 liters by 2016. Car SUVs also experienced a decline in engine displacement. For a list of car SUVs, see Table 4.9.

Table 4.13
Production-Weighted Engine Size of New Domestic and Import Cars
Model Years 1975-2016
(liters^a)

Model Year	Car	Car SUV
1975	4.72	4.29
1980	3.08	4.59
1985	2.90	2.80
1986	2.74	2.79
1987	2.65	2.93
1988	2.62	3.26
1989	2.67	3.70
1990	2.67	3.43
1991	2.67	3.52
1992	2.79	3.44
1993	2.72	3.90
1994	2.75	3.43
1995	2.74	3.51
1996	2.70	3.52
1997	2.69	3.11
1998	2.69	3.57
1999	2.72	3.46
2000	2.70	3.46
2001	2.70	3.18
2002	2.72	3.00
2003	2.70	2.97
2004	2.75	3.13
2005	2.72	3.05
2006	2.82	3.02
2007	2.70	3.03
2008	2.70	2.93
2009	2.54	2.87
2010	2.56	2.82
2011	2.61	2.72
2012	2.43	2.74
2013	2.38	2.64
2014	2.39	2.52
2015	2.38	2.51
2016	2.34	2.43
<i>Annual average percentage change</i>		
1975–2016	-1.7%	-1.4%
2006–2016	-1.8%	-2.2%

Source:

U.S. Environmental Protection Agency, *Light-Duty Automotive Technology, Carbon Dioxide Emissions, and Fuel Economy Trends: 1975 Through 2016*, November 2016. (Additional resources: www.epa.gov/fueleconomy/light-duty-automotive-technology-carbon-dioxide-emissions-and-fuel-economy-trends-1975-0)

^a 1 liter = 61.02 cubic inches.



The production-weighted engine size of truck sport utility vehicles (SUVs) declined an average of 2.3% per year from 2006 to 2016, while the engine size of pickups in 2016 decreased by only 0.5%.

Table 4.14
Production-Weighted Engine Size of New Domestic and Import Light Trucks,
Model Years 1975-2016
(liters^a)

Model Year	Pickup	Van	Truck SUV
1975	5.01	5.21	5.44
1980	3.87	4.72	4.83
1985	3.62	3.87	3.64
1986	3.38	3.74	3.44
1987	3.31	3.70	3.47
1988	3.75	3.75	3.64
1989	3.87	3.69	4.00
1990	4.05	3.69	3.85
1991	3.80	3.61	3.82
1992	4.02	3.64	3.85
1993	4.00	3.57	4.00
1994	4.06	3.70	4.02
1995	4.21	3.79	4.02
1996	4.11	3.61	4.24
1997	4.33	3.61	4.18
1998	4.13	3.56	4.13
1999	4.38	3.65	4.15
2000	4.18	3.56	4.15
2001	4.41	3.75	3.92
2002	4.44	3.57	4.02
2003	4.33	3.59	4.05
2004	4.61	3.59	4.13
2005	4.65	3.54	4.00
2006	4.56	3.54	3.87
2007	4.69	3.59	3.93
2008	4.69	3.61	3.77
2009	4.70	3.52	3.46
2010	4.80	3.51	3.47
2011	4.62	3.47	3.56
2012	4.69	3.44	3.52
2013	4.62	3.43	3.36
2014	4.80	3.49	3.21
2015	4.54	3.33	3.24
2016	4.34	3.33	3.08
<i>Annual average percentage change</i>			
1975–2016	-0.3%	-1.1%	-1.4%
2006–2016	-0.5%	-0.6%	-2.3%

Note: Includes light trucks of 8,500 lb or less.

Source:

U.S. Environmental Protection Agency, *Light-Duty Automotive Technology, Carbon Dioxide Emissions, and Fuel Economy Trends: 1975 Through 2016*, November 2016. (Additional resources: www.epa.gov/fueleconomy/light-duty-automotive-technology-carbon-dioxide-emissions-and-fuel-economy-trends-1975-0)

^a 1 liter = 61.02 cubic inches.



The production-weighted loaded vehicle weight of cars declined almost 550 lb from 1975 to 2016, while car SUVs declined by 151 lb.

Table 4.15
Production-Weighted Loaded Vehicle Weight^a of New Domestic and Import Cars,
Model Years 1975–2016
(pounds)

Model Year	Car	Car SUV
1975	4,058	4,000
1980	3,101	4,000
1981	3,076	4,000
1982	3,054	2,630
1983	3,112	3,124
1984	3,099	3,487
1985	3,093	3,469
1986	3,041	3,479
1987	3,031	3,492
1988	3,047	3,495
1989	3,099	3,497
1990	3,176	3,518
1991	3,154	3,733
1992	3,240	3,713
1993	3,207	3,848
1994	3,250	3,735
1995	3,263	3,763
1996	3,282	3,710
1997	3,274	3,549
1998	3,306	3,824
1999	3,365	3,831
2000	3,369	3,870
2001	3,380	3,765
2002	3,391	3,747
2003	3,417	3,716
2004	3,462	3,854
2005	3,463	3,848
2006	3,534	3,876
2007	3,507	3,935
2008	3,527	3,902
2009	3,464	3,846
2010	3,474	3,949
2011	3,559	3,890
2012	3,452	3,915
2013	3,465	3,966
2014	3,497	3,865
2015	3,489	3,868
2016	3,509	3,849
<i>Annual average percentage change</i>		
1975–2016	-0.4%	-0.1%
2006–2016	-0.1%	-0.1%

Source:

U.S. Environmental Protection Agency, *Light-Duty Automotive Technology, Carbon Dioxide Emissions, and Fuel Economy Trends: 1975 Through 2016*, November 2016. (Additional resources: www.epa.gov/fueleconomy/light-duty-automotive-technology-carbon-dioxide-emissions-and-fuel-economy-trends-1975-0)

^a Loaded vehicle weight is equal to the vehicle's curb weight plus 300 pounds.



The production-weighted loaded vehicle weight of pickups, vans, and truck SUVs increased from 1975 to 2016. Pickups gained almost 1,200 lb while vans gained 210 lb and truck SUVs gained 261 lb.

Table 4.16
Production-Weighted Loaded Vehicle Weight of New Domestic and Import Light Trucks,
Model Years 1975–2016
(pounds)

Model Year	Pickup	Van	Truck SUV
1975	4,012	4,196	4,214
1980	3,740	4,353	4,237
1981	3,679	4,324	4,208
1982	3,629	4,342	4,494
1983	3,544	4,414	4,270
1984	3,619	4,075	4,049
1985	3,642	3,975	4,092
1986	3,574	3,998	3,958
1987	3,526	3,972	3,882
1988	3,737	4,053	3,906
1989	3,803	4,057	4,086
1990	3,928	4,095	4,098
1991	3,779	4,133	4,157
1992	3,976	4,151	4,204
1993	3,996	4,105	4,331
1994	4,056	4,156	4,331
1995	4,182	4,110	4,323
1996	4,190	4,195	4,386
1997	4,415	4,240	4,463
1998	4,282	4,183	4,450
1999	4,486	4,306	4,518
2000	4,340	4,276	4,602
2001	4,551	4,518	4,546
2002	4,690	4,394	4,636
2003	4,642	4,393	4,754
2004	4,939	4,487	4,756
2005	4,988	4,430	4,756
2006	4,968	4,475	4,715
2007	5,144	4,479	4,797
2008	5,161	4,527	4,727
2009	5,176	4,572	4,548
2010	5,309	4,533	4,555
2011	5,268	4,502	4,665
2012	5,335	4,442	4,640
2013	5,429	4,543	4,584
2014	5,485	4,489	4,483
2015	5,165	4,416	4,533
2016	5,177	4,406	4,475
<i>Annual average percentage change</i>			
1975–2016	0.6%	0.1%	0.1%
2006–2016	0.4%	-0.2%	-0.5%

Source:

U.S. Environmental Protection Agency, *Light-Duty Automotive Technology, Carbon Dioxide Emissions, and Fuel Economy Trends: 1975 Through 2016*, November 2016. (Additional resources: www.epa.gov/fueleconomy/light-duty-automotive-technology-carbon-dioxide-emissions-and-fuel-economy-trends-1975-0)

^a Loaded vehicle weight is equal to the vehicle's curb weight plus 300 pounds.



The average light vehicle in 2015 contained more than 2,000 pounds of steel, most of it conventional steel. High and medium strength steel, however, almost 18% of the vehicle. The use of aluminum grew from 1995 to 2015, while the use of iron castings declined.

Table 4.17
Average Material Consumption for a Domestic Light Vehicle^a,
Model Years 1995, 2000, and 2015

Material	1995		2000		2015	
	Pounds	Percentage	Pounds	Percentage	Pounds	Percentage
Regular steel	1,630	44.1%	1,655	42.4%	1,330	33.3%
High and medium strength steel	324	8.8%	408	10.5%	701	17.6%
Stainless steel	51	1.4%	62	1.6%	75	1.9%
Other steels	46	1.2%	26	0.7%	32	0.8%
Iron castings	466	12.6%	432	11.1%	268	6.7%
Aluminum	231	6.3%	268	6.9%	395	9.9%
Magnesium castings	4	0.1%	8	0.2%	10	0.2%
Copper and brass	50	1.4%	52	1.3%	66	1.7%
Lead	33	0.9%	36	0.9%	35	0.9%
Zinc castings	19	0.5%	13	0.3%	8	0.2%
Powder metal parts	29	0.8%	36	0.9%	45	1.1%
Other metals	4	0.1%	4	0.1%	5	0.1%
Plastics and plastic composites	240	6.5%	286	7.3%	334	8.4%
Rubber	149	4.0%	166	4.3%	198	5.0%
Coatings	23	0.6%	25	0.6%	29	0.7%
Textiles	42	1.1%	44	1.1%	45	1.1%
Fluids and lubricants	192	5.2%	207	5.3%	225	5.6%
Glass	97	2.6%	103	2.6%	95	2.4%
Other materials	64	1.7%	71	1.8%	95	2.4%
Total	3,694	100.0%	3,902	100.0%	3,991	100.0%

Source:

Ward's Communications, www.wardsauto.com.

^a Percentages may not sum to totals due to rounding.



The number of franchised dealerships which sell new light-duty vehicles (cars and light trucks) has declined 46% since 1970. This decline, along with increasing light vehicle sales, caused the average number of vehicles sold to be 1,028 vehicles per dealer.

Table 4.18
New Light Vehicle Dealerships and Sales, 1970–2016

Calendar year	Number of franchised new light vehicle dealerships ^a	New light vehicle sales (thousands)	Light vehicle sales per dealer
1970	30,800	9,856	320
1975	29,600	10,677	361
1980	27,900	10,909	391
1981	26,350	10,235	388
1982	25,700	10,019	390
1983	24,725	11,669	472
1984	24,725	13,579	549
1985	24,725	14,667	593
1986	24,825	15,998	644
1987	25,150	14,802	589
1988	25,025	15,347	613
1989	25,000	14,389	576
1990	24,825	13,851	558
1991	24,200	12,307	509
1992	23,500	12,842	546
1993	22,950	13,869	604
1994	22,850	15,024	657
1995	22,800	14,673	644
1996	22,750	14,998	659
1997	22,700	15,014	661
1998	22,600	15,384	681
1999	22,400	16,711	746
2000	22,250	17,164	771
2001	22,150	16,950	765
2002	21,800	16,675	765
2003	21,725	16,494	759
2004	21,650	16,737	773
2005	21,640	16,774	775
2006	21,495	16,336	760
2007	21,200	15,867	748
2008	20,770	13,015	627
2009	20,010	10,236	512
2010	18,460	11,394	617
2011	17,700	12,542	709
2012	17,540	14,220	811
2013	17,665	15,279	865
2014	16,396	16,192	988
2015	16,545	17,095	1,033
2016	16,708	17,169	1,028
<i>Average annual percentage change</i>			
1970–2016	-1.3%	1.2%	2.6%
2006–2016	-2.5%	0.5%	3.1%

Source:

Number of dealers - National Automobile Dealers Association website, www.nada.org. (Additional resources: www.nada.org/2016NADAdat Highlights/). Light-duty vehicle sales - See tables 4.5 and 4.6.

^a As of the beginning of the year.



In 2010 the number of conventional refueling stations fell below 160,000 for the first time in the series history and continued to decline through 2013. The number of vehicles fueling at those stations fell in 2009 for the first time in several years but began rising slowly in 2011. In 2013, there were 0.61 fueling stations per thousand vehicles or 1.65 thousand vehicles per station.

Table 4.19
Conventional Refueling Stations, 1993-2013

Year	Number of retail outlets	Vehicles in operation (thousands)	Stations per thousand vehicles	Thousand vehicles per station
	Conventional fuels			
1993	207,416	186,315	1.11	0.90
1994	202,878	188,714	1.08	0.93
1995	195,455	193,441	1.01	0.99
1996	190,246	198,294	0.96	1.04
1997	187,892	201,071	0.93	1.07
1998	182,596	205,043	0.89	1.12
1999	180,567	209,509	0.86	1.16
2000	175,941	213,299	0.82	1.21
2001	172,169	216,683	0.79	1.26
2002	170,018	221,027	0.77	1.30
2003	167,571	225,882	0.74	1.35
2004	167,346	232,167	0.72	1.39
2005	168,987	238,384	0.71	1.41
2006	167,476	244,643	0.69	1.46
2007	164,292	248,701	0.66	1.51
2008	161,068	249,813	0.64	1.55
2009	162,350	248,972	0.65	1.53
2010	159,006	248,231	0.64	1.56
2011	157,393	248,932	0.63	1.58
2012	156,065	251,497	0.62	1.61
2013	152,995	252,715	0.61	1.65

Notes: This data series was discontinued after 2013. The County Business Patterns (CBP) data published by the Bureau of the Census tells the number of establishments by North American Industry Classification System (NAICS). NAICS is an industry classification system that groups establishments into industries based on the activities in which they are primarily engaged. NAICS 447 represents gasoline stations. However, the CBP gasoline station data differ from the National Petroleum News Survey data by as much as 30% (117,189 stations in 2005); the CBP may not include every gasoline retail outlet due to the classification of the primary activity of the business.

Alternative Fuel Refueling Stations are listed in Chapter 6.

Sources:

Conventional refueling stations: National Petroleum News Survey, 2013. (Source discontinued after 2013.)

Conventional vehicles: IHS Automotive, Detroit, MI. **FURTHER REPRODUCTION PROHIBITED.**



The National Highway Traffic Safety Administration and the Environmental Protection Agency issued joint rulemaking to establish a new National Program to regulate fuel economy and greenhouse gas emissions for model year (MY) 2012-2025 cars and light trucks. The standards for model years 2021-2025 are currently under review.

Table 4.20
Fuel Economy and Carbon Dioxide Emissions Standards, MY 2012-2025

Year	Cars	Light trucks	Combined cars and light trucks	
Average required fuel economy (miles per gallon)				
2012	33.3	25.4	29.7	
2013	34.2	26.0	30.5	
2014	34.9	26.6	31.3	
2015	36.2	27.5	32.6	
2016	37.8	28.8	34.1	
2017	40.1	29.4	35.4	
2018	41.6	30.0	36.5	
2019	43.1	30.6	37.7	
2020	44.8	31.2	38.9	
2021	46.8	33.3	41.0	Standards under review
2022	49.0	34.9	43.0	
2023	51.2	36.6	45.1	
2024	53.6	38.5	47.4	
2025	56.2	40.3	49.7	
Average projected emissions compliance levels under the footprint-based carbon dioxide standards (grams per mile)				
2012	263	346	295	
2013	256	337	286	
2014	247	326	276	
2015	236	312	263	
2016	225	298	250	
2017	212	295	243	
2018	202	285	232	
2019	191	277	222	
2020	182	269	213	
2021	172	249	199	Standards under review
2022	164	237	190	
2023	157	225	180	
2024	150	214	171	
2025	143	203	163	

Note: The required fuel economy, along with projections of CO₂ emissions, shown here use a model year 2008 baseline. The presented rates of increase in stringency for NHTSA CAFE standards are lower than the Environmental Protection Agency (EPA) rates of increase in stringency for greenhouse gas (GHG) standards. One major difference is that NHTSA's standards, unlike EPA's, do not reflect the inclusion of air conditioning system refrigerant and leakage improvements, but EPA's standards would allow consideration of such improvements which reduce GHGs but generally do not affect fuel economy. The 2025 EPA GHG standard of 163 grams/mile would be equivalent to 54.5 mpg, if the vehicles were to meet this level all through fuel economy improvements. The agencies expect, however, that a portion of these improvements will be made through reductions in air conditioning leakage, which would not contribute to fuel economy.

Source:

Federal Register, Vol. 77, No. 199, October 15, 2012. (Additional resources: www.nhtsa.gov/fuel-economy)



The target levels for the fuel economy and carbon dioxide emission standards for vehicles manufactured in model years 2012-on are assigned based on a vehicle's "footprint." Each footprint has a different target. The vehicle footprint is calculated as:

$$\text{footprint} = \text{track width} \times \text{wheelbase},$$

where

*track width = lateral distance between the centerlines of the base tires at ground, and
wheelbase = longitudinal distance between the front and rear wheel centerlines.*

Table 4.21
Fuel Economy and Carbon Dioxide Targets for Model Year 2025

Vehicle type	Example models	Example model footprint (square feet)	CO ₂ emissions target (grams per mile)	Fuel economy target (miles per gallon)
Example Passenger Cars				
Compact car	Honda Fit	40	131	61.1
Midsized car	Ford Fusion	46	147	54.9
Fullsize car	Chrysler 300	53	170	48.0
Example Light-Duty Trucks				
Small SUV	4WD Ford Escape	44	170	47.5
Midsized crossover	Nissan Murano	49	188	43.4
Minivan	Toyota Sienna	55	209	39.2
Large pickup truck	Chevy Silverado	67	252	33.0

Notes: The model year 2025 targets are currently under review. Examples in table use model year 2012 vehicle specifications. The fuel economy from this table will not match the fuel economy listed on the window sticker of a new vehicle. Window sticker fuel economy is calculated by a different methodology than the Corporate Average Fuel Economy.

Source:

Federal Register, Vol. 77, No. 199, October 15, 2012. (Additional resources: www.nhtsa.gov/fuel-economy)



The Corporate Average Fuel Economy standards were first established by the U.S. Energy Policy and Conservation Act of 1975 (PL94-163). These standards must be met at the manufacturer level. Some manufacturers fall short of meeting the standards while others exceed them. Legislation passed in December 2007 changed the CAFE standards beginning in the 2011 model year (MY). Some two-wheel drive sport utility vehicles are classified as cars under the final standards for MY 2011-2021.

Table 4.22
Car Corporate Average Fuel Economy (CAFE) Standards versus
Sales-Weighted Fuel Economy Estimates, 1978–2017^a
(miles per gallon)

Model year ^b	Cars				CAFE estimates
	CAFE standards		CAFE estimates ^c		Cars and light trucks combined
	Domestic	Import	Domestic	Import	
1978	18.0	18.0	18.7	27.3	19.9
1980	20.0	20.0	22.6	29.6	23.1
1985	27.5	27.5	26.3	31.5	25.4
1990	27.5	27.5	26.9	29.9	25.4
1991	27.5	27.5	27.3	30.1	25.6
1992	27.5	27.5	27.0	29.2	25.1
1993	27.5	27.5	27.8	29.6	25.2
1994	27.5	27.5	27.5	29.6	24.7
1995	27.5	27.5	27.7	30.3	24.9
1996	27.5	27.5	28.1	29.6	24.9
1997	27.5	27.5	27.8	30.1	24.6
1998	27.5	27.5	28.6	29.2	24.7
1999	27.5	27.5	28.0	29.0	24.5
2000	27.5	27.5	28.7	28.3	24.8
2001	27.5	27.5	28.7	29.0	24.5
2002	27.5	27.5	29.1	28.8	24.7
2003	27.5	27.5	29.1	29.9	25.1
2004	27.5	27.5	29.9	28.7	24.6
2005	27.5	27.5	30.5	29.9	25.4
2006	27.5	27.5	30.3	29.7	25.8
2007	27.5	27.5	30.6	32.2	26.6
2008	27.5 ^d	27.5	31.2	31.8	27.1
2009	27.5 ^d	27.5	32.1	33.8	29.0
2010	27.5 ^d	27.5	33.1	35.2	29.3
2011	30.0	30.4	32.7	33.7	29.0
2012	32.7	33.4	34.8	36.0	30.8
2013	33.2	33.9	36.1	36.8	31.6
2014	34.0	34.6	36.3	36.9	31.7
2015	35.2	35.8	37.2	37.3	32.2
2016	36.5 ^e	37.3 ^e	37.2 ^e	37.6 ^e	32.1 ^e
2017	38.5 ^e	34.5 ^e	38.5 ^e	32.8 ^e	31.8 ^e

Source:

U.S. Department of Transportation, NHTSA, "Summary of Fuel Economy Performance," Washington, DC, December 2014 and updates 2017. (Additional resources: www.nhtsa.gov)

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

^b Model year as determined by the manufacturer on a vehicle by vehicle basis.

^c All CAFE calculations are sales-weighted.

^d Unreformed standards, which were an option from 2008-2010. See Table 4.20 for reformed standards.

^e Projected required average fuel economy standards value based on pre-model year reports.



The Corporate Average Fuel Economy standards for light trucks are lower than the car standards. Light trucks include pickups, minivans, sport utility vehicles and vans. New legislation passed in December 2007 changed the CAFE standards beginning in the 2011 model year (MY). Some two-wheel drive sport utility vehicles are classified as cars under the final standards for MY 2011-2021.

Table 4.23
Light Truck Corporate Average Fuel Economy (CAFE) Standards versus
Sales-Weighted Fuel Economy Estimates, 1978–2017^a
(miles per gallon)

Model year ^c	Light trucks ^b				CAFE estimates
	CAFE standards	CAFE estimates ^d			Cars and light trucks combined
		Domestic	Import	Combined	
1978	^e	^f	^f	^f	19.9
1980	^e	16.8	24.3	18.5	23.1
1985	19.5	19.6	26.5	20.7	25.4
1990	20.0	20.3	23.0	20.8	25.4
1991	20.2	20.9	23.0	21.3	25.6
1992	20.2	20.5	22.7	20.8	25.1
1993	20.4	20.7	22.8	21.0	25.2
1994	20.5	20.5	22.1	20.8	24.7
1995	20.6	20.3	21.5	20.5	24.9
1996	20.7	20.5	22.2	20.8	24.9
1997	20.7	20.1	22.1	20.6	24.6
1998	20.7	20.5	23.0	21.0	24.7
1999	20.7	20.4	22.5	20.9	24.5
2000	20.7	21.1	19.7	21.3	24.8
2001	20.7	20.6	21.8	20.9	24.5
2002	20.7	20.6	21.9	21.4	24.7
2003	20.7	21.8	22.4	21.8	25.1
2004	20.7	20.7	22.3	21.5	24.6
2005	21.0	^f	^f	22.1	25.4
2006	21.6	^f	^f	22.5	25.8
2007	22.2	^f	^f	23.1	26.6
2008	22.4 ^g	^f	^f	23.6	27.1
2009	23.0 ^g	^f	^f	24.8	29.0
2010	23.4 ^g	^f	^f	25.2	29.3
2011	24.3	^f	^f	24.7	29.0
2012	25.3	^f	^f	25.0	30.8
2013	25.9	^f	^f	25.7	31.6
2014	26.3	^f	^f	26.5	31.7
2015	27.6	^f	^f	27.3	32.2
2016	28.8 ^h	^f	^f	27.2 ^h	32.1 ^h
2017	29.3 ^h	^f	^f	28.0 ^h	31.8 ^h

Source:

U.S. Department of Transportation, NHTSA, "Summary of Fuel Economy Performance," Washington, DC, December 2014 and updates 2017. (Additional resources: www.nhtsa.gov)

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

^b Represents two- and four-wheel drive trucks combined. Gross vehicle weight of 0-6,000 pounds for model year 1978-1979 and 0-8,500 pounds for subsequent years.

^c Model year as determined by the manufacturer on a vehicle by vehicle basis.

^d All CAFE calculations are sales-weighted.

^e Standards were set for two-wheel drive and four-wheel drive light trucks, but no combined standard was set in this year.

^f Data are not available.

^g Unreformed standards, which were an option from 2008-2010. See Table 4.20 for reformed standards.

^h Projected required average fuel economy standards value based on pre-model year reports.



Manufacturers of cars and light trucks whose vehicles do not meet the CAFE standards are fined. Data from the National Highway Traffic Safety Administration show the CAFE fine in the year in which the money was collected, which may not be the same year in which it was assessed. A manufacturer can also use CAFE credits to offset fines. Fines for recent model years are still being collected.

Table 4.24
Corporate Average Fuel Economy (CAFE) Fines Collected, 1983-2014^a

Model year	Current dollars	2014 constant dollars ^b
1983	\$57,970	\$137,795
1984	\$5,958,020	\$13,572,370
1985	\$15,564,540	\$34,241,988
1986	\$29,871,815	\$64,523,120
1987	\$31,260,530	\$65,146,945
1988	\$43,470,545	\$86,984,561
1989	\$48,549,420	\$92,680,843
1990	\$48,308,615	\$87,486,902
1991	\$42,243,030	\$73,418,386
1992	\$38,286,565	\$64,589,435
1993	\$28,688,380	\$46,991,566
1994	\$31,498,570	\$50,303,216
1995	\$40,787,498	\$63,342,984
1996	\$19,301,930	\$29,126,612
1997	\$36,211,850	\$53,412,479
1998	\$21,739,774	\$31,566,151
1999	\$27,516,451	\$39,100,876
2000	\$51,067,038	\$70,217,177
2001	\$35,507,412	\$47,473,409
2002	\$20,041,533	\$26,374,657
2003	\$15,225,419	\$19,595,114
2004	\$30,411,986	\$38,106,218
2005	\$25,057,126	\$30,369,236
2006	\$40,933,954	\$48,056,461
2007	\$37,385,941	\$42,694,745
2008	\$11,619,696	\$12,781,666
2009	\$9,148,425	\$10,090,713
2010	\$23,803,412	\$25,850,505
2011	\$40,013,270	\$42,093,960
2012	\$14,962,382	\$15,426,216
2013	\$19,036,963	\$19,341,554
2014	\$2,289,788	\$2,289,788

Source:

U.S. Department of Transportation, National Highway Traffic Safety Administration, Office of Vehicle Safety Compliance, Washington, DC, December 2014 and updates, 2017. Data accessed July 18, 2017. (Additional resources: www.nhtsa.gov)

^a These are fines which are actually collected. Fines which are assessed in certain year may not have been collected in that year.

^b Adjusted using the Consumer Price Inflation Index.



Consumers must pay the Gas Guzzler Tax when purchasing a car that has an Environmental Protection Agency (EPA) fuel economy rating (combined city and highway) less than that stipulated in the table below. The Gas Guzzler Tax doubled in 1991 after remaining constant from 1986 to 1990. The tax has not changed since 1991. This tax does not apply to light trucks such as pickups, minivans, sport utility vehicles, and vans.

Table 4.25
The Gas Guzzler Tax on New Cars
(dollars per vehicle)

Vehicle fuel economy (mpg)	1980	1981	1982	1983	1984	1985	1986-90	1991 - on
Over 22.5	0	0	0	0	0	0	0	0
22.0-22.5	0	0	0	0	0	0	500	1,000
21.5-22.0	0	0	0	0	0	0	500	1,000
21.0-21.5	0	0	0	0	0	0	650	1,300
20.5-21.0	0	0	0	0	0	500	650	1,300
20.0-20.5	0	0	0	0	0	500	850	1,700
19.5-20.0	0	0	0	0	0	600	850	1,700
19.0-19.5	0	0	0	0	450	600	1,050	2,100
18.5-19.0	0	0	0	350	450	800	1,050	2,100
18.0-18.5	0	0	200	350	600	800	1,300	2,600
17.5-18.0	0	0	200	500	600	1,000	1,300	2,600
17.0-17.5	0	0	350	500	750	1,000	1,500	3,000
16.5-17.0	0	200	350	650	750	1,200	1,500	3,000
16.0-16.5	0	200	450	650	950	1,200	1,850	3,700
15.5-16.0	0	350	450	800	950	1,500	1,850	3,700
15.0-15.5	0	350	600	800	1,150	1,500	2,250	4,500
14.5-15.0	200	450	600	1,000	1,150	1,800	2,250	4,500
14.0-14.5	200	450	750	1,000	1,450	1,800	2,700	5,400
13.5-14.0	300	550	750	1,250	1,450	2,200	2,700	5,400
13.0-13.5	300	550	950	1,250	1,750	2,200	3,200	6,400
12.5-13.0	550	650	950	1,550	1,750	2,650	3,200	6,400
Under 12.5	550	650	1,200	1,550	2,150	2,650	3,850	7,700

Source:

Internal Revenue Service, Form 6197, (Rev. 10-05), "Gas Guzzler Tax." (Additional resources: www.irs.ustreas.gov)



Consumers who purchased these 2016 model year vehicles paid the Gas Guzzler tax.

Table 4.26
List of Model Year 2016 Cars with Gas Guzzler Taxes^a

Manufacturer	Model(s)	Size class	Unadjusted combined city/highway fuel economy	Adjusted combined city/highway fuel economy
Aston Martin	DB9	Minicompact Cars	19	15
Aston Martin	Rapide S	Subcompact Cars	21	17
Aston Martin	V12 Vantage S	Two Seaters	18	14
Aston Martin	V8 Vantage	Two Seaters	19	15
Aston Martin	V8 Vantage	Two Seaters	21	16
Aston Martin	V8 Vantage S	Two Seaters	19	15
Aston Martin	V8 Vantage S	Two Seaters	21	16
Aston Martin	Vanquish	Minicompact Cars	20	16
Aston Martin	Vantage GT	Two Seaters	19	15
Aston Martin	Vantage GT	Two Seaters	21	16
Audi	A8L	Large Cars	21	17
Bentley	Continental GT	Compact Cars	19	15
Bentley	Continental GT Convertible	Subcompact Cars	18	15
Bentley	Continental GT Convertible	Subcompact Cars	22	17
Bentley	Flying Spur	Midsize Cars	18	15
Bentley	Flying Spur	Midsize Cars	22	17
Bentley	Mulsanne	Midsize Cars	17	13
BMW	M5	Midsize Cars	21	16
BMW	M5	Midsize Cars	22	17
BMW	M6 Convertible	Subcompact Cars	21	16
BMW	M6 Convertible	Subcompact Cars	22	17
BMW	M6 Coupe	Subcompact Cars	21	16
BMW	M6 Coupe	Subcompact Cars	22	17
BMW	M6 Gran Coupe	Compact Cars	21	16
BMW	M6 Gran Coupe	Compact Cars	22	17
FCA	Challenger	Midsize Cars	22	17
FCA	Challenger SRT8	Midsize Cars	20	16
FCA	Challenger SRT8	Midsize Cars	22	17
FCA	Charger SRT8	Large Cars	20	16
FCA	Viper SRT	Two Seaters	19	15
Ferrari	F12	Two Seaters	17	13
Ferrari	F12 tdf	Two Seaters	16	12
Ferrari	F12 tdf	Two Seaters	17	13
Ferrari	F60 America	Two Seaters	16	13
Ferrari	F60 America	Two Seaters	17	13
Ferrari	FF	Midsize Cars	16	13
Ferrari	FF	Midsize Cars	17	13
Ford	Shelby GT350 Mustang	Subcompact Cars	21	16
GM	Corvette	Two Seaters	20	16
GM	CTS-V	Midsize Cars	21	17
GM	SS	Large Cars	20	16
GM	SS	Large Cars	21	17
GM	XTS Limo	Special Purpose Vehicle 2WD	22	17



Table 4.26 (Continued)
List of Model Year 2016 Cars with Gas Guzzler Taxes^a

Make	Model(s)	Size class	Unadjusted combined city/highway fuel economy	Adjusted combined city/highway fuel economy
Lamborghini	Aventador Coupe	Two Seaters	16	13
Lamborghini	Aventador Roadster	Two Seaters	15	12
Lamborghini	Huracan	Two Seaters	21	17
Lamborghini	Huracan Spyder	Two Seaters	20	16
Maserati	Granturismo	Subcompact Cars	20	16
Maserati	Granturismo Convertible	Subcompact Cars	20	15
Maserati	Quattroporte GTS	Large Cars	22	17
Mercedes-Benz	AMG S 65	Large Cars	19	15
Mercedes-Benz	AMG S 65 (coupe)	Compact Cars	19	15
Mercedes-Benz	AMG SL 65	Two Seaters	21	17
Mercedes-Benz	Maybach S 600	Large Cars	20	15
Mercedes-Benz	S 600	Large Cars	21	16
Pagani	Huayra Coupe	Two Seaters	15	13
Porsche	911 GT3	Two Seaters	22	17
Porsche	911 GT3RS	Two Seaters	21	16
Porsche	911 R	Minicompact Cars	21	16
Rolls-Royce	Dawn	Compact Cars	18	14
Rolls-Royce	Ghost	Large Cars	19	15
Rolls-Royce	Ghost EWB	Large Cars	19	15
Rolls-Royce	Phantom	Large Cars	17	14
Rolls-Royce	Phantom Coupe	Compact Cars	17	14
Rolls-Royce	Phantom Drophead Coupe	Compact Cars	17	14
Rolls-Royce	Phantom EWB	Large Cars	17	14
Rolls-Royce	Wraith	Midsize Cars	19	15
Roush	Roush Stage 3 Mustang	Subcompact Cars	20	16
Roush	Roush Stage 3 Mustang	Subcompact Cars	21	16

Source:

U.S. Department of Energy and U.S. Environmental Protection Agency, Fuel Economy Guide database,
www.fueleconomy.gov

^a Tax is based on unadjusted combined fuel economy; adjusted combined fuel economy is used on window stickers.



The IRS collected \$58.7 million in 2015 from those buying cars with combined city/highway fuel economy less than 22.5 miles per gallon. This tax does not apply to light trucks such as pickups, minivans, sport utility vehicles, and vans. It is worthy to note that total revenue from fines paid by consumers to purchase gas-guzzling vehicles greatly exceeds the overall fines paid by manufacturers whose vehicles fail to meet CAFE standards (see Table 4.22).

Table 4.27
Tax Receipts from the Sale of Gas Guzzlers, 1980–2015
 (thousands)

Model year	Current dollars	2015 constant dollars ^a
1980	740	2,129
1981	780	2,034
1982	1,720	4,225
1983	4,020	9,566
1984	8,820	20,120
1985	39,790	87,648
1986	147,660	319,324
1987	145,900	304,408
1988	116,780	233,972
1989	109,640	209,569
1990	103,200	187,147
1991	118,400	206,041
1992	144,200	243,605
1993	111,600	183,053
1994	64,100	102,515
1995	73,500	114,309
1996	52,600	79,459
1997	48,200	71,179
1998	47,700	69,360
1999	68,300	97,168
2000	70,800	97,449
2001	78,200	104,657
2002	79,700	105,004
2003	126,700	163,207
2004	140,800	176,665
2005	163,800	198,788
2006	201,700	237,135
2007	178,700	204,276
2008	172,428	189,818
2009	99,300	109,705
2010	85,226	92,637
2011	68,905	72,605
2012	73,500	75,876
2013	61,300	62,368
2014	48,200	48,257
2015	58,700	58,700

Source:

Ward's Communications, Detroit, MI, 2017. Original data source: Internal Revenue Service. (Additional resources: www.epa.gov/fueleconomy/guzzler)

^a Adjusted using the Consumer Price Inflation Index.



Autonomie is a system simulation tool for vehicle energy consumption and performance analysis. It is used to evaluate the energy consumption and cost of multiple advanced powertrain technologies. Autonomie was used to develop data on the relationship between steady-state vehicle speed and fuel economy.

Table 4.28
Fuel Economy by Speed, Autonomie Model Results

Speed (mph)	Gasoline conventional			Diesel conventional			Hybrid vehicle
	Midsize car	Small SUV	Large SUV	Midsize car	Small SUV	Large SUV	Midsize Car
	(miles per gallon)						
45	43	37	35	57	48	48	55
55	45	36	31	55	45	40	46
65	38	30	29	45	36	35	38
75	32	26	25	37	30	29	33
	<i>Fuel economy loss</i>						
55 - 65 mph	15%	16%	7%	18%	19%	13%	18%
65 - 75 mph	15%	16%	15%	18%	18%	17%	12%
55 - 75 mph	28%	29%	21%	33%	34%	27%	28%

Source:

Argonne National Laboratory, Autonomie model, August 2016, www.autonomie.net. (Additional resources: www.anl.gov/energy/transportation)



The latest study of vehicle fuel economy by speed indicated higher fuel economy around 40 miles per hour, as did the 1973 and 1984 studies. Engineers at Oak Ridge National Laboratory believe that the lowest speed in the vehicle's highest gear is where the best fuel economy is typically obtained. That speed will be different for individual vehicles.

Table 4.29
Fuel Economy by Speed, 1973, 1984, 1997, and 2012 Studies
(miles per gallon)

Speed (miles per hour)	1973 ^a (13 vehicles)	1984 ^b (15 vehicles)	1997 ^c (9 vehicles)	2012 ^d (74 vehicles)
15	^e	21.1	24.4	^e
20	^e	25.5	27.9	^e
25	^e	30.0	30.5	^e
30	21.1	31.8	31.7	^e
35	21.1	33.6	31.2	^e
40	21.1	33.6	31.0	33.2
45	20.3	33.5	31.6	^e
50	19.5	31.9	32.4	31.9
55	18.5	30.3	32.4	^e
60	17.5	27.6	31.4	27.9
65	16.2	24.9	29.2	^e
70	14.9	22.5	26.8	24.1
75	^e	20.0	24.8	^e
80	^e	^e	^e	20.5
<i>Fuel economy loss</i>				
50–60 mph	10.3%	13.5%	3.1%	12.5%
60–70 mph	14.9%	18.5%	14.6%	13.6%
50–70 mph	23.6%	29.5%	17.3%	24.5%

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.
- 1997 - West, B.H., R.N. McGill, J.W. Hodgson, S.S. Sluder, and D.E. Smith, *Development and Verification of Light-Duty Modal Emissions and Fuel Consumption Values for Traffic Models*, FHWA-RD-99-068, U.S. Department of Transportation, Federal Highway Administration, Washington, DC, March 1999.
- 2012 - U.S. Department of Energy and U.S. Environmental Protection Agency, Fuel Economy Guide website: www.fueleconomy.gov. The Green Car Congress, "ORNL researchers quantify the effect of increasing highway speed on fuel economy." February 8, 2013.

^a Model years 1970 and earlier cars.

^b Model years 1981–84 cars and light trucks.

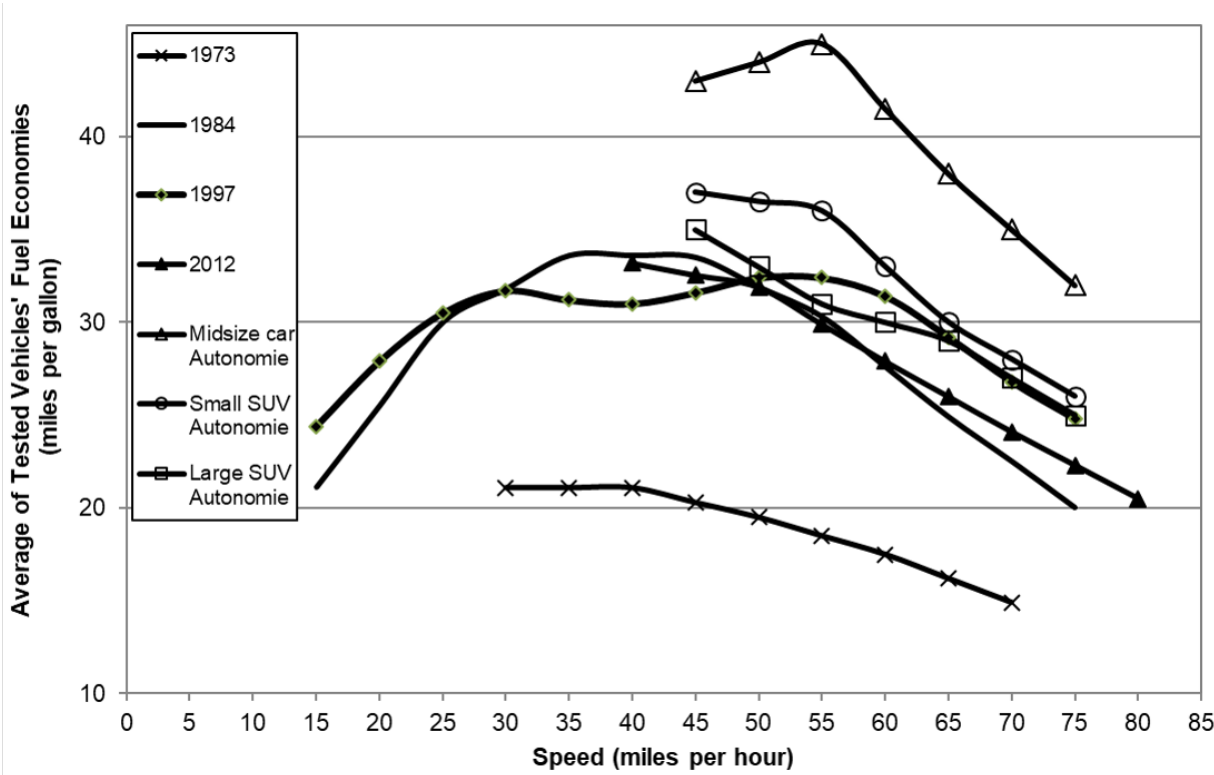
^c Model years 1988–97 cars and light trucks.

^d Model years 2003–2012 cars and light trucks.

^e Data are not available.



Figure 4.2. Fuel Economy by Speed, 1973, 1984, 1997, and 2012 Studies and Autonomie Model Results



Sources:
See Tables 4.28 and 4.29.



This table shows the driving cycles for the new methodology that the Environmental Protection Agency (EPA) used to determine fuel economy ratings for new vehicles beginning in model year 2008. In addition to the Urban Driving Cycle and the Highway Driving cycle, the EPA will also use three additional tests to adjust fuel economy ratings to account for higher speeds, air conditioner use, and colder temperatures. Though the EPA uses a complex combination of these five cycles to determine the fuel economy that will be posted on a new vehicle window sticker, the manufacturer's Corporate Average Fuel Economy is still calculated using only the city and highway driving cycles. To know more about new vehicle fuel economy ratings, visit www.fueleconomy.gov.

Table 4.30
Driving Cycle Attributes

	Test schedule				
	City	Highway	High speed	Air conditioner (AC)	Cold temp
Trip type	Low speeds in stop-and-go urban traffic	Free-flow traffic at highway speeds	Higher speeds; harder acceleration & braking	AC use under hot ambient conditions	City test w/colder outside temperature
Top speed	56 mph	60 mph	80 mph	54.8 mph	56 mph
Average speed	21 mph	48 mph	48 mph	21 mph	21 mph
Max. acceleration	3.3 mph/sec	3.2 mph/sec	8.46 mph/sec	5.1 mph/sec	3.3 mph/sec
Simulated distance	11 mi.	10.3 mi.	8 mi.	3.6 mi.	11 mi.
Time	31.2 min.	12.6 min.	9.9 min.	9.9 min.	31.2 min.
Stops	23	None	4	5	23
Idling time	18% of time	None	7% of time	19% of time	18% of time
Engine startup ^a	Cold	Warm	Warm	Warm	Cold
Lab temperature	68-86° F	68-86° F	68-86° F	95° F	20° F
Vehicle air conditioning	Off	Off	Off	On	Off

Source:

U.S. Department of Energy and U.S. Environmental Protection Agency, Fuel Economy website, www.fueleconomy.gov.

^a A vehicle's engine doesn't reach maximum fuel efficiency until it is warm.



These driving cycles simulate the performance of an engine while driving in the city and on the highway. Once the city cycle is completed, the engine is stopped, and then started again for the 8.5-minute hot start cycle. Three additional cycles also influence new vehicle fuel economy ratings beginning with the 2008 model year.

Figure 4.3. City Driving Cycle

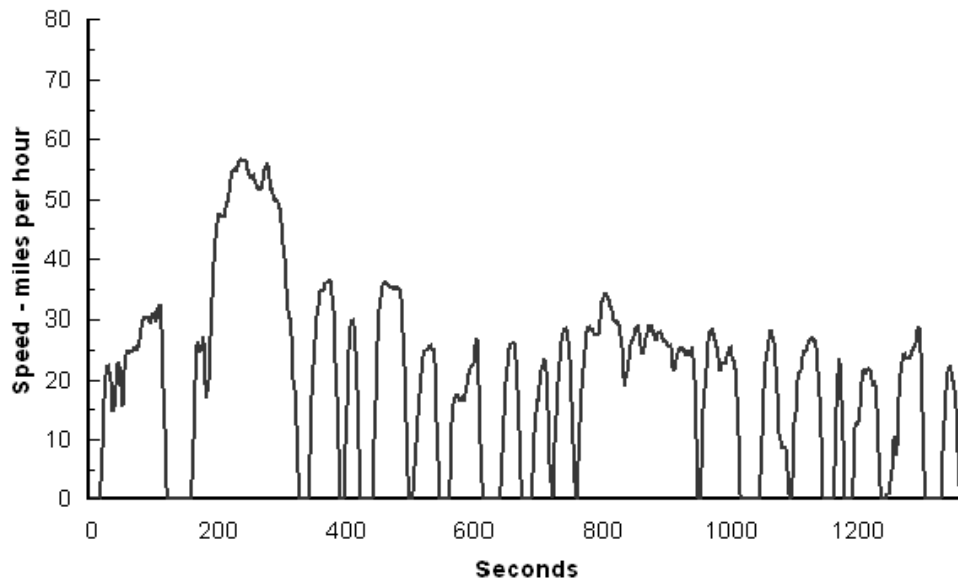
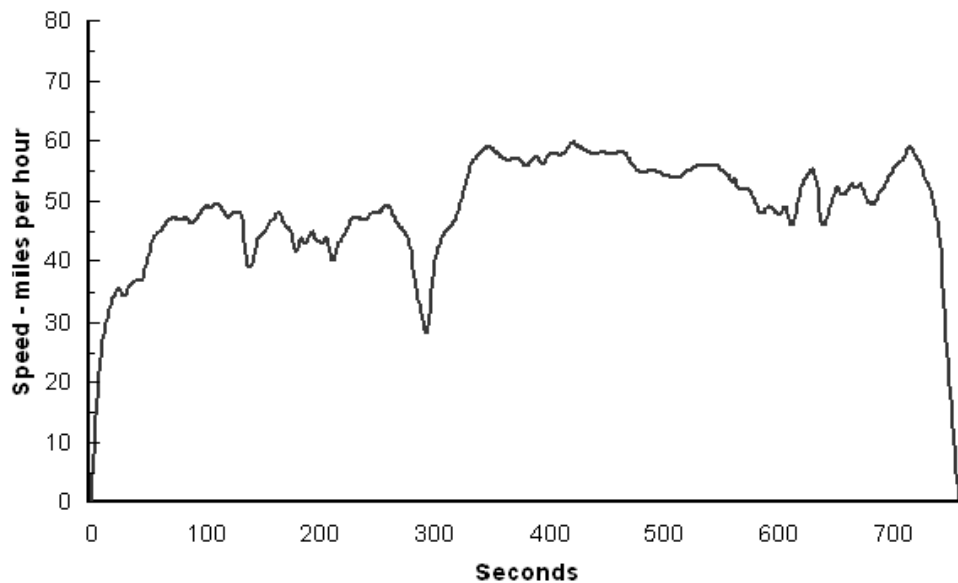


Figure 4.4. Highway Driving Cycle



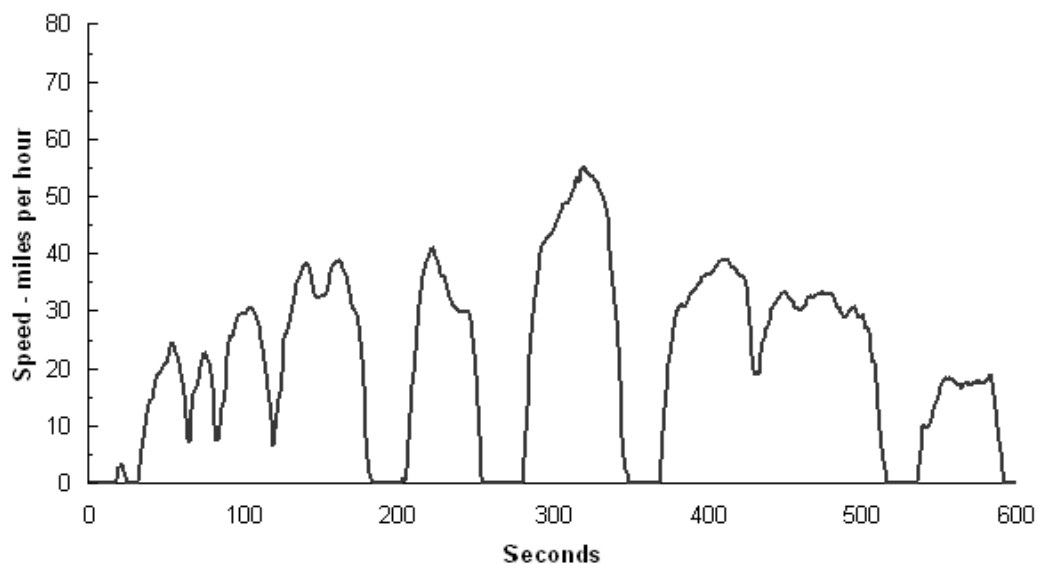
Source:

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.



Beginning with the 2008 model year, these cycles influence the new vehicle fuel economy ratings.

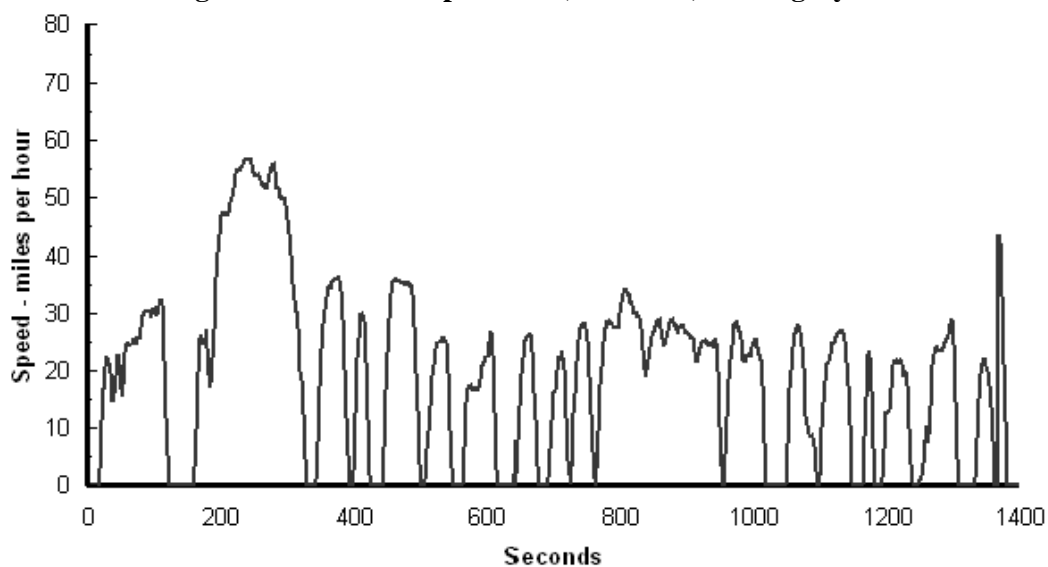
Figure 4.5. Air Conditioning (SC03) Driving Cycle



Source:

U.S. Department of Energy and Environmental Protection Agency, Fuel Economy website, www.fueleconomy.gov.

Figure 4.6. Cold Temperature (Cold FTP) Driving Cycle



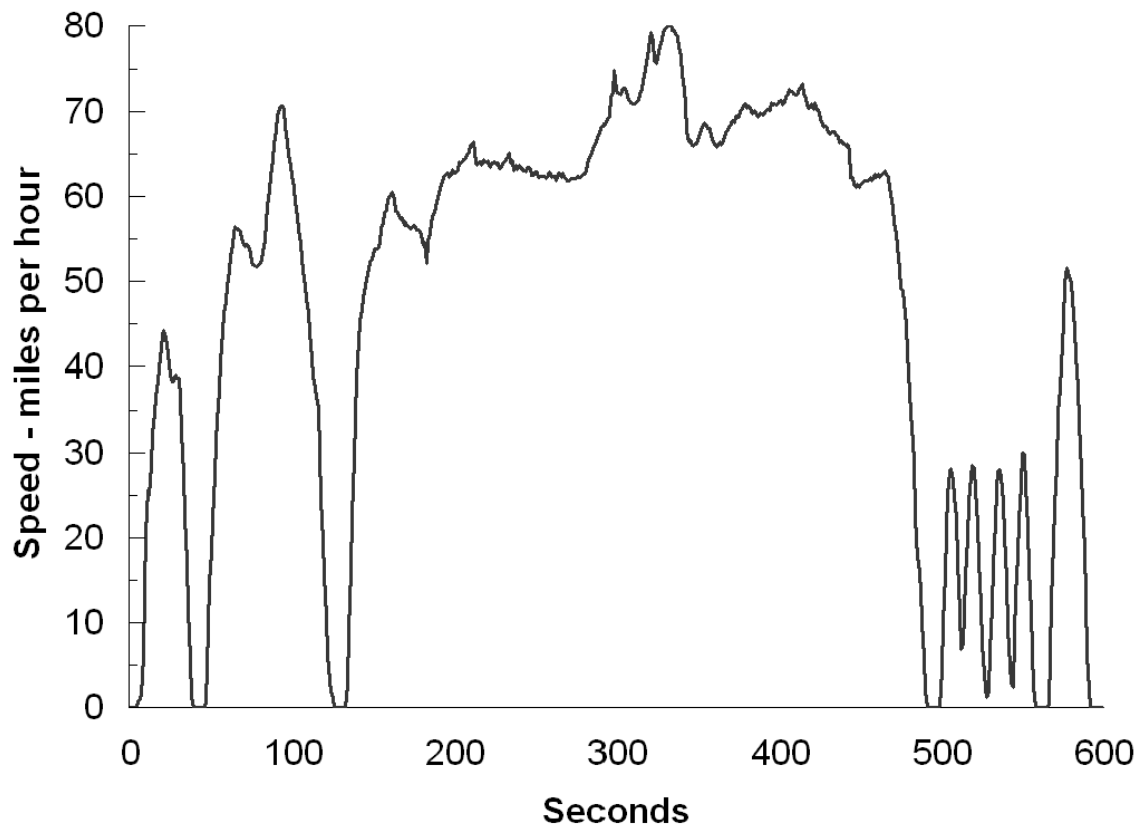
Source:

U.S. Department of Energy and Environmental Protection Agency, Fuel Economy website, www.fueleconomy.gov.



Beginning with the 2008 model year, this cycle influences the new vehicle fuel economy ratings. The US06 driving cycle was originally developed as a supplement to the Federal Test Procedure. It is a short-duration cycle (600 seconds) which represents hard-acceleration driving.

Figure 4.7. High-Speed (US06) Driving Cycle



Source:

U.S. Department of Energy and Environmental Protection Agency, Fuel Economy website, www.fueleconomy.gov.



The Environmental Protection Agency also uses other driving cycles to test new vehicles (although these do not affect the fuel economy ratings). The New York Test Cycle was developed in the 1970's in order to simulate driving in downtown congested areas. The Representative Number Five Test Cycle was developed in the 1990's to better represent actual on-road driving by combining modern city and freeway driving.

Figure 4.8. New York City Driving Cycle

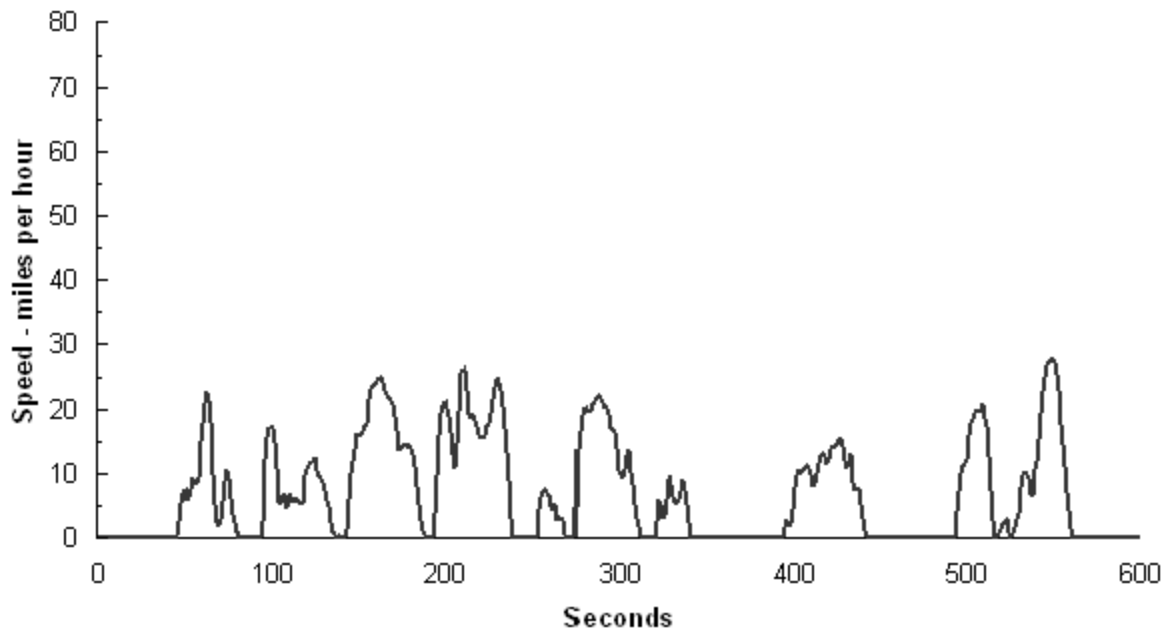
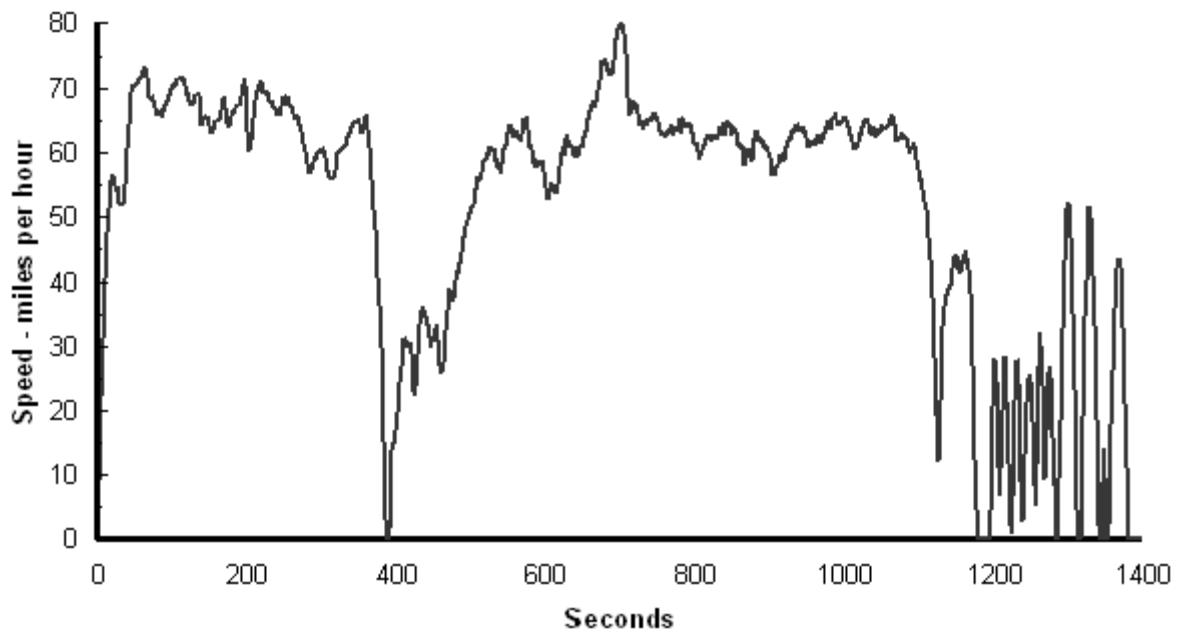


Figure 4.9. Representative Number Five Driving Cycle



Source:

Data obtained from Michael Wang, Argonne National Laboratory, Argonne, IL, 1997.



Testing cycles to determine vehicle fuel economy and emissions vary by country. The United States currently uses five different drive cycles to determine vehicle fuel economy. In Europe, the NEDC cycle is being replaced by the WLTC, but the NEDC continues to be used in China. The ARTEMIS cycles are not used in vehicle certification, but are used to represent real world driving in Europe.

Table 4.31
Comparison of U.S., European, and Japanese Driving Cycles Attributes

Cycle	Time (seconds)	Distance (miles)	Average Speed (mph)	Maximum Speed (mph)	Maximum Acceleration (mph/s)
United States					
City	1,872	11.0	21.2	56.0	3.3
Highway	765	10.3	48.3	60.0	3.2
High-Speed	594	8.0	48.4	80.0	8.5
Air Conditioner Use	594	3.6	21.2	54.8	5.1
Cold Temperatures	1,872	11.0	21.2	56.0	3.3
World Light Vehicle Test Cycle (WLTC)					
Low	589	1.9	11.7	35.1	3.6
Medium	433	3.0	24.5	47.6	3.6
High	455	4.4	35.1	60.5	3.7
Extra High	323	5.1	57.0	81.6	2.3
Total WLTC	1,800	14.5	28.9	81.6	3.7
Japan					
JC08	1,204	5.1	15.2	50.7	3.8
New European Driving Cycle (NEDC)					
Urban Driving Cycle (UDC)	780	2.5	11.8	31.1	2.3
Extra Urban Driving Cycle (EUDC)	400	4.3	38.9	74.6	1.9
Total NEDC	1,180	6.8	20.9	74.6	2.3
ARTEMIS					
Urban	993	3.0	11.0	35.9	6.4
Rural Road	1,082	10.7	35.7	69.3	5.3
Motorway	1,068	17.9	60.1	81.9	4.3
Total ARTEMIS	3,143	31.6	36.2	81.9	6.4

Source:

United States - U.S. Department of Energy, Fuel Economy Guide website,
www.fueleconomy.gov/feg/fe_test_schedules.shtml

All other - Compiled from public sources by Aymeric Rousseau, Argonne National Laboratory, September 2016.



Testing cycles to determine vehicle fuel economy and emissions vary by country and therefore it is difficult to make a direct comparison. Simulation results show up to a 28% difference in the test cycles for each vehicle type. Note that the differences in these cycle results also vary with each individual vehicle tested.

Table 4.32
Example of Differing Results Using the U.S., European, and Japanese Driving Cycles

Vehicle type	Miles per gallon			Percentage difference from	
	U.S. Corporate Average Fuel Economy (CAFE) cycle	New European Driving Cycle (NEDC)	Japan JC08 cycle	CAFE to NEDC	CAFE to JC08
Small car	34.8	32.4	27.6	-7%	-21%
Large car	26.6	24.7	21.5	-7%	-19%
Minivan	23.9	20.5	17.2	-14%	-28%
Sport-utility vehicle	20.2	17.6	14.6	-13%	-28%
Pickup	18.8	15.9	13.5	-15%	-28%

Note: Simulation results for identical gasoline vehicles (i.e., results for the same small car on each of the three cycles).

Source:

The International Council on Clean Transportation, *Passenger Vehicle Greenhouse Gas and Fuel Economy Standards: A Global Update*, July 2009.



Chapter 5

Heavy Vehicles and Characteristics

Summary Statistics from Tables in this Chapter

Source		
Table 5.1	Class 3-8 single-unit trucks, 2015	
	<i>Registration (thousands)</i>	8,456
	<i>Vehicle miles (millions)</i>	109,597
	<i>Fuel economy (miles per gallon)</i>	7.4
Table 5.2	Class 7-8 combination trucks, 2015	
	<i>Registration (thousands)</i>	2,747
	<i>Vehicle miles (millions)</i>	170,246
	<i>Fuel economy (miles per gallon)</i>	5.9
Table 5.14	Freight Shipments, 2012 Commodity Flow Survey	
Table 5.14	<i>Value (billion dollars)</i>	13,852
Table 5.15	<i>Tons (millions)</i>	11,299
Table 5.16	<i>Ton-miles (billions)</i>	2,970



Class 3-8 single-unit trucks include trucks over 10,000 lb gross vehicle weight with the cab/engine and cargo space together as one unit. Most of these trucks would be used for business or for individuals with heavy hauling or towing needs. Very heavy single-units, such as concrete mixers and dump trucks, are also in this category. The data series was changed by the FHWA back to 2007.

Table 5.1
Summary Statistics for Class 3-8 Single-Unit Trucks, 1970–2015

Year	Registrations (thousands)	Vehicle travel (million miles)	Average annual miles per vehicle	Fuel use (million gallons)	Fuel economy (miles per gallon)
1970	3,681	27,081	7,357	3,968	6.8
1975	4,232	34,606	8,177	5,420	6.4
1980	4,374	39,813	9,102	6,923	5.8
1981	4,455	39,568	8,882	6,867	5.8
1982	4,325	40,658	9,401	6,803	6.0
1983	4,204	42,546	10,120	6,965	6.1
1984	4,061	44,419	10,938	7,240	6.1
1985	4,593	45,441	9,894	7,399	6.1
1986	4,313	45,637	10,581	7,386	6.2
1987	4,188	48,022	11,467	7,523	6.4
1988	4,470	49,434	11,059	7,701	6.4
1989	4,519	50,870	11,257	7,779	6.5
1990	4,487	51,901	11,567	8,357	6.2
1991	4,481	52,898	11,805	8,172	6.5
1992	4,370	53,874	12,328	8,237	6.5
1993	4,408	56,772	12,879	8,488	6.7
1994	4,906	61,284	12,492	9,032	6.8
1995	5,024	62,705	12,481	9,216	6.8
1996	5,266	64,072	12,167	9,409	6.8
1997	5,293	66,893	12,638	9,576	7.0
1998	5,414	67,894	12,540	9,741	7.0
1999	5,763	70,304	12,199	9,372	7.5
2000	5,926	70,500	11,897	9,563	7.4
2001	5,704	72,448	12,701	9,667	7.5
2002	5,651	75,866	13,425	10,321	7.4
2003	5,849	77,757	13,294	8,881	8.8
2004	6,161	78,441	12,732	8,959	8.8
2005	6,395	78,496	12,275	9,501	8.3
2006	6,649	80,344	12,084	9,852	8.2 ^a
2007	8,117	119,979	14,781	16,314	7.3
2008	8,228	126,855	15,417	17,144	7.4
2009	8,356	120,207	14,386	16,253	7.4
2010	8,217	110,738	13,477	15,097	7.3
2011	7,819	103,803	13,276	14,214	7.3
2012	8,190	105,605	12,894	14,376	7.3
2013	8,126	106,582	13,116	14,502	7.3
2014	8,329	109,301	13,123	14,894	7.3
2015	8,456	109,597	12,961	14,850	7.4
<i>Average annual percentage change</i>					
1970–2015	1.9%	3.2%	1.3%	3.0%	0.2%
2005–2015	2.8%	3.4%	0.5%	4.6%	-1.1%

Source:

U. S. Department of Transportation, Federal Highway Administration, *Highway Statistics 2015*, Washington, DC, 2016, Table VM-1 and annual. (Additional resources: www.fhwa.dot.gov)

^a Due to FHWA methodology changes, data from 2007-on are not comparable with previous data.



Class 7-8 combination trucks include all trucks designed to be used in combination with one or more trailers with a gross vehicle weight rating over 26,000 lb. The average vehicle travel of these trucks (on a per truck basis) far surpasses the travel of other trucks due to long-haul freight movement. The data series was changed by the FHWA back to 2007.

Table 5.2
Summary Statistics for Class 7-8 Combination Trucks, 1970–2015

Year	Registrations (thousands)	Vehicle travel ^a (million miles)	Average annual miles per vehicle	Fuel use (million gallons)	Fuel economy (miles per gallon)
1970	905	35,134	38,822	7,348	4.8
1975	1,131	46,724	41,312	9,177	5.1
1980	1,417	68,678	48,467	13,037	5.3
1981	1,261	69,134	54,825	13,509	5.1
1982	1,265	70,765	55,941	13,583	5.2
1983	1,304	73,586	56,431	13,796	5.3
1984	1,340	77,377	57,744	14,188	5.5
1985	1,403	78,063	55,640	14,005	5.6
1986	1,408	81,038	57,555	14,475	5.6
1987	1,530	85,495	55,879	14,990	5.7
1988	1,667	88,551	53,120	15,224	5.8
1989	1,707	91,879	53,825	15,733	5.8
1990	1,709	94,341	55,202	16,133	5.8
1991	1,691	96,645	57,153	16,809	5.7
1992	1,675	99,510	59,409	17,216	5.8
1993	1,680	103,116	61,379	17,748	5.8
1994	1,681	108,932	64,802	18,653	5.8
1995	1,696	115,451	68,073	19,777	5.8
1996	1,747	118,899	68,059	20,192	5.9
1997	1,790	124,584	69,600	20,302	6.1
1998	1,831	128,159	69,994	21,100	6.1
1999	2,029	132,384	65,246	24,537	5.4
2000	2,097	135,020	64,387	25,666	5.3
2001	2,154	136,584	63,409	25,512	5.4
2002	2,277	138,737	60,930	26,480	5.2
2003	1,908	140,160	73,459	23,815	5.9
2004	2,010	142,370	70,831	24,191	5.9
2005	2,087	144,028	69,012	27,689	5.2
2006	2,170	142,169	65,516	28,107	5.1 ^b
2007	2,635	184,199	69,905	30,904	6.0
2008	2,585	183,826	71,113	30,561	6.0
2009	2,617	168,100	64,234	28,050	6.0
2010	2,553	175,789	68,856	29,927	5.9
2011	2,452	163,791	66,809	28,181	5.8
2012	2,469	163,602	66,262	27,975	5.8
2013	2,471	168,436	68,155	28,795	5.8
2014	2,577	169,830	65,897	29,118	5.8
2015	2,747	170,246	61,978	28,884	5.9
<i>Average annual percentage change</i>					
1970–2015	2.5%	3.6%	1.0%	3.1%	0.5%
2005–2015	2.8%	1.7%	-1.1%	0.4%	1.3%

Source:

U. S. Department of Transportation, Federal Highway Administration, *Highway Statistics 2015*, Washington, DC, 2016, Table VM-1 and annual. (Additional resources: www.fhwa.dot.gov)

^a The Federal Highway Administration changed the combination truck travel methodology in 1993.

^b Due to FHWA methodology changes, data from 2007-on are not comparable with previous data.



Truck sales rose in 2010 for the first time since the sales peak in 2004 and have thus far continued to rise. Trucks under 10,000 lb continue to dominate truck sales.

Table 5.3
New Retail Truck Sales by Gross Vehicle Weight, 1970–2016^a
(thousands)

Calendar year	Class 1 6,000 lb or less	Class 2 6,001– 10,000 lb	Class 3 10,001– 14,000 lb	Class 4 14,001– 16,000 lb	Class 5 16,001– 19,500 lb	Class 6 19,501– 26,000 lb	Class 7 26,001– 33,000 lb	Class 8 33,001 lb and over	Total
Domestic sales (import data are not available)									
1970 ^b	1,049	408	6	12	58	133	36	89	1,791
1975	1,101	952	23	1	9	159	23	83	2,351
1980	985	975	4	^c	2	90	58	117	2,231
1981	896	850	1	^c	2	72	51	100	1,972
1982	1,102	961	1	^c	1	44	62	76	2,248
1983	1,314	1,207	^c	^c	1	47	59	82	2,710
1984	2,031	1,224	6	^c	5	55	78	138	3,538
1985	2,408	1,280	11	^c	5	48	97	134	3,983
Domestic and import sales									
1986	3,380	1,214	12	^c	6	45	101	113	4,870
1987	3,435	1,175	14	2	8	44	103	131	4,912
1988	3,467	1,333	14	21	8	54	103	148	5,149
1989	3,313	1,297	19	27	7	39	93	145	4,942
1990	3,451	1,097	21	27	5	38	85	121	4,846
1991	3,246	876	21	24	3	22	73	99	4,365
1992	3,608	1,021	26	26	4	28	73	119	4,903
1993	4,119	1,232	27	33	4	27	81	158	5,681
1994	4,527	1,506	35	44	4	20	98	186	6,421
1995	4,422	1,631	40	53	4	23	107	201	6,481
1996	4,829	1,690	52	59	7	19	104	170	6,930
1997	5,085	1,712	53	57	9	18	114	179	7,226
1998	5,263	2,036	102	43	25	32	115	209	7,826
1999	5,707	2,366	122	49	30	48	130	262	8,716
2000	5,965	2,421	117	47	29	51	123	212	8,965
2001	6,073	2,525	102	52	24	42	92	140	9,050
2002	6,068	2,565	80	38	24	45	69	146	9,035
2003	6,267	2,671	91	40	29	51	67	142	9,357
2004	6,458	2,796	107	47	36	70	75	203	9,793
2005	6,586	2,528	167	49	46	60	89	253	9,777
2006	6,136	2,438	150	50	49	70	91	284	9,268
2007	5,682	2,623	166	51	45	54	70	151	8,842
2008	4,358	1,888	135	36	40	39	49	133	6,680
2009	3,528	1,306	112	20	24	22	39	95	5,145
2010	4,245	1,513	161	12	31	29	38	107	6,137
2011	4,714	1,735	195	10	42	41	41	171	6,951
2012	5,164	1,811	223	9	55	40	47	195	7,544
2013	5,615	2,077	254	12	60	47	48	185	8,298
2014	6,209	2,275	264	13	67	52	54	220	9,154
2015	7,161	2,417	283	14	72	55	59	249	10,310
2016	7,724	2,572	296	14	72	62	60	193	10,993
<i>Average annual percentage change</i>									
1970–1985	5.7%	7.9%	4.1%	^c	-15.1%	-6.6%	6.8%	2.8%	5.5%
1986–2016	2.8%	2.5%	11.3%	6.9% ^d	8.6%	1.1%	-1.7%	1.8%	2.8%
2006–2016	2.3%	0.5%	7.0%	-12.0%	3.9%	-1.2%	-4.1%	-3.8%	1.7%

Source:

Ward's Communications, www.wardsauto.com. (Additional resources: www.wardsauto.com)

^a Sales include domestic-sponsored imports.

^b Data for 1970 is based on new truck registrations.

^c Data are not available.

^d 1987–2016.



The Vehicle Inventory and Use Survey (VIUS) was discontinued, thus the 2002 VIUS data remain the latest available.

The United States Department of Transportation, the United States Department of Energy, and the United States Department of Agriculture are funding a planning study to design and scope a new VIUS, possibly utilizing new forms of survey technologies.

There is an opportunity to provide input on how VIUS data have been used; which survey elements are essential to your future data and policy needs; and, elements which should be added or deleted. To review the questions from the 2002 survey prior to providing input, go to www.census.gov/svsd/www/vius/questionnaires.html.

To give input towards a new VIUS data collection, email VIUS@dot.gov.

Vehicle Inventory and Use Survey

The Vehicle Inventory and Use Survey (VIUS), which was formerly the Truck Inventory and Use Survey (TIUS), provides data on the physical and operational characteristics of the Nation's truck population. It is based on a probability sample of private and commercial trucks registered (or licensed) in each state. In 1997, the survey was changed to the Vehicle Inventory and Use Survey due to future possibilities of including additional vehicle types. The 2002 VIUS, however, only includes trucks. Copies of the 2002 VIUS report or CD may be obtained by contacting the U.S. Bureau of the Census, Transportation Characteristics Surveys Branch (301) 457-2797. Internet site:

www.census.gov/svsd/www/tiusview.html

Since 1987, the survey has included minivans, vans, station wagons on truck chassis, and sport utility vehicles in addition to the bigger trucks. The 1977 and 1982 surveys did not include those vehicle types. The estimated number of trucks that were within the scope of the 2002 VIUS and registered in the United States as of July 1, 2002 was 85.2 million. These trucks were estimated to have been driven a total of 1,115 billion miles during 2002, an increase of 6.8% from 1997. The average annual miles traveled per truck was estimated at 13,100 miles.

In 2016, the California Department of Transportation is conducting a survey to collect data on the physical and operational characteristics of the State's commercial vehicle population called the California Vehicle Inventory Use and Survey. Internet site:

www.dot.ca.gov/hq/tpp/offices/omsp/statewide_modeling/cal_vehicle_survey.html



Table 5.4
Truck Statistics by Gross Vehicle Weight Class, 2002

Manufacturer's gross vehicle weight class	Number of trucks	Percentage of trucks	Average annual miles per truck	Harmonic mean fuel economy	Percentage of fuel use
1) 6,000 lb and less	51,941,389	61.0%	11,882	17.6	42.7%
2) 6,001 – 10,000 lb	28,041,234	32.9%	12,684	14.3	30.5%
3) 10,001 – 14,000 lb	691,342	0.8%	14,094	10.5	1.1%
4) 14,001 – 16,000 lb	290,980	0.3%	15,441	8.5	0.5%
5) 16,001 – 19,500 lb	166,472	0.2%	11,645	7.9	0.3%
6) 19,501 – 26,000 lb	1,709,574	2.0%	12,671	7.0	3.2%
Medium truck subtotal	2,858,368	3.4%	13,237	8.0	5.2%
7) 26,001 – 33,000 lb	179,790	0.2%	30,708	6.4	0.9%
8) 33,001 lb and up	2,153,996	2.5%	45,739	5.7	20.7%
Total	85,174,777	100.0%	13,088	13.5	100.0%
Light truck subtotal	79,982,623	93.9%	12,163	16.2	73.2%
Medium truck subtotal	2,858,368	3.4%	13,237	8.0	5.2%
Heavy truck subtotal	2,333,786	2.7%	44,581	5.8	21.6%

Source:

U.S. Department of Commerce, Bureau of the Census, *2002 Vehicle Inventory and Use Survey*, Microdata File on CD, 2005. (Additional resources: www.census.gov/svsd/www.tiusview.html)

Table 5.5
Truck Harmonic Mean Fuel Economy by Size Class, 1992, 1997, and 2002
(miles per gallon)

Manufacturer's gross vehicle weight class	1992 TIUS	1997 VIUS	2002 VIUS
1) 6,000 lb and less	17.2	17.1	17.6
2) 6,001–10,000 lb	13.0	13.6	14.3
3) 10,000–14,000 lb	8.8	9.4	10.5
4) 14,001–16,000 lb	8.8	9.3	8.5
5) 16,001–19,500 lb	7.4	8.7	7.9
6) 19,501–26,000 lb	6.9	7.3	7.0
7) 26,001–33,000 lb	6.5	6.4	6.4
8) 33,001 lb and over	5.5	5.7	5.7
Light truck subtotal	15.7	15.8	16.2
Medium truck subtotal	7.3	8.6	8.0
Large truck subtotal	5.6	6.1	5.8

Note: Based on average fuel economy as reported by respondent.

Sources:

Estimates are based on data provided on the following public use files: U.S. Department of Commerce, Bureau of the Census, Census of Transportation, Washington, DC, *1992 Truck Inventory and Use Survey*, 1995; *1997 Vehicle Inventory and Use Survey*, 2000, and *2002 Vehicle Inventory and Use Survey*, 2005. (Additional resources: www.census.gov/svsd/www.tiusview.html)



As expected, most light trucks travel within 50 miles of their home base and refuel at public stations. About sixty percent of heavy trucks travel over 50 miles from their home base and 36% of them refuel at central company-owned refueling stations.

Table 5.6
Truck Statistics by Size, 2002

	Manufacturer's gross vehicle weight class			Total
	Light (10,000 lb)	Medium (10,001– 26,000 lb)	Heavy (26,000 lb)	
Typical trip miles or range of operation ^a				
Under 50 miles	69.2%	61.5%	40.7%	68.2%
51–100 miles	8.5%	11.7%	13.5%	8.7%
101–200 miles	2.4%	3.2%	6.7%	2.5%
201–500 miles	1.1%	1.8%	7.6%	1.3%
501 miles or more	1.4%	2.2%	10.4%	1.7%
Off-road	1.1%	3.5%	3.2%	1.2%
Vehicle not in use	2.2%	4.4%	3.2%	2.3%
Not reported	14.1%	11.7%	14.7%	14.1%
Total^b	100.0%	100.0%	100.0%	100.0%
Primary refueling facility				
Gas station	96.9%	62.4%	28.4%	93.9%
Truck stop	0.7%	7.7%	31.9%	1.8%
Own facility	2.0%	27.3%	36.2%	3.7%
Other nonpublic facility	0.3%	2.6%	3.5%	0.5%
Other	0.0%	0.0%	0.0%	0.0%
Total^b	100.0%	100.0%	100.0%	100.0%

Source:

U.S. Department of Commerce, Bureau of the Census, *2002 Vehicle Inventory and Use Survey*, Microdata. File on CD, 2005. (Additional resources: www.census.gov/svsd/www/tiusview.html)

^a The respondent was asked to choose the category which best described the trips made by the vehicle.

^b Percentages may not sum to totals due to rounding.



More medium truck owners listed construction as the truck's major use than any other major use category. Construction was the second highest major use for light trucks and heavy trucks.

Table 5.7
Percentage of Trucks by Size Ranked by Major Use, 2002

Rank	Light (< 10,000 lb average weight)	Medium (10,001 – 26,000 lb average weight)	Heavy (> 26,000 lb average weight)
1	Personal 81.5%	Construction 18.4%	For hire 30.1%
2	Construction 4.6%	Agriculture 16.2%	Construction 15.9%
3	Other services^a 2.5%	For hire 9.6%	Agriculture 12.2%
4	Not in use 2.2%	Retail 7.1%	Retail 5.4%
5	Agriculture 1.9%	Not in use 6.4%	Not in use 5.1%
6	Retail 1.5%	Leasing 6.2%	Waste management 5.0%
7	Unknown 1.3%	Wholesale 5.5%	Manufacturing 4.9%
8	Leasing 0.7%	Waste management 5.4%	Wholesale 4.8%
9	Manufacturing 0.7%	Utilities 5.0%	Leasing 4.6%
10	Utilities 0.6%	Personal 4.8%	Unknown 3.2%
11	Waste management 0.6%	Unknown 4.4%	Personal 2.5%
12	Wholesale 0.6%	Manufacturing 3.3%	Mining 2.4%
13	Information services 0.4%	Other services^a 3.2%	Other services^a 1.3%
14	For hire 0.4%	Food services 1.6%	Utilities 1.1%
15	Food services 0.3%	Information services 1.3%	Food services 1.1%
16	Arts 0.2%	Mining 1.1%	Arts 0.3%
17	Mining 0.1%	Arts 0.5%	Information services 0.1%

Source:

U.S. Department of Commerce, Bureau of the Census, *2002 Vehicle Inventory and Use Survey*, Micro data File on CD, 2005. (Additional resources: www.census.gov/svsd/www/tiusview.html)

^a Business and personal services.



Nearly half of trucks in fleets of 11-20 and 21-50 vehicles use company-owned facilities. Most trucks in smaller fleets use public gas stations for fueling.

Table 5.8
Percentage of Trucks by Fleet Size and Primary Fueling Facility, 2002

Truck fleet size	Primary refueling facility				Total ^a
	Gas station	Truck stop	Own facility	Other's facility	
1-5	73.8%	6.1%	18.2%	1.9%	100.0%
6-10	55.3%	5.7%	35.5%	3.4%	100.0%
11-20	41.1%	5.1%	48.9%	4.9%	100.0%
21-50	42.9%	3.7%	49.8%	3.6%	100.0%
51 or more	48.3%	6.3%	44.4%	1.0%	100.0%
Fleets of 6 or more vehicles	47.6%	5.2%	43.9%	3.4%	100.0%
No fleet	96.4%	1.6%	1.7%	0.3%	100.0%

Source:

U.S. Department of Commerce, Bureau of the Census, *2002 Vehicle Inventory and Use Survey*, Microdata File on CD, 2005. (Additional resources: www.census.gov/svsd/www/tiusview.html)

^a Percentages may not sum to totals due to rounding.



Most trucks are fueled at gas stations but for-hire or warehousing trucks are more often fueled at truck stops. Mining trucks and vehicle leasing or rental trucks fuel at the companies' own facility more than 30% of the time.

Table 5.9
Share of Trucks by Major Use and Primary Fueling Facility, 2002

Major use	Gas station	Truck stop	Own facility	Others facility	Other	All ^a
Personal	98.6%	0.6%	0.7%	0.1%	0.1%	100.0%
Other services	96.0%	1.4%	1.6%	0.9%	0.1%	100.0%
All	93.9%	1.8%	3.7%	0.5%	0.0%	100.0%
Information services	92.3%	0.4%	7.2%	0.1%	0.0%	100.0%
Retail trade	86.6%	3.5%	8.6%	1.2%	0.0%	100.0%
Construction	84.7%	3.3%	9.8%	2.2%	0.0%	100.0%
Accommodation or food services	82.4%	7.5%	8.8%	1.3%	0.0%	100.0%
Manufacturing	81.5%	5.1%	11.9%	1.5%	0.0%	100.0%
Arts, entertainment, recreation services	81.1%	4.3%	14.2%	0.3%	0.0%	100.0%
Waste mgmt, landscaping, admin/support services	78.2%	3.0%	17.1%	1.6%	0.0%	100.0%
Wholesale trade	76.2%	6.6%	12.0%	5.1%	0.0%	100.0%
Utilities	72.6%	1.8%	24.3%	1.3%	0.0%	100.0%
Agriculture, forestry, fishing, hunting	62.7%	6.7%	29.4%	1.0%	0.1%	100.0%
Vehicle leasing or rental	60.2%	1.3%	31.8%	6.8%	0.0%	100.0%
Mining	48.7%	8.5%	34.3%	8.5%	0.0%	100.0%
For-hire or warehousing	33.3%	38.7%	25.8%	2.3%	0.0%	100.0%
Overall	93.9%	1.8%	3.7%	0.5%	0.0%	100.0%

Source:

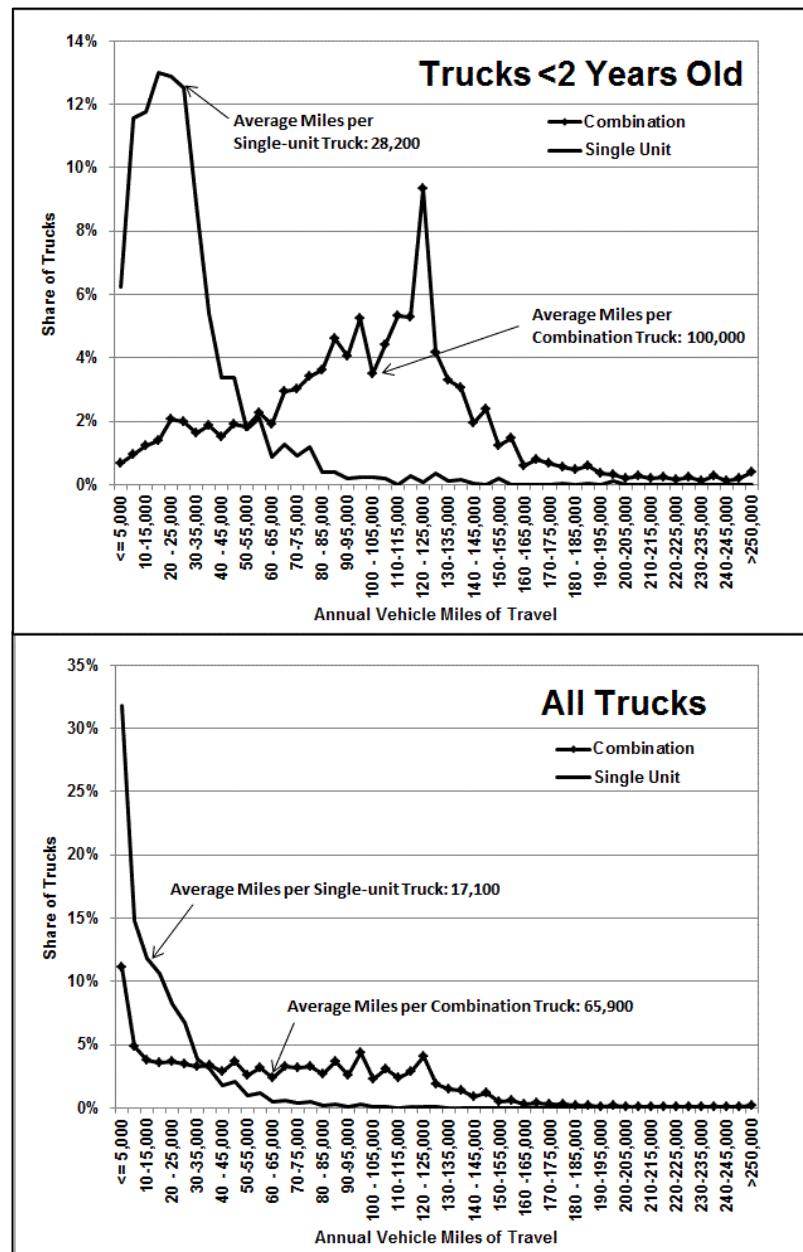
U.S. Department of Commerce, Bureau of the Census, *2002 Vehicle Inventory and Use Survey*, Microdata File on CD, 2005. (Additional resources: www.census.gov/svsd/www/tiusview.html)

^a Percentages may not sum to totals due to rounding.



The figure below shows the distribution of annual travel the two types of Class 7 and 8 vehicles—combination units (separate tractor and trailer) and single units (tractor and trailer on a single chassis). This information is for all trucks and trucks two years old or less. Combination trucks, dominated by box-type trailers, display the greatest amount of annual travel of all heavy vehicle types, as is evidenced both by the range of annual use. Most of the single-unit trucks in the survey travel 40,000 miles per year or less.

Figure 5.1. Distribution of Trucks over 26,000 lb by Vehicle-Miles Traveled



Note: Heavy trucks (class 7 & 8) are greater than 26,000 pounds gross vehicle weight based on the manufacturer's rating.

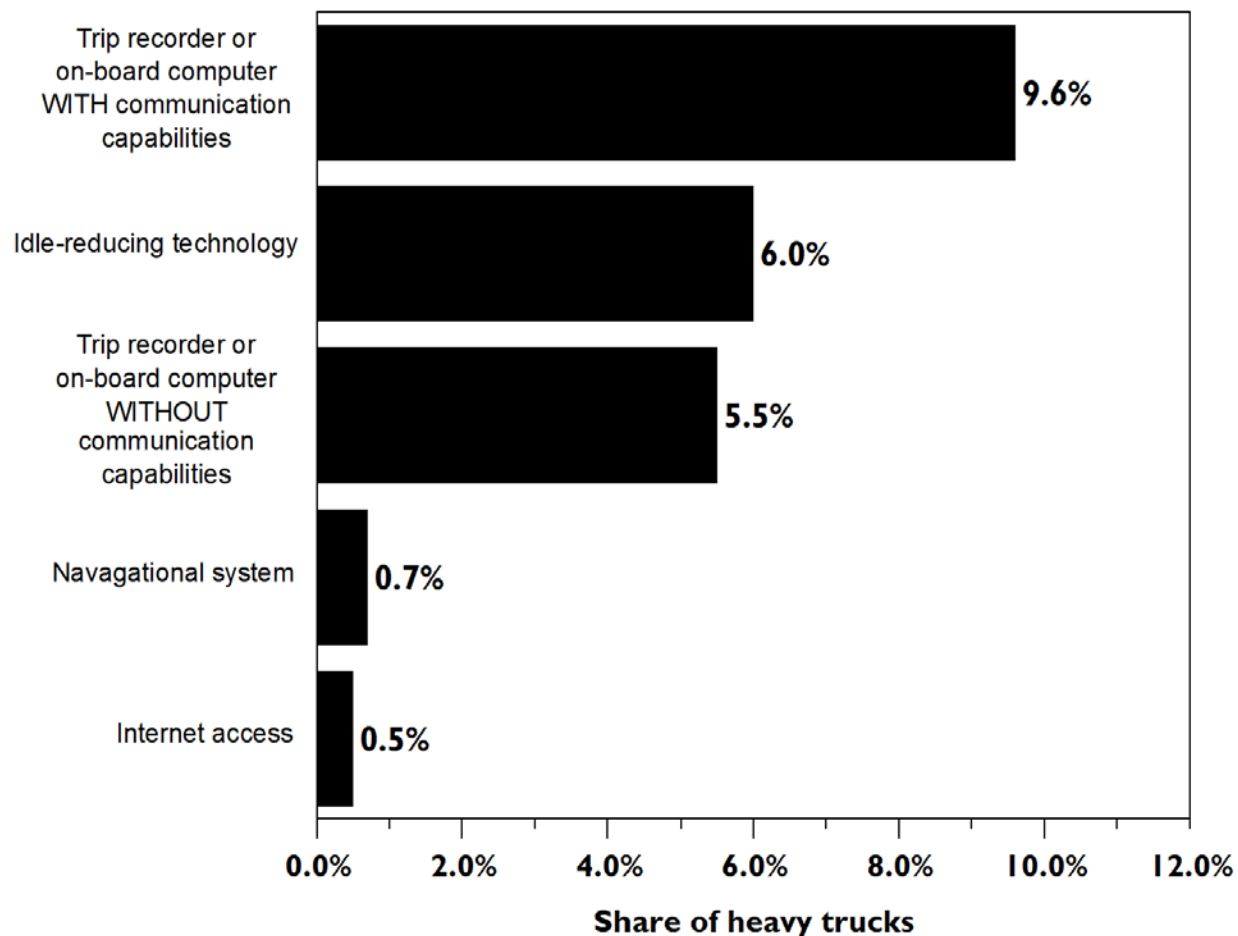
Source:

U.S. Department of Commerce, Bureau of the Census, *2002 Vehicle Inventory and Use Survey*, Microdata File on CD, 2005. (Additional resources: www.census.gov/svsd/www/tiusview.html)



The latest Vehicle Inventory and Use Survey asked truck owners if the truck had certain features as permanent equipment on the truck. Some of the features asked about were onboard computers, idle-reduction devices, navigational systems, and Internet access. Of the 2.3 million heavy trucks (class 7 & 8) in the United States, nearly 10% were equipped with onboard computers that had communication capabilities and another 5% had onboard computers without communication capabilities. Six percent of heavy trucks were equipped with idle-reducing technology. Navigational systems and Internet access were available in less than one percent of heavy trucks.

Figure 5.2. Share of Heavy Trucks with Selected Electronic Features, 2002



Note: Heavy trucks (class 7 & 8) are greater than 26,000 pounds gross vehicle weight based on the manufacturer's rating.

Source:

U.S. Department of Commerce, Bureau of the Census, *2002 Vehicle Inventory and User Survey*, Microdata File on CD, 2005.



Fuel Economy Study for Class 8 Trucks

As part of a study sponsored by the U.S. Department of Energy (DOE) Vehicle Technologies Office (VTO), the Oak Ridge National Laboratory (ORNL) in conjunction with several industry partners has collected data and information related to heavy-truck operation in real-world highway environments. The primary objective of the project was to collect real-world performance and spatial data for long-haul operations of Class 8 tractor-trailers from a fleet engaged in normal freight operations. Six model-year 2005 Class 8 trucks from the selected fleet, which operates within a large area of the country extending from the east coast to Mountain Time Zone and from Canada to the US-Mexican border, were instrumented and 60 channels of data were collected for over a year at a rate of 5 Hz (or 5 readings per second). Those channels included information such as instantaneous fuel rate, engine speed, gear ratio, vehicle speed, and other information read from the vehicle's databus; weather information (wind speed, precipitation, air temperature, etc.) gathered from an on-board weather station; spatial information (latitude, longitude, altitude) acquired from a GPS (Global Positioning System) device; and instantaneous tractor and trailer weight obtained from devices mounted on the six participating tractors and ten trailers. Three of the six instrumented tractors and five of the ten instrumented trailers were mounted with New Generation Single Wide-Based Tires and the others with regular dual tires. Over the duration of this phase of the project (just over a year) the six tractors traveled nearly 700,000 miles.

To find out more about this project, contact Oscar Franzese, franzeseo@ornl.gov, 865-946-1304. The final report on this project is available on-line at: cta.ornl.gov/cta/Publications/Reports/ORNL_TM_2008-122.pdf.



The type of terrain a truck is traveling on can cause significant differences in fuel efficiency. This study (see page 5–13 for project description) shows fuel economy on severe upslopes is less than half that on flat terrain. On severe downslopes, the fuel economy was two times higher than on flat terrain.

Table 5.10
Effect of Terrain on Class 8 Truck Fuel Economy

Type of terrain	Share of data records	All trucks	Average fuel efficiency (mpg)		
			Tractors with dual tires	Tractors with single (wide) tires	Difference between dual and single tires (percent)
Severe upslope (>4%)	0.7%	2.90	2.86	2.94	2.91%
Mild upslope (1% to 4%)	13.2%	4.35	4.25	4.44	4.35%
Flat terrain (1% to 1%)	72.4%	7.33	7.08	7.58	7.13%
Mild downslope (-4% to -1%)	12.6%	15.11	14.64	15.57	6.36%
Severe downslope (<-4%)	1.1%	23.5	21.82	25.3	15.97%

Source:

Capps, Gary, Oscar Franzese, Bill Knee, M.B. Lascurain, and Pedro Otaduy. *Class-8 Heavy Truck Duty Cycle Project Final Report*, ORNL/TM-2008/122, Oak Ridge National Laboratory, Oak Ridge, TN, December 2008. (Additional resources: cta.ornl.gov/cta/Publications/Reports/ORNL_TM_2008-122.pdf)



This table presents a distribution of distance traveled, fuel consumed, and fuel economy by speed and by type of tires for the vehicles participating in the project (see page 5-13 for project description). The speed bins are divided into 5-mile intervals, going from 0+ mph (i.e., speed > 0.00 mph) to 85 mph, while the four main columns of the table are organized by the type of tires that were mounted on the tractor and trailers. The first row of the table contains information about fuel consumed while the vehicle was idling (i.e., the vehicle was static with the engine on) with the following rows presenting information about the distance traveled, fuel consumed, and fuel economy for each one of the speed intervals. The next-to-the-last row shows the totals for both traveled distances and fuel consumed as well as the overall fuel economy for each tire-combination category. The latter are then used to compute the percentage difference in terms of fuel economy from dual tire tractors and trailers, which is the most common tire setup for large trucks at the present time.

Table 5.11
Fuel Economy for Class 8 Trucks as Function of Speed
and Tractor-Trailer Tire Combination

Speed (mph)	Dual tire tractor – dual tire trailer			Dual tire tractor – single (wide) tire trailer			Single (wide) tire tractor – dual tire trailer			Single (wide) tire tractor – single (wide) tire trailer		
	Distance traveled (miles)	Fuel cons. (gal)	Fuel econ. (MPG)	Distance traveled (miles)	Fuel cons. (gal)	Fuel econ. (MPG)	Distance traveled (miles)	Fuel cons. (gal)	Fuel econ. (MPG)	Distance traveled (miles)	Fuel cons. (gal)	Fuel econ. (MPG)
Idling	N/A	1,858.5	N/A	N/A	967.9	N/A	N/A	1,676.4	N/A	N/A	706.0	N/A
0+ to 5	281	101.8	2.76	148	50.4	2.93	368.0	124.2	3.0	156	52.8	2.96
5+ to 10	674	198.8	3.39	368	103.2	3.56	808.0	245.4	3.3	331	98.8	3.35
10+ to 15	723	192.0	3.77	396	98.3	4.03	848.0	216.5	3.9	343	87.0	3.95
15+ to 20	744	199.1	3.73	404	100.9	4.00	882.0	221.6	4.0	361	90.5	3.98
20+ to 25	938	228.4	4.11	489	113.6	4.31	1,111.0	244.2	4.6	462	101.1	4.57
25+ to 30	1,178	266.9	4.41	609	131.5	4.63	1,420.0	286.9	5.0	580	117.6	4.93
30+ to 35	1,481	336.8	4.40	753	154.2	4.88	1,774.0	341.1	5.2	708	141.1	5.02
35+ to 40	1,917	403.5	4.75	1,000	193.6	5.17	2,284.0	433.6	5.3	941	184.3	5.10
40+ to 45	2,955	584.1	5.06	1,543	285.9	5.40	3,380.0	603.6	5.6	1,350	254.4	5.31
45+ to 50	4,935	907.9	5.43	2,573	447.7	5.75	5,410.0	872.8	6.2	2,177	360.4	6.04
50+ to 55	9,397	1,629.8	5.77	4,962	811.5	6.11	10,046.0	1,622.7	6.2	3,877	625.5	6.20
55+ to 60	20,656	3,297.2	6.26	11,707	1,721.9	6.80	22,373.0	3,257.8	6.9	8,710	1,246.9	6.99
60+ to 65	38,964	5,879.6	6.63	21,472	2,980.8	7.20	34,517.0	4,840.0	7.1	14,944	2,049.4	7.29
NOT ADJUSTED FOR TERRAIN: See note below.												
65+ to 70	58,304	8,313.2	7.01	27,931	3,652.2	7.65	65,063.0	9,256.4	7.0	27,144	3,880.1	7.00
70+ to 75	56,378	7,483.2	7.53	21,751	2,745.5	7.92	66,882.0	8,435.6	7.9	32,887	4,056.1	8.11
75+ to 85	7,849	808.2	9.71	3,610	403.2	8.95	11,513.0	911.1	12.6	6,817	512.2	13.31
Total ^a	207,374	30,831.0	6.73	99,714	13,994.0	7.13	228,680.0	31,913.0	7.2	101,790	13,858.0	7.35
Percent increase in fuel economy from dual tire trac/trail	0.00%			5.93%			6.53%			9.20%		

Note: These data were not adjusted to account for the effects of terrain. The increase in fuel economy for speeds above 70 mph is likely due to the vehicle achieving high speeds while traveling down slope. Therefore, this increase in fuel economy is not expected to be characteristic of all travel at these higher speeds.

Source:

Capps, Gary, Oscar Franzese, Bill Knee, M.B. Lascrain, and Pedro Otaduy. *Class-8 Heavy Truck Duty Cycle Project Final Report*, ORNL/TM-2008/122, Oak Ridge National Laboratory, Oak Ridge, TN, December 2008. (Additional resources: cta.ornl.gov/cta/Publications/Reports/ORNLTM_2008-122.pdf)

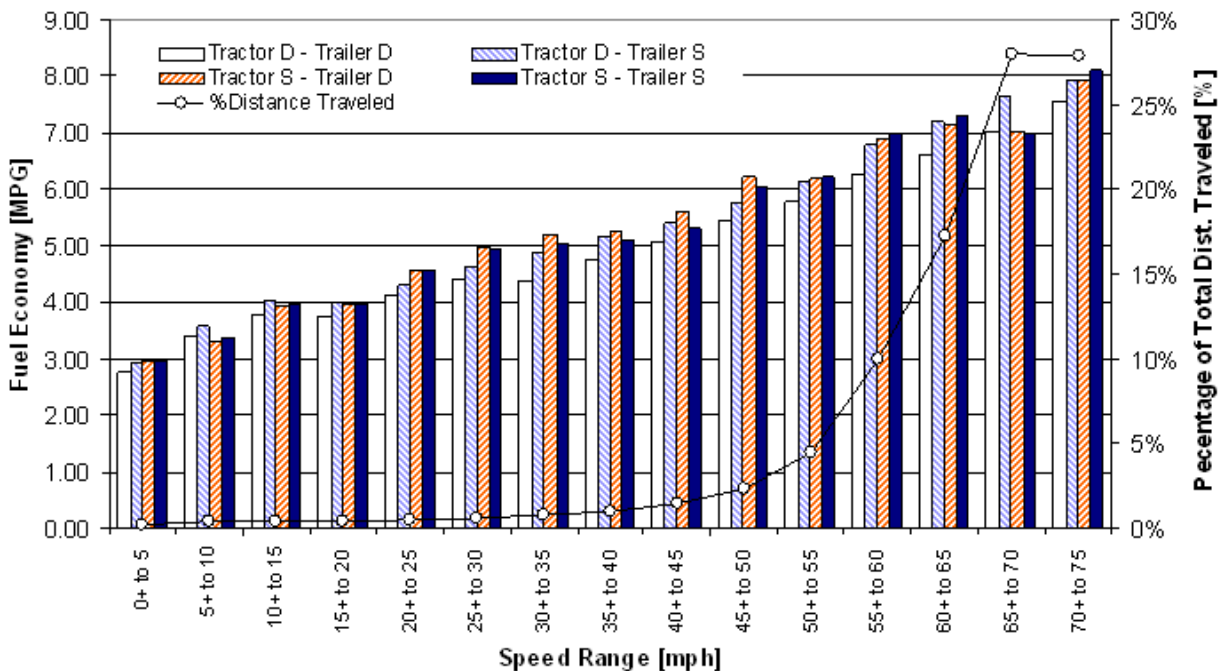
^a Total fuel consumed does not include fuel consumed while idling.



The fuel economy information presented in Table 5.11 is on the upper limits of today's large-truck fleets and is mostly a result of driver training and the extensive vehicle maintenance (including constant tire pressure) to which the fleet company participating in this project adheres. Nevertheless, the results of this extensive test indicate that there are substantial gains in terms of fuel economy for large trucks when single (wide) tires are used in combination with dual tires or alone (best case). Figure 5.3 shows the information from Table 5.11 in a graphical form (bars) and also displays for each speed bin the percentage of the total distance that is traveled at that speed (line). It is possible to observe that above 80% of the distance traveled by long-haul Class 8 trucks is done at speeds above 55 mph. Therefore, any gains in fuel economies at these speeds derived from a given tire combination would have a very large impact on the overall fuel economy of these types of trucks. Figure 5.3 shows that, except for the D-S combination within the 65+ to 70 mph, the combinations with all single (wide) tires perform better and, therefore, obtain the largest overall fuel economy.

Figure 5.3. Class 8 Truck Fuel Economy as a Function of Speed and Tractor-Trailer Tire Combination and Percentage of Total Distance Traveled as a Function of Speed

NOT ADJUSTED FOR TERRAIN: See note below.



Note: D = Dual tire. S = Single (wide) tire.

These data were not adjusted to account for the effects of terrain. The increase in fuel economy for speeds above 70 mph is likely due to the vehicle achieving high speeds while traveling down slope. Therefore, this increase in fuel economy is not expected to be characteristic of all travel at these higher speeds.

Source:

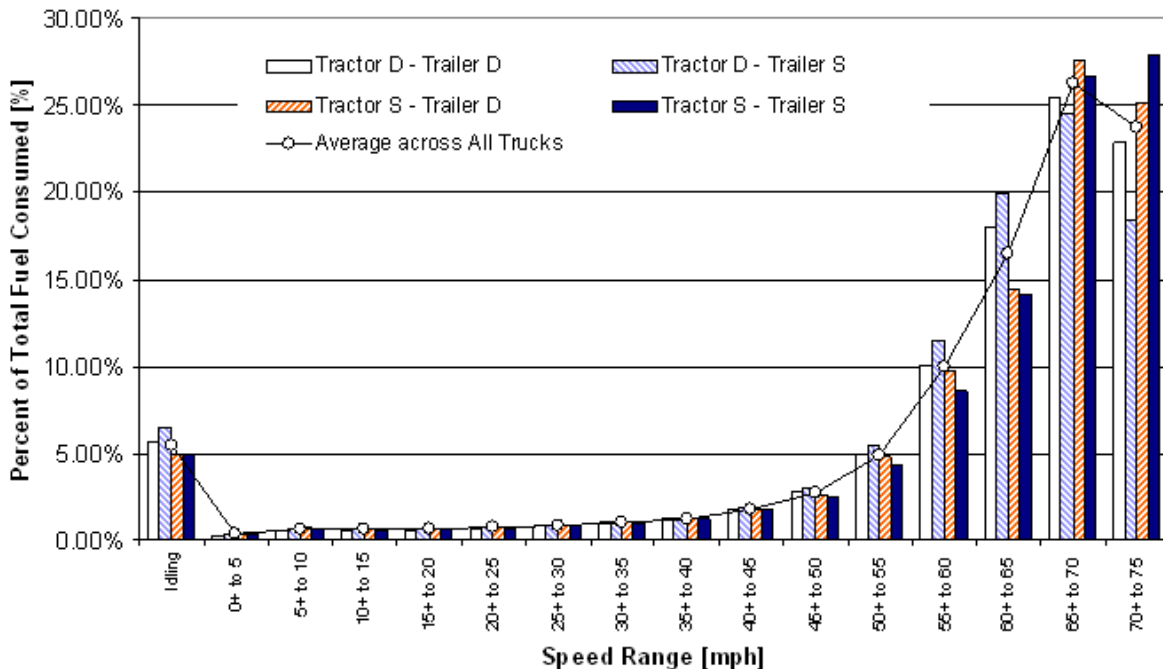
Capps, Gary, Oscar Franzese, Bill Knee, M.B. Lascrain, and Pedro Otaduy. *Class-8 Heavy Truck Duty Cycle Project Final Report*, ORNL/TM-2008/122, Oak Ridge National Laboratory, Oak Ridge, TN, December 2008. (Additional resources: cta.ornl.gov/cta/Publications/Reports/ORNLTM_2008-122.pdf)



This graph presents for each one of the four tire-combination categories the percent of total fuel that is consumed when traveling at different speeds (bars) as well as the average percent of fuel consumed for each speed bin (line). As opposed to Table 5.11, the total fuel consumed on this graph includes the fuel consumed while idling.

Figure 5.4. Class 8 Truck Percent of Total Fuel Consumed as a Function of Speed and Tractor-Trailer Tire Combination

NOT ADJUSTED FOR TERRAIN: See note below



Note: D = Dual tire. S = Single (wide) tire.

These data were not adjusted to account for the effects of terrain. The increase in fuel economy for speeds above 70 mph is likely due to the vehicle achieving high speeds while traveling down slope. Therefore, this increase in fuel economy is not expected to be characteristic of all travel at these higher speeds.

Source:

Capps, Gary, Oscar Franzese, Bill Knee, M.B. Lascurain, and Pedro Otaduy. *Class-8 Heavy Truck Duty Cycle Project Final Report*, ORNL/TM-2008/122, Oak Ridge National Laboratory, Oak Ridge, TN, December 2008. (Additional resources: cta.ornl.gov/cta/Publications/Reports/ORNL_TM_2008-122.pdf)



A typical class 8 truck tractor weighs about 17,000 lb. The powertrain is nearly a quarter of the weight (24%) while the truck body structure is 19%.

Table 5.12
Class 8 Truck Weight by Component

	Pounds	Share of total
Wheels and tires	1,700	10%
Chassis/frame	2,040	12%
Drivetrain and suspension	2,890	17%
Misc. accessories/systems	3,060	18%
Truck body structure	3,230	19%
Powertrain	4,080	24%
Total	17,000	100%

Notes:

- Powertrain includes engine and cooling system, transmission and accessories.
- Truck body structure includes cab-in-white, sleeper unit, hood and fairings, interior and glass.
- Miscellaneous accessories/systems include batteries, fuel system, and exhaust hardware.
- Drivetrain and suspension includes drive axles, steer axle, and suspension system.
- Chassis/frame includes frame rails and crossmembers, fifth wheel and brackets. Wheels and tires include a set of 10 aluminum wheels, plus tires.

Source:

National Academy of Sciences, *Technologies and Approaches to Reducing the Fuel Consumption of Medium and Heavy-Duty Vehicles*, prepublication copy, March 2010, p. 5-42.



The gross weight of a vehicle (GVW) is the weight of the empty vehicle plus the weight of the maximum payload that the vehicle was designed to carry. In cars and small light trucks, the difference between the empty weight of the vehicle and the GVW is not significantly different (1,000 to 1,500 lb). The largest trucks and tractor-trailers, however, have a payload capacity share of 200%, which means they can carry 200% of their empty weight. The medium-sized trucks (truck classes 3-6) have payload capacity shares between 50% and 100%.

Table 5.13
Gross Vehicle Weight vs. Empty Vehicle Weight

Vehicle description	Truck class	Gross vehicle weight range (pounds)	Empty vehicle weight range (pounds)	Maximum payload capacity (pounds)	Payload capacity share (percent of empty weight)
Cars		3,200-6,000	2,400-5,000	1,000	20%
Minivans, small SUVs, small pick-ups	1	4,000-2,400	3,200-4,500	1,500	33%
Large SUVs, standard pick-ups	2a	6,001-8,500	4,500-6,000	2,500	40%
Large SUVs, standard pick-ups	2b	8,501-10,000	5,000-6,300	3,700	60%
Utility van, multi- purpose, mini-bus, step van	3	10,001-14,000	7,650-8,750	5,250	60%
City delivery, parcel delivery, large walk-in, bucket, landscaping	4	14,001-16,000	7,650-8,750	7,250	80%
City delivery, parcel delivery, large walk-in, bucket	5	16,001-19,500	9,500-10,000	8,700	80%
City delivery, school bus, large walk-in, bucket	6	19,501-26,000	11,500-14,500	11,500	80%
City bus, furniture, refrigerated, refuse, fuel tanker, dump, tow, concrete, fire engine, tractor-trailer	7	26,001-33,000	11,500-14,500	18,500	125%
Refuse, concrete, furniture, city bus, tow, fire engine (straight trucks)	8a	33,001-80,000	20,000-26,000	54,000	200%
Tractor-trailer: van, refrigerated, bulk tanker, flat bed (combination trucks)	8b	33,001-80,000	20,000-26,000	54,000	200%

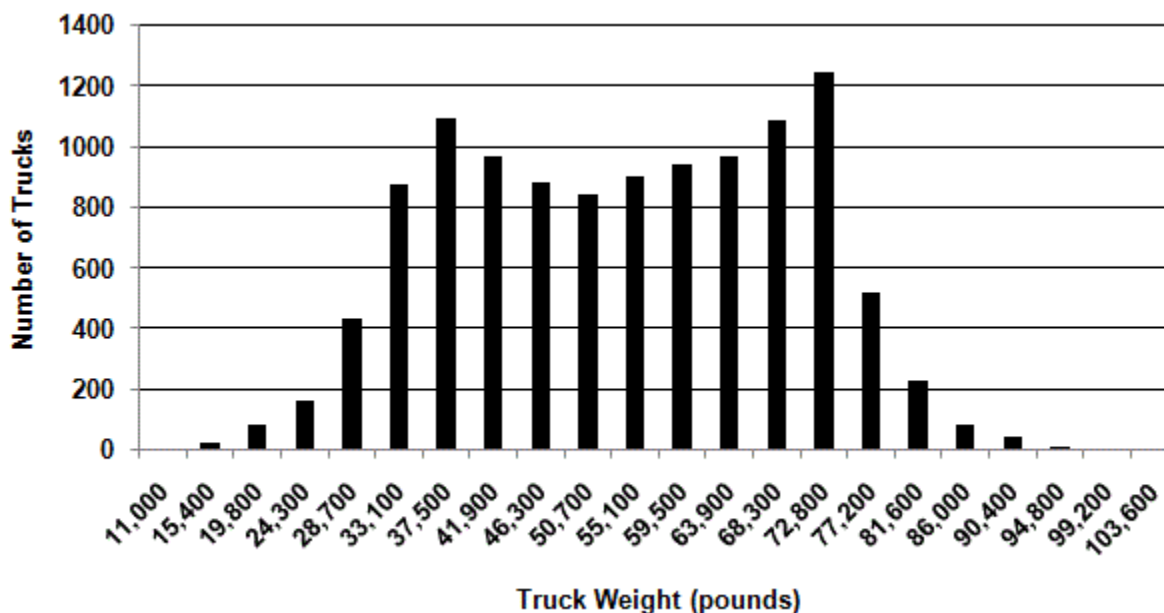
Source:

National Academy of Sciences, *Technologies and Approaches to Reducing the Fuel Consumption of Medium and Heavy-Duty Vehicles*, prepublication copy, March 2010, pp. 2-2 and 5-42.



According to weigh-in-motion data collected by fifteen states, the majority of 5-axle tractor-trailers on the road weigh between 33,000 and 73,000 lb. Eleven percent of the tractor-trailers had weight recorded around 72,800 lb and 10% around 68,300 lb. Another 10% of tractor-trailers were on the lighter end of the scale – around 37,500 lb. These data show that only a small percent of trucks on the road are near the maximum roadway gross vehicle weight of 80,000 lb. Thus, most trucks are filling the trailer space to capacity (cubing-out) before they reach the maximum weight limit (weighing-out).

Figure 5.5. Distribution of Class 8 Trucks by On-Road Vehicle Weight, 2008^a



Note: Data are from these 15 States: California, Connecticut, Florida, Georgia, Hawaii, Iowa, Minnesota, Missouri, Montana, North Carolina, Oregon, Pennsylvania, South Dakota, Texas, and Washington.

Source:

National Academy of Sciences, *Technologies and Approaches to Reducing the Fuel Consumption of Medium and Heavy-Duty Vehicles*, prepublication copy, March 2010, p. 5-45. Original source: Federal Highway Administration, Vehicle Travel Information System, 2008.

^a Study reported data on 5-axle tractor-trailers which are class 8 trucks. Single-unit class 8 trucks were not considered in the study.



Commodity Flow Survey

The Commodity Flow Survey (CFS) designed to provide data on the flow of goods and materials by mode of transport. The survey was first conducted in various years from 1963 to 1977, and was again conducted in 1993, 1997, 2002, 2007, and 2012 with improvements in methodology, sample size, and scope. Data collection for the 2017 survey began in late 2016. It is a shipper-based survey which covers business establishments from these industries:

- Mining
- Manufacturing
- Wholesale trade
- Select Retail and Services

Industries not covered by CFS include transportation, construction, most retail and services industries, farms, fisheries, foreign establishments, and most government-owned establishments. Before 1993 data were collected only on the principal mode of travel, but after that time all modes of a shipment were captured in the data.

The CFS is a joint effort of the Bureau of Transportation Statistics and the U.S. Census Bureau. Additional information on the survey can be found at: www.rita.dot.gov/bts/sites/rita.dot.gov.bts/files/publications/commodity_flow_survey/index.html or www.census.gov/econ/cfs/



Industries covered by the 2012 Commodity Flow Survey (CFS) shipped goods worth over \$13 trillion. Compared to the 1993 CFS, the value of shipments is up 1.7% per year and tons shipped are up 0.8% per year. By value, multiple mode shipments increased 2.8% per year from 1993 to 2012.

Table 5.14
Value of Goods Shipped in the United States: Comparison of the 1993, 1997, 2002, 2007 and 2012 Commodity Flow Surveys^a

	1993 (billion 2012 dollars)	1997 (billion 2012 dollars)	2002 (billion 2012 dollars)	2007 (billion 2012 dollars)	2012 (billion dollars)	Average annual percent change (1993-2012)
All modes	10,106.6	9,933.3	10,716.8	12,938.9	13,852.1	1.7%
Single modes	8,542.3	8,181.8	8,996.6	10,562.8	11,900.4	1.8%
Truck ^b	7,612.4	7,126.0	7,957.3	9,230.4	10,132.2	1.5%
For-hire truck	4,538.0	4,150.4	4,794.9	5,487.5	6,504.6	1.9%
Private truck	3,035.4	2,913.2	3,120.8	3,742.8	3,627.6	0.9%
Rail	427.7	457.2	396.8	483.3	473.1	0.5%
Water	106.6	108.5	114.0	127.2	301.6	5.6%
Inland water	70.4	77.1	73.3	100.8	218.9	6.2%
Great Lakes	^c	2.2	1.1	^c	0.4	^c
Deep sea	34.2	29.2	39.6	25.5	59.9	3.0%
Multiple waterways	^c	^d	^d	^d	22.3	^c
Air (includes truck and air)	240.4	327.7	338.1	279.4	450.6	3.4%
Pipeline ^e	155.4	162.4	190.4	442.5	542.9	6.8%
Multiple modes	1,145.4	1,353.1	1,377.3	2,067.1	1,950.8	2.8%
Parcel, U.S.P.S. or courier	973.7	1,224.4	1,260.6	1,729.5	1,688.2	2.9%
Truck and rail	143.6	108.3	89.2	207.3	224.8	2.4%
Truck and water	16.2	11.8	18.3	64.7	29.0	3.1%
Rail and water	6.4	2.5	4.2	15.4	8.0	1.2%
Other multiple modes	5.6	6.1	4.9	50.2	0.7	-10.3%
Other and unknown modes	418.8	398.5	342.8	309.1	1.0	-27.2%

Source:

U.S. Department of Transportation, Bureau of Transportation Statistics and U.S. Department of Commerce, Bureau of the Census, 1993, 1997, 2002, 2007, and 2012 Commodity Flow Surveys, Table 1a. (Additional resources: http://www.census.gov/econ/cfs/historical_data.html)

^a Detail may not add to total because of rounding.

^b "Truck" as a single mode includes shipments which went by private truck only, for-hire truck only, or a combination of private truck and for-hire truck.

^c Denotes data do not meet publication standards because of high sampling variability or poor response quality.

^d Data are not available.

^e CFS data for pipeline exclude most shipments of crude oil.



Industries covered by the 2012 Commodity Flow Survey (CFS) shipped over 11 billion tons of goods nationwide. Nearly three-quarters of the freight tonnage was shipped by truck.

Table 5.15
Tons of Freight in the United States: Comparison of the 1993, 1997, 2002, 2007 and 2012 Commodity Flow Surveys^a

	1993 (millions)	1997 (millions)	2002 (millions)	2007 (millions)	2012 (millions)	Average annual percent change (1993-2012)
All modes	9,688.50	11,089.7	11,667.9	12,543.4	11,299.4	0.8%
Single modes	8,922.30	10,436.5	11,086.7	11,698.1	10,905.5	1.1%
Truck ^b	6,385.9	7,700.7	7,842.8	8,778.7	8,060.2	1.2%
For-hire truck	2,808.3	3,402.6	3,657.3	4,075.1	4,298.7	2.3%
Private truck	3,543.5	4,137.3	4,149.7	4,703.6	3,761.3	0.3%
Rail	1,544.10	1,549.8	1,873.9	1,861.3	1,628.5	0.3%
Water	505.4	563.4	681.2	403.6	576.0	0.7%
Inland water	362.5	414.8	458.6	343.3	424.5	0.8%
Great Lakes	33	38.4	38.0	17.8	31.4	-0.3%
Deep sea	109.9	110.2	184.6	42.5	73.0	-2.1%
Multiple waterways	^c	^c	^c	^c	47.1	^c
Air (includes truck and air)	3.1	4.5	3.8	3.6	4.8	2.3%
Pipeline ^d	483.6	618.2	685.0	650.9	636.0	1.5%
Multiple modes	225.7	216.7	216.7	573.7	357.0	2.4%
Parcel, U.S.P.S. or courier	18.9	23.7	25.5	33.9	28.5	2.2%
Truck and rail	40.6	54.2	43.0	225.6	213.8	9.1%
Truck and water	68	33.2	23.3	145.5	56.7	-1.0%
Rail and water	79.2	79.3	105.1	54.9	55.6	-1.8%
Other multiple modes	18.9	26.2	19.8	113.8	2.5	-10.1%
Other and unknown modes	540.5	436.5	364.6	271.6	36.8	-13.2%

Source:

U.S. Department of Transportation, Bureau of Transportation Statistics and U.S. Department of Commerce, Bureau of the Census, *1993, 1997, 2002, 2007, and 2012 Commodity Flow Survey*, Table 1a. (Additional resources: http://www.census.gov/econ/cfs/historical_data.html)

^a Detail may not add to total because of rounding.

^b "Truck" as a single mode includes shipments which went by private truck only, for-hire truck only, or a combination of private truck and for-hire truck.

^c Data are not available.

^d CFS data for pipeline exclude most shipments of crude oil.



Industries covered by the 2012 Commodity Flow Survey (CFS) accounted for 2.9 trillion ton-miles on the nation's highways, railways, waterways, pipelines, and aviation system. Ton-miles increased an average of 1.1% per year from 1993 to 2012.

Table 5.16
Growth of Ton-Miles in the United States: Comparison of the 1993, 1997, 2002, 2007 and 2012 Commodity Flow Surveys^a

	1993 (billions)	1997 (billions)	2002 (billions)	2007 (billions)	2012 (billions)	Average annual percent change (1993-2012)
All modes	2,420.90	2,661.4	3,137.9	3,344.7	2,969.5	1.1%
Single modes	2,136.90	2,383.5	2,867.9	2,894.3	2,697.4	1.2%
Truck ^b	869.5	1,023.5	1,255.9	1,342.1	1,247.7	1.9%
For-hire truck	629	741.1	959.6	1,055.6	1,050.9	2.7%
Private truck	235.9	268.6	291.1	286.5	196.8	-0.9%
Rail	942.6	1,022.5	1,261.6	1,344.0	1,211.5	1.3%
Water	272	261.7	282.7	157.3	192.9	-1.8%
Inland water	164.4	189.3	211.5	117.5	118.7	-1.7%
Great Lakes	12.4	13.4	13.8	6.9	11.0	-0.6%
Deep sea	95.2	59.0	57.4	33.0	22.1	-7.4%
Multiple waterways	^c	^c	^c	^c	41.0	^c
Air (includes truck and air)	4	6.2	5.8	4.5	5.8	2.0%
Pipeline ^d	^c	^e	^e	^e	^e	^c
Multiple modes	191.5	204.5	225.7	416.6	271.8	1.9%
Parcel, U.S.P.S. or courier	13.2	18.0	19.0	28.0	22.7	2.9%
Truck and rail	37.7	55.6	45.5	196.8	169.5	8.2%
Truck and water	40.6	34.8	32.4	98.4	48.6	1.0%
Rail and water	70.2	77.6	115.0	47.1	29.2	-4.5%
Other multiple modes	^c	18.6	13.8	46.4	1.9	^c
Other and unknown modes	92.6	73.4	44.2	33.8	0.3	-26.0%

Source:

U.S. Department of Transportation, Bureau of Transportation Statistics and U.S. Department of Commerce, Bureau of the Census, *1993, 1997, 2002, 2007 and 2012 Commodity Flow Surveys*, Table 1a. (Additional resources: http://www.census.gov/econ/cfs/historical_data.html)

^a Detail may not add to total because of rounding.

^b "Truck" as a single mode includes shipments which went by private truck only, for-hire truck only, or a combination of private truck and for-hire truck.

^c Data are not available.

^d CFS data for pipeline exclude most shipments of crude oil.

^e Denotes data do not meet publication standards because of high sampling variability or poor response quality.



Industries covered by the 2012 Commodity Flow Survey (CFS) had an average shipment length of 630 miles, a 49% increase from the 1993 survey. For single mode shipments, air had the highest shipment length in 2012; for multiple modes, truck and water had the highest length.

Table 5.17
Average Miles per Shipment in the United States: Comparison of the 1993, 1997, 2002, 2007 and 2012 Commodity Flow Surveys^a

	1993 (miles)	1997 (miles)	2002 (miles)	2007 (miles)	2012 (miles)	Average annual percent change (1997-2012)
All modes	424	472	546	619	630	2.1%
Single modes	197	184	240	234	262	1.5%
Truck ^b	144	144	173	206	227	2.4%
For-hire truck	472	485	523	599	508	0.4%
Private truck	52	53	64	57	58	0.6%
Rail	766	769	807	728	805	0.3%
Water	^c	482	568	520	908	^c
Inland water	^c	177	450	144	275	^c
Great Lakes	534	204	339	657	347	-2.2%
Deep sea	1,861	1,024	664	923	1,157	-2.5%
Multiple waterways	^c	^c	^c	^c	1,034	^c
Air (includes truck and air)	1,415	1,380	1,919	1,304	1,295	-0.5%
Pipeline ^d	^c	^e	^e	^e	^e	^c
Multiple modes	736	813	895	975	922	1.2%
Parcel, U.S.P.S. or courier	734	813	894	975	922	1.2%
Truck and rail	1,403	1,347	1,413	1,007	988	-1.8%
Truck and water	1,417	1,265	1,950	1,429	1,562	0.5%
Rail and water	627	1,092	957	1,928	1,073	2.9%
Other multiple modes	1,082	^e	^e	1,182	^e	^c
Other and unknown modes	229	122	130	116	2	-22.1%

Source:

U.S. Department of Transportation, Bureau of Transportation Statistics and U.S. Department of Commerce, Bureau of the Census, *1993, 1997, 2002, 2007 and 2012 Commodity Flow Surveys*, Table 1a. (Additional resources: http://www.census.gov/econ/cfs/historical_data.html)

^a Detail may not add to total because of rounding.

^b "Truck" as a single mode includes shipments which went by private truck only, for-hire truck only, or a combination of private truck and for-hire truck.

^c Data are not available.

^d CFS data for pipeline exclude most shipments of crude oil.

^e Denotes data do not meet publication standards because of high sampling variability or poor response quality.





Chapter 6

Alternative Fuel and Advanced Technology Vehicles and Characteristics

Summary Statistics from Tables in this Chapter

Source		
Table 6.1	Alternative fuel vehicles made available, 2015	2,011,061
	<i>E85</i>	1,881,500
	<i>LPG</i>	2,248
	<i>CNG</i>	8,744
	<i>Electric</i>	118,560
	<i>LNG</i>	7
	<i>Hydrogen</i>	2
Table 6.11	Number of alternative fuel refuel sites, 2017	59,926
	<i>Electric outlets</i>	50,481
	<i>LPG</i>	3,541
	<i>CNG</i>	1,697
	<i>Biodiesel</i>	710
	<i>Hydrogen</i>	63

Fuel type abbreviations are used throughout this chapter.

B20 = 20% biodiesel, 80% petroleum diesel

CNG = compressed natural gas

E85 = 85% ethanol, 15% gasoline

E95 = 95% ethanol, 5% gasoline

H₂ = hydrogen

LNG = liquefied natural gas

LPG = liquefied petroleum gas



Alternative Fuels

The Energy Policy Act of 1992 defines alternative fuels and allows the U.S. Department of Energy (DOE) to add to the list of alternative fuels if the fuel is substantially nonpetroleum, yields substantial energy security benefits, and offers substantial environmental benefits. DOE currently recognizes the following as alternative fuels:

- methanol, ethanol, and other alcohols,
- blends of 85% or more of alcohol with gasoline,
- natural gas and liquid fuels domestically produced from natural gas,
- liquefied petroleum gas (propane),
- coal-derived liquid fuels,
- hydrogen,
- electricity,
- biodiesel (B100),
- fuels (other than alcohol) derived from biological materials,
- P-series.

Alternative Fuels Data Center

DOE established the Alternative Fuels Data Center (AFDC) in 1991 to support its work aimed at fulfilling the Alternative Motor Fuels Act directives. Since then, the AFDC has expanded its focus to include all advanced transportation fuels, vehicles, and technologies. 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.

Much of the AFDC data can be obtained through their website: **www.afdc.energy.gov**. Several tables and graphs in this chapter contain statistics which were generated by the AFDC. Below are some links to specific areas of the AFDC website.

Alternative & Advanced Fuels – www.afdc.energy.gov

Alternative Fueling Station Locator – www.afdc.energy.gov/afdc/locator/stations

Alternative & Advanced Vehicles – www.afdc.energy.gov/fuels

State & Federal Incentives & Laws – www.afdc.energy.gov/afdc/laws

Data Analysis & Trends – www.afdc.energy.gov/data

Tools – www.afdc.energy.gov/tools



The Energy Information Administration (EIA) is no longer publishing estimates of the number of alternative vehicles in use in the United States. EIA does publish the number of alternative fuel vehicles “made available” each year, beginning in 2004. The alternative fuel vehicles “made available” are estimates from vehicle manufacturer production and companies performing vehicle conversions. The data are more of a proxy for alternative fuel vehicle sales than for vehicle population, but EIA cautions that the data are not actual sales data.

Table 6.1
Estimates of Alternative Fuel Highway Vehicles Made Available, 2004-2015

Year	CNG	Electricity	E85	Hydrogen	LNG	LPG
2004	7,752	2,200	674,678	31	136	2,150
2005	3,304	2,281	743,948	74	68	700
2006	3,128	2,715	1,011,399	40	92	473
2007	2,487	3,152	1,115,069	63	26	356
2008	4,440	2,802	1,175,345	63	384	695
2009	3,770	2,255	805,777	26	126	861
2010	4,973	2,229	1,484,945	64	231	747
2011	5,674	25,382	2,116,273	107	137	1,054
2012	7,672	46,624	2,446,966	56	101	1,134
2013	9,454	130,323	2,665,470	10	344	2,700
2014	6,662	92,594	2,433,113	3	535	1,708
2015	8,744	118,560	1,881,500	2	7	2,248

Note: “Made available” refers to the supply of warranted alternative fuel vehicles by manufacturers and aftermarket conversion companies. These do not represent sales.

Source:

U. S. Department of Energy, Energy Information Administration website, “Alternative Fuel Vehicle Data,” www.eia.gov/renewable/afv, August 2017. (Additional resources: www.eia.gov)



The hybrid share of all light vehicles fell to 2.0% of all light vehicle sales in 2016. Plug-in vehicles certified for highway use began selling in 2010 and were 0.9% of the light vehicle market in 2016.

Table 6.2
Hybrid and Plug-In Vehicle Sales, 1999-2016

Calendar year	Hybrid vehicle sales (thousands)	Plug-in vehicle sales ^a (thousands)	All light vehicle sales (thousands)	Hybrid share of all light vehicles	Plug-in share of all light vehicles
1999	0.0	0.0	16,711	0.0%	0.0%
2000	9.4	0.0	17,164	0.1%	0.0%
2001	20.3	0.0	16,950	0.1%	0.0%
2002	36.0	0.0	16,675	0.2%	0.0%
2003	47.6	0.0	16,494	0.3%	0.0%
2004	84.2	0.0	16,737	0.5%	0.0%
2005	205.9	0.0	16,774	1.2%	0.0%
2006	251.9	0.0	16,336	1.5%	0.0%
2007	351.1	0.0	15,867	2.2%	0.0%
2008	315.8	0.0	13,015	2.4%	0.0%
2009	290.3	0.0	10,236	2.8%	0.0%
2010	274.6	0.3	11,394	2.4%	0.0%
2011	266.5	17.8	12,542	2.1%	0.1%
2012	434.6	53.2	14,220	3.1%	0.4%
2013	495.5	97.1	15,279	3.2%	0.6%
2014	452.2	118.9	16,192	2.8%	0.7%
2015	384.4	115.3	17,095	2.2%	0.7%
2016	346.9	159.6	17,169	2.0%	0.9%

Note: Plug-in vehicle sales include only those vehicles certified for highway use. Small electric carts and neighborhood electric vehicles are excluded.

Sources:

Hybrid and Electric Vehicle Sales – Compiled by the Transportation Research Center at Argonne National Laboratory, 2017. (Additional resources: www.anl.gov/energy-systems/project/light-duty-electric-drive-vehicles-monthly-sales-updates)

All Light Vehicle Sales – Table 3.11.

^a Includes plug-in hybrid-electric vehicles and all-electric vehicles.



Trolleybus, heavy rail, and light rail use nearly all alternative fuels. However, the 41.4% of buses using alternative fuels replace a lot of traditional fuel use. Heavy rail units have the highest average age.

Table 6.3
Alternative Fuel Transit Vehicles, 2016

Mode	Average age	Percent powered by alternative fuels	Number of vehicles
Bus ^a	7.3	41.4%	63,573
Commuter rail locomotive ^b	21.7	9.2%	6,278
Commuter rail self-propelled car	20.7	90.6%	^c
Ferry Boat	23.6	^c	119
Heavy Rail ^d	26.2	100.0%	10,737
Light Rail ^e	18.4	100.0%	2,083
Demand Response	5.8	2.3%	^c
Trolleybus	10.3	100.0%	611
Vanpool	3.7	7.5%	13,129

Note: See Glossary for definition of modes, such as paratransit and vanpool. The number of vehicles is a 2015 number.

Source:

U.S. Department of Transportation, Federal Transit Administration, National Transit Database. (Additional resources: www.transit.dot.gov/ntd)

^a Includes bus rapid transit and commuter bus vehicles.

^b Electric car or diesel-propelled railway for urban passenger train service between a central city and adjacent suburbs.

^c Data are not available.

^d An electric railway with the capacity for a heavy volume of traffic.

^e Typically an electric railway with a light volume traffic capacity with power drawn from an overhead electric line.



Table 6.4
E85 Flex-Fuel Vehicles Available by Manufacturer, Model Year 2017

Model	Type	Emission class
Audi A5 Cabriolet quattro	Sedan/Wagon	LEV II ULEV, Tier 3 Bin 125
Audi A5 quattro	Sedan/Wagon	LEV II ULEV
Audi Q5 AWD	SUV	LEV II ULEV, Tier 2 Bin 5
Chevrolet Equinox AWD	SUV	TBD
Chevrolet Equinox FWD	SUV	TBD
Chevrolet Impala	Sedan/Wagon	TBD
Chevrolet Silverado C15 2WD 4.3L	Truck	TBD
Chevrolet Silverado C15 2WD 5.3L	Truck	TBD
Chevrolet Silverado K15 4WD 4.3L	Truck	TBD
Chevrolet Silverado K15 4WD 5.3L	Truck	TBD
Chevrolet Suburban C1500 2WD	SUV	TBD
Chevrolet Suburban K1500 4WD	SUV	TBD
Chevrolet Tahoe C1500 2WD	SUV	TBD
Chevrolet Tahoe K1500 4WD	SUV	TBD
Chrysler 200 3.6L	Sedan/Wagon	TBD
Chrysler 200 2.4L	Sedan/Wagon	TBD
Chrysler 200 AWD	Sedan/Wagon	TBD
Dodge Grand Caravan	Van	TBD
Dodge Journey	SUV	TBD
Ford Escape FWD FFV	SUV	TBD
Ford Explorer 2WD FFV	SUV	TBD
Ford Explorer AWD FFV	SUV	TBD
Ford Transit Connect Van FFV	Van	TBD
Ford Transit Connect Wagon FFV	Sedan/Wagon	TBD
Ford Transit Connect Wagon LWB FFV	Sedan/Wagon	TBD
Ford Transit T150 Wagon FFV	Van	TBD
GMC Sierra C15 2WD	Truck	TBD
GMC Sierra C15 2WD	Truck	TBD
GMC Sierra K15 4WD	Truck	TBD
GMC Sierra K15 4WD	Truck	TBD
GMC Terrain FWD	SUV	TBD
GMC Yukon C1500 2WD	SUV	TBD
GMC Yukon C1500 XL 2WD	SUV	TBD
GMC Yukon K1500 4WD	SUV	TBD
GMC Yukon K1500 XL 4WD	SUV	TBD
Jeep Cherokee 4WD	SUV	TBD
Jeep Cherokee FWD	SUV	TBD
Jeep Renegade 2WD	SUV	TBD
Mercedes-Benz CLA250 4matic	Sedan/Wagon	TBD
Mercedes-Benz GLA250 4matic	SUV	TBD
Mercedes-Benz GLE350 4matic	SUV	TBD
Ram 1500 2WD	Truck	TBD
Ram 1500 4WD	Truck	TBD
Toyota Tundra 2WD FFV	Truck	TBD
Toyota Tundra 4WD FFV	Truck	TBD

Note: LEV = low emission vehicle. ILEV = inherently low emission vehicle. ULEV = ultra low emission vehicle. ZEV = zero emission vehicle. TLEV = transitional low emission vehicle. SULEV = super ultra low emission vehicle. See Chapter 12 for details on emissions. TBD = to be determined.

Source:

U.S. Department of Energy, Alternative Fuels Data Center website, “Alternative Fuel and Advanced Vehicle Search,” www.afdc.energy.gov/vehicles/search, August 2017. (Additional resources: www.afdc.energy.gov)



Table 6.5
B20, CNG, and LPG Vehicles Available by Manufacturer, Model Year 2017

Model	Fuel	Vehicle Type	Emission Class
Chevrolet Colorado 2WD	B20	Truck	Tier 3 Bin 125, LEV III ULEV125
Chevrolet Colorado 4WD	B20	Truck	Tier 3 Bin 125, LEV III ULEV125
Chevrolet Express 2500	B20	Van	TBD
Chevrolet Silverado 2500 HD 2WD/4WD	B20	Truck	TBD
Ford Super Duty F-250	B20	Truck	TBD
Ford Transit T150 Wagon	B20	Van	TBD
GMC Canyon 2WD	B20	Truck	Tier 3 Bin 125, LEV III ULEV125
GMC Canyon 4WD	B20	Truck	Tier 3 Bin 125, LEV III ULEV125
GMC Savanna 2500	B20	Van	TBD
GMC Sierra 2500 Denali HD 2WD/4WD	B20	Truck	TBD
GMC Sierra 2500 HD 2WD/4WD	B20	Truck	TBD
Jaguar F-Pace	B20	SUV	Tier 3 Bin 160, LEV III LEV160
Jaguar XE	B20	Sedan/Wagon	Tier 3 Bin 160, LEV III LEV160
Jaguar XE AWD	B20	Sedan/Wagon	Tier 3 Bin 160, LEV III LEV160
Jaguar XF AWD	B20	Sedan/Wagon	Tier 3 Bin 160, LEV III LEV160
Jeep Grand Cherokee 2WD/4WD	B20	SUV	TBD
Land Rover Range Rover Sport	B20	SUV	TBD
Nissan Titan HD 2WD/4WD	B20	Truck	TBD
Ram 1500 HD	B20	Truck	TBD
Ram 2500 HD	B20	Truck	TBD
Ram Promaster 1500/2500	B20	Van	TBD
Chevrolet Express 2500	CNG	Van	TBD
Chevrolet Silverado 2500 HD 2WD/4WD	CNG	Truck	TBD
Ford F-150	CNG	Truck	TBD
Ford Transit 150/250	CNG	Van	TBD
Ford Transit Connect	CNG	Van	TBD
GMC Savanna 2500	CNG	Van	TBD
GMC Sierra 2500 HD 2WD/4WD	CNG	Truck	TBD
Ram 2500 HD	CNG	Truck	TBD
Chevrolet Express 2500	LPG	Van	TBD
Chevrolet Silverado 2500 HD 2WD/4WD	LPG	Truck	TBD
Ford F-150	LPG	Truck	TBD
Ford Super Duty F-250	LPG	Truck	TBD
Ford Transit 150/250	LPG	Van	TBD
Ford Transit Connect	LPG	Van	TBD
GMC Savanna 2500	LPG	Van	TBD
GMC Sierra 2500 HD 2WD/4WD	LPG	Truck	TBD
Ram 2500 HD	LPG	Truck	TBD

Note: LEV = low emission vehicle. ILEV = inherently low emission vehicle. ULEV = ultra low emission vehicle. ZEV = zero emission vehicle. TLEV = transitional low emission vehicle. SULEV = super ultra low emission vehicle. See Chapter 12 for details on emissions. TBD = to be determined.

Source:

U.S. Department of Energy, Alternative Fuels Data Center website, “Alternative Fuel and Advanced Vehicle Search,” www.afdc.energy.gov/vehicles/search, August 2017. (Additional resources: www.afdc.energy.gov)



Table 6.6
Hybrid-Electric Vehicles Available by Manufacturer, Model Year 2017

Model	Vehicle Type	Emission Class
Acura MDX Hybrid	SUV	TBD
Acura NSX Hybrid	Two-Seater	LEV III ULEV125, Tier 3 Bin 125
Acura RLX Hybrid	Sedan/Wagon	Tier 3 Bin 30, LEV-III SULEV30
BMW I8	Two-Seater	Tier 3 Bin 125, LEV-II ULEV
Chevrolet Malibu Hybrid	Sedan/Wagon	Tier 3 Transitional Bin 110
Chevrolet Silverado 15 Hybrid 2WD	Truck	LEV III ULEV125, Bin 5
Chevrolet Silverado 15 Hybrid 4WD	Truck	Bin 5, LEV III ULEV125
Ferrari LaFerrari Aperta	Two-Seater	Tier 3 Bin 125
Ford C-MAX Hybrid	Sedan/Wagon	TBD
Ford Fusion Hybrid FWD	Sedan/Wagon	LEV-III SULEV30, Tier 3 Bin 30
GMC Sierra 15 Hybrid 2WD	Truck	LEV III ULEV125, Bin 5
GMC Sierra 15 Hybrid 4WD	Truck	LEV III ULEV125, Bin 5
Honda Accord Hybrid	Sedan/Wagon	LEV-III SULEV30/PZEV, Tier 3
Hyundai Ioniq	Sedan/Wagon	TBD
Hyundai Ioniq Blue	Sedan/Wagon	TBD
Hyundai Sonata Hybrid	Sedan/Wagon	LEV III ULEV125, Tier 3 Bin 125
Hyundai Sonata Hybrid SE	Sedan/Wagon	Tier 3 Bin 125, LEV III ULEV125
Infiniti Q50 Hybrid	Sedan/Wagon	Tier 3 Bin 125, LEV II ULEV
Infiniti Q50 Hybrid AWD	Sedan/Wagon	Tier 3 Bin 125, LEV II ULEV
Infiniti Q60 Hybrid AWD	SUV	LEV II ULEV, Tier 3 Bin 125
Infiniti Q60 Hybrid FWD	SUV	Tier 3 Bin 125, LEV II ULEV
Infiniti Q70 Hybrid	Sedan/Wagon	Tier 3 Bin 125, LEV II ULEV
Kia Niro	Sedan/Wagon	TBD
Kia Niro FE	Sedan/Wagon	TBD
Kia Niro Touring	Sedan/Wagon	TBD
Kia Optima Hybrid	Sedan/Wagon	LEV III ULEV125, Tier 3 Bin 125
Lexus CT 200h	Sedan/Wagon	Tier 3 Bin 30, LEV-III SULEV30
Lexus ES 300h	Sedan/Wagon	TBD
Lexus GS 450h	Sedan/Wagon	TBD
Lexus NX 300h	SUV	Tier 3 Bin 30, LEV-III SULEV30
Lexus RX 450h	SUV	TBD
Lincoln MKZ Hybrid FWD	Sedan/Wagon	TBD
Nissan Rogue AWD Hybrid	SUV	TBD
Nissan Rogue FWD Hybrid	SUV	TBD
Nissan Rogue SV FWD Hybrid	SUV	TBD
Toyota Avalon Hybrid	Sedan/Wagon	Tier 3 Bin 30, LEV-III
Toyota Camry Hybrid LE	Sedan/Wagon	TBD
Toyota Camry Hybrid XLE/SE	Sedan/Wagon	TBD
Toyota Highlander Hybrid 4WD	SUV	TBD
Toyota Highlander Hybrid 4WD LE Plus	SUV	TBD
Toyota Prius	Sedan/Wagon	TBD
Toyota Prius c	Sedan/Wagon	TBD
Toyota Prius Eco	Sedan/Wagon	TBD
Toyota Prius v	Sedan/Wagon	TBD
Toyota RAV4 Hybrid AWD	SUV	TBD

Note: LEV = low emission vehicle. ILEV = inherently low emission vehicle. ULEV = ultra-low emission vehicle. ZEV = zero emission vehicle. TLEV = transitional low emission vehicle. Does not include plug-in hybrid electric vehicles. See Chapter 12 for details on emissions.

Source:

U.S. Department of Energy, Alternative Fuels Data Center website, “Alternative Fuel and Advanced Vehicle Search,” www.afdc.energy.gov/vehicles/search, August 2017. (Additional resources: www.afdc.energy.gov)



Table 6.7
Electric-Drive Vehicles Available by Manufacturer, Model Year 2017

Model	Drive Type	Vehicle Type	Emission Class
BMW i3 BEV	EV	Sedan/Wagon	TBD
BMW i3 BEV	EV	Sedan/Wagon	TBD
BYD Motors e6	EV	Sedan/Wagon	TBD
Chevrolet Bolt	EV	Sedan/Wagon	ZEV, Tier III Bin 0
Fiat 500e	EV	Sedan/Wagon	ZEV, Tier III Bin 0
Ford Focus Electric	EV	Sedan/Wagon	TBD
Honda Clarity	EV	Sedan/Wagon	TBD
Hyundai Ioniq	EV	Sedan/Wagon	TBD
Kia Soul	EV	Sedan/Wagon	ZEV, Tier III Bin 0
Mercedes-Benz B250e	EV	Sedan/Wagon	ZEV, Tier III Bin 0
Mitsubishi i-MiEV	EV	Sedan/Wagon	ZEV, Tier III Bin 0
Nissan Leaf	EV	Sedan/Wagon	ZEV, Tier III Bin 0
Smart ForTwo	EV	Two-Seater	TBD
Tesla Model S AWD - 60D	EV	Sedan/Wagon	TBD
Tesla Model S AWD - 75D	EV	Sedan/Wagon	TBD
Tesla Model S AWD - P100D	EV	Sedan/Wagon	TBD
Tesla Model S AWD - P90D	EV	Sedan/Wagon	TBD
Tesla Model S RWD 60 kWh	EV	Sedan/Wagon	TBD
Tesla Model S RWD 75 kWh	EV	Sedan/Wagon	TBD
Tesla Model X AWD - 60D	EV	SUV	TBD
Tesla Model X AWD - 75D	EV	SUV	TBD
Tesla Model X AWD - 90D	EV	SUV	TBD
Tesla Model X AWD - P100D	EV	SUV	TBD
Tesla Model X AWD - P90D	EV	SUV	TBD
Volkswagen e-Golf	EV	Sedan/Wagon	TBD
Audi A3 e-tron	PHEV	Sedan/Wagon	LEV-III SULEV30/PZEV, Tier 3
BMW 330e	PHEV	Sedan/Wagon	Tier 3 Bin 125, LEV III ULEV125
BMW 740e xDrive	PHEV	Sedan/Wagon	Tier 3 Bin 125, LEV III ULEV125
BMW i3 REX	PHEV	Sedan/Wagon	TBD
BMW X5 xDrive40e	PHEV	SUV	LEV-II ULEV, Tier 2 Bin 5
Cadillac CT6 PHEV	PHEV	Sedan/Wagon	TBD
Chevrolet Volt	PHEV	Sedan/Wagon	Tier 3 Bin 125, LEV-III SULEV30
Chrysler Pacifica PHEV	PHEV	Sedan/Wagon	TBD
Ford C-Max Energi	PHEV	Sedan/Wagon	TBD
Ford Fusion Energi Plug in Hybrid	PHEV	Sedan/Wagon	Tier 3 Bin 30, LEV-III SULEV30
Hyundai Ioniq	PHEV	Sedan/Wagon	TBD
Hyundai Sonata Plug-in Hybrid	PHEV	Sedan/Wagon	LEV-III SULEV30/PZEV, Tier 3
Kia Optima Plug-In Hybrid	PHEV	Sedan/Wagon	Tier 3 Bin 125, LEV III ULEV125
Mercedes-Benz C350e	PHEV	Sedan/Wagon	TBD
Mercedes-Benz GLE550e	PHEV	SUV	TBD
Mercedes-Benz S550e	PHEV	Sedan/Wagon	TBD
Porsche 918 Spyder	PHEV	Two-Seater	TBD
Porsche Cayenne S e-Hybrid	PHEV	SUV	LEV-II ULEV, Bin 5
Porsche Panamera 4 e-Hybrid	PHEV	Sedan/Wagon	TBD
Toyota Prius Prime	PHEV	Sedan/Wagon	TBD
Volvo XC90 T8 Plug-in Hybrid	PHEV	SUV	LEV-III SULEV30/PZEV, Tier 3 Bin 30
Honda Clarity Fuel Cell	FCEV	Sedan/Wagon	TBD
Hyundai Tucson	FCEV	SUV	Tier III Bin 0, ZEV
Toyota Mirai	FCEV	Sedan/Wagon	ZEV, Tier III Bin 0

Note: EV = electric vehicle; PHEV = plug-in hybrid-electric vehicle; FCEV = hydrogen fuel cell vehicle; LEV = low emission vehicle; ILEV = inherently low emission vehicle; ULEV = ultra-low emission vehicle; ZEV = zero emission vehicle; TLEV = transitional low emission vehicle; SULEV = super ultra-low emission vehicle; AT-PZEV = advanced technology - partial zero emissions vehicle. See Chapter 12 for details on emissions.

Source:

U.S. Department of Energy, Alternative Fuels Data Center website, “Alternative Fuel and Advanced Vehicle Search,” www.afdc.energy.gov/vehicles/search, August 2017. (Additional resources: www.afdc.energy.gov)



In 1991 there were only two alternative fuel vehicle (AFV) models on the market which were fueled by M85. In 2017 there were 111 different models of AFV on the market, with 41% of those fueled by E85. Another 41% of the models available in 2017 are electric vehicles, which include plug-in hybrid-electric vehicles.

Table 6.8.
Number of Alternative Fuel Vehicle Models Available, 1991–2017
(number of models available)

Year	Propane ^a	CNG ^a	Ethanol (E85)	Methanol (M85)	Electric vehicle ^b	Hydrogen	Total
1991	0	0	0	2	0	0	2
1992	0	2	1	2	0	0	5
1993	0	2	1	4	0	0	7
1994	0	2	1	2	0	0	5
1995	0	10	0	2	1	0	13
1996	0	10	1	1	0	0	12
1997	3	9	1	1	3	0	17
1998	3	12	2	0	8	0	25
1999	5	16	6	0	16	0	43
2000	2	15	8	0	12	0	37
2001	5	16	11	0	10	0	42
2002	5	18	16	0	6	0	45
2003	1	16	22	0	5	0	44
2004	1	16	19	0	1	0	37
2005	0	5	24	0	0	0	29
2006	0	5	22	0	0	0	27
2007	0	1	31	0	0	0	32
2008	1	1	31	0	1	0	34
2009	1	1	36	0	1	0	39
2010	0	1	34	0	1	0	36
2011	0	1	72	0	2	0	75
2012	1	6	62	0	6	1	76
2013	6	11	84	0	15	1	117
2014	14	19	90	0	16	2	141
2015	10	17	84	0	27	3	141
2016	5	12	66	0	29	3	115
2017	9	8	45	0	46	3	111
<i>Average annual percentage change</i>							
1991–2017	c	c	c	-100.0%	c	c	16.7%
2007–2017	c	23.1%	3.8%	c	c	c	13.2%

Source:

U.S. Department of Energy, Alternative Fuels Data Center website, “Light-Duty AFC, HEV, and Diesel Model Offerings, By Fuel Type,” www.afdc.energy.gov/data/10303, September 2016 and estimates for 2017. (Additional resources: www.afdc.energy.gov)

^a Dedicated and bi-fuel vehicles.

^b Electric vehicles include plug-in hybrid-electric vehicles but do not include neighborhood electric vehicles, low-speed electric vehicles, or two-wheeled electric vehicles.

^c Average annual percentage change cannot be calculated from zero.



Table 6.9
Hybrid-Electric Medium/Heavy Trucks and Buses Available by Manufacturer, 2017

Manufacturer - Model	Drive type	Truck type
Daimler Buses North America Orion VII Hybrid Low-Floor	Hybrid Electric	Transit Bus
DesignLine Corp. EcoSaver IV	Hybrid Electric	Transit Bus
Foton America FCB 30-foot; FCB 35-foot; FCB 40-foot	Hybrid Electric	Transit Bus
Glaval Bus Universal	Hybrid Electric	Shuttle Bus
International DuraStar Hybrid	Hybrid Electric	Vocational/Cab Chassis
Navistar HC300 Hybrid	Hybrid Electric	School Bus
North American Bus Industries 31LFW / 35LFW / 40LFW	Hybrid Electric	Transit Bus
North American Bus Industries CompoBus	Hybrid Electric	Transit Bus
North American Bus Industries 42BRT	Hybrid Electric	Transit Bus
North American Bus Industries 60BRT	Hybrid Electric	Transit Bus
Turtle Top Odyssey XLT	Hybrid Electric	Shuttle Bus
XL Hybrid - Chevrolet Express 2500/3500 HD	Hybrid Electric	Van
XL Hybrid - Ford Transit	Hybrid Electric	Van
XL Hybrid - General Motors Savana 2500/3500 HD	Hybrid Electric	Van
XL Hybrid - Isuzu Reach	Hybrid Electric	Van
XL Hybrid - Ford E 350/450	Hybrid Electric	Vocational/Cab Chassis
XL Hybrid - Ford F-59 Super Duty	Hybrid Electric	Vocational/Cab Chassis
XL Hybrid - General Motors 3500/4500 HD	Hybrid Electric	Vocational/Cab Chassis
Autocar E3-Hybrid Drive	Hybrid - Diesel	Refuse
ElDorado National E-Z Rider II	Hybrid - Diesel	Transit Bus
ENC E-Z RIDER II	Hybrid - Diesel	Transit Bus
Gillig Corp. Trolley	Hybrid - Diesel	Transit Bus
Gillig Corp. Standard, BRT, BRTPlus, Commuter	Hybrid - Diesel	Transit Bus
Hino 195h Hybrid COE, 195h-DC Hybrid COE	Hybrid - Diesel	Vocational/Cab Chassis
Motor Coach Industries D4500 CT Hybrid Commuter Coach	Hybrid - Diesel	Transit Bus
New Flyer Xcelsior	Hybrid - Diesel	Transit Bus
Nova Bus LFS Artic HEV	Hybrid - Diesel	Transit Bus
Nova Bus LFS HEV	Hybrid - Diesel	Transit Bus
DesignLine Corp. EcoSaver IV	Hybrid - CNG	Transit Bus

Source:

U.S. Department of Energy, Alternative Fuels Data Center website, www.afdc.energy.gov/vehicles/search, August 2017. (Additional resources: www.afdc.energy.gov)



Table 6.10
Electric-Drive Medium/Heavy Trucks and Buses Available by Manufacturer, 2017

Manufacturer - Model	Drive type	Truck type
Via Motors VTRUX	Plug-in Hybrid Electric	Van
BYD (Build Your Dream) C10 45ft Coach	Electric	Transit Bus
BYD (Build Your Dream) C6 23ft Coach	Electric	Transit Bus
BYD (Build Your Dream) C9 40ft Coach	Electric	Transit Bus
BYD (Build Your Dream) K11 60ft Transit Bus	Electric	Transit Bus
BYD (Build Your Dream) K7 30ft Transit Bus	Electric	Transit Bus
BYD (Build Your Dream) K9 40ft Transit Bus	Electric	Transit Bus
BYD (Build Your Dream) K9S 35ft Transit Bus	Electric	Transit Bus
BYD (Build Your Dream) Q1M	Electric	Truck
BYD (Build Your Dream) Step Van	Electric	Truck
BYD (Build Your Dream) T9	Electric	Truck
BYD (Build Your Dream) T5	Electric	Vocational/Cab Chassis
BYD (Build Your Dream) T7	Electric	Vocational/Cab Chassis
Capacity Trucks HETT	Electric	Tractor
DesignLine Corp. Eco-Smart 1	Electric	Transit Bus
Ebus 40 Foot CompositeEbus	Electric	Transit Bus
Ebus EBUS22	Electric	Transit Bus
First Priority GreenFleet - Lion Bus Type C	Electric	School Bus
First Priority GreenFleet - Trans Tech Type A	Electric	School Bus
First Priority GreenFleet Medium Duty Truck	Electric	Truck
First Priority GreenFleet Walk-In Van	Electric	Van
GGT Electric Electric	Electric	Vocational/Cab Chassis
Navistar-Modec EV Alliance eStar	Electric	Step Van
New Flyer Xcelsior	Electric	Transit Bus
Nova Bus LFSE	Electric	Transit Bus
Orange EV Multiple	Electric	Tractor
Phoenix Motorcars Shuttle Bus	Electric	Shuttle Bus
Phoenix Motorcars Flatbed	Electric	Vocational/Cab Chassis
Phoenix Motorcars Utility Vehicle	Electric	Vocational/Cab Chassis
Proterra Catalyst	Electric	Transit Bus
Trans Tech ETrans	Electric	School Bus
Workhorse Custom Chassis E-Gen	Electric	Vocational/Cab Chassis
Zenith Motors 250/350	Electric	Van
Zenith Motors Shuttle Van	Electric	Van
ZeroTruck ZeroTruck	Electric	Vocational/Cab Chassis
Capacity Trucks ZETT	Hydrogen Fuel Cell	Tractor
Van Hool A300L Fuel Cel	Hydrogen Fuel Cell	Transit Bus
Vision Motor Corp. Tyrano	Hydrogen Fuel Cell	Tractor
Vision Motor Corp. ZETT Zero Emission Terminal Tractor	Hydrogen Fuel Cell	Tractor

Source:

U.S. Department of Energy, Alternative Fuels Data Center website, www.afdc.energy.gov/vehicles/search, August 2017. (Additional resources: www.afdc.energy.gov)



This list includes public and private refuel sites; therefore, not all of these sites are available to the public.

Table 6.11
Number of Alternative Refuel Sites by State and Fuel Type, 2017

State	B20 sites	CNG sites	E85 sites	Electric stations	Electric charging outlets	Hydrogen sites	LNG sites	LPG sites	Totals by State ^a
Alabama	5	32	41	126	252	0	2	97	429
Alaska	0	1	0	6	9	0	0	7	17
Arizona	76	34	26	426	1,055	0	8	93	1,292
Arkansas	5	16	44	56	85	0	1	40	191
California	36	326	137	4,442	16,052	42	45	294	16,932
Colorado	16	44	92	503	1,204	1	1	59	1,417
Connecticut	2	21	4	347	777	2	1	21	828
Delaware	1	1	1	37	97	1	0	9	110
Dist. of Columbia	7	2	3	100	268	1	0	0	281
Florida	14	57	79	1,035	2,301	0	3	142	2,596
Georgia	23	48	55	678	1,905	0	4	101	2,136
Hawaii	8	1	2	271	623	4	0	5	643
Idaho	2	11	6	68	151	0	2	31	203
Illinois	14	48	268	520	1,141	1	2	123	1,597
Indiana	6	35	202	190	384	0	2	186	815
Iowa	9	9	242	109	222	0	0	33	515
Kansas	4	20	21	195	740	0	1	41	827
Kentucky	4	12	73	78	163	0	1	36	289
Louisiana	2	23	11	81	180	0	1	47	264
Maine	3	2	0	116	199	0	0	14	218
Maryland	13	16	36	518	1,255	0	1	34	1,355
Massachusetts	11	16	7	545	1,404	2	1	34	1,475
Michigan	9	23	252	538	1,159	2	0	103	1,548
Minnesota	7	25	355	298	741	0	0	48	1,176
Mississippi	4	7	3	45	69	0	2	91	176
Missouri	3	22	96	356	1,476	0	1	69	1,667
Montana	7	1	2	30	79	0	0	48	137
Nebraska	2	11	86	60	142	0	1	27	269
Nevada	4	5	19	193	553	0	1	34	616
New Hampshire	4	3	0	98	192	0	0	25	224
New Jersey	5	28	5	255	566	0	0	19	623
New Mexico	5	14	12	58	151	0	1	59	242
New York	34	94	69	845	1,724	1	0	71	1,993
North Carolina	116	42	77	543	1,270	0	1	93	1,599
North Dakota	3	1	41	9	13	0	0	24	82
Ohio	14	61	159	346	691	3	6	91	1,025
Oklahoma	5	122	31	54	117	0	1	140	416
Oregon	70	16	10	554	1,343	0	2	56	1,497
Pennsylvania	6	73	56	371	738	0	3	104	980
Rhode Island	5	4	0	88	224	0	0	7	240
South Carolina	24	12	64	221	446	2	1	48	597
South Dakota	2	1	73	23	40	0	0	27	143
Tennessee	29	22	79	445	1,039	0	5	88	1,262
Texas	18	125	215	1,020	2,661	1	19	476	3,515
Utah	1	86	1	138	345	0	6	48	487
Vermont	2	3	0	164	413	0	0	2	420
Virginia	11	20	29	448	1,053	0	2	92	1,207
Washington	39	26	20	779	2,066	0	2	88	2,241
West Virginia	2	4	33	58	151	0	0	13	203
Wisconsin	5	58	153	295	487	0	1	75	779
Wyoming	13	13	13	30	65	0	0	28	132
Totals by Fuel	710	1,697	3,303	18,809	50,481	63	31	3,541	59,926

Source:

U.S. Department of Energy, Alternative Fuels Data Center website,
www.afdc.energy.gov/afdc/fuels/stations_counts.html, August 2017. (Additional resources: www.afdc.energy.gov)

^a Totals by State is the total number of fuel types available at stations. Stations are counted once for each type of fuel available. For electric, the number of charging outlets was used.



There were just over 3,000 propane stations in the United States in 1992 making up 89% of all alternative refueling stations. Electric vehicle stations, which after 2011 are counted by the number of plugs rather than by the geographic location, have the largest number of stations in 2016.

Table 6.12
Number of Alternative Refuel Stations, 1992–2016
(number of stations)

Year	Propane	CNG	LNG	Biodiesel ^a	Ethanol (E85)	Methanol (M85)	Electric vehicle ^b	Hydrogen	Total
1992	3,297	349	c	0	2	43	c	c	3,691
1993	3,297	497	c	0	7	50	c	c	3,851
1994	3,299	1,042	c	0	32	82	c	c	4,455
1995	3,299	1,065	c	0	37	88	188	c	4,677
1996	4,252	1,419	72	0	68	95	194	c	6,100
1997	4,255	1,426	71	0	71	106	310	c	6,239
1998	5,318	1,268	66	0	40	91	486	c	7,269
1999	4,153	1,267	46	0	49	51	490	c	6,056
2000	3,268	1,217	44	2	113	3	558	c	5,205
2001	3,403	1,232	44	16	154	0	693	c	5,542
2002	3,431	1,166	36	79	149	0	873	7	5,741
2003	3,966	1,035	62	142	188	0	830	7	6,230
2004	3,689	917	58	176	200	0	671	9	5,720
2005	2,995	787	40	304	436	0	588	14	5,164
2006	2,619	732	37	459	762	0	465	17	5,091
2007	2,371	721	35	742	1,208	0	442	32	5,551
2008	2,175	778	38	645	1,644	0	430	46	5,756
2009	2,468	772	36	679	1,928	0	465	63	6,411
2010	2,647	841	39	644	2,142	0	541	58	6,912
2011	2,597	910	45	627	2,442	0	3,394	56	10,071
2012	2,654	1,107	59	675	2,553	0	13,392	58	20,498
2013	2,956	1,263	81	757	2,639	0	19,410	53	27,159
2014	2,931	1,495	103	783	2,840	0	25,602	51	33,805
2015	3,594	1,563	111	721	2,990	0	30,945	39	39,963
2016	3,665	1,725	140	697	3,090	0	42,011	54	51,382
<i>Average annual percentage change</i>									
1992-2016	0.4%	6.9%	c	c	35.8%	-100.0%	c	c	11.6%
2006-2016	3.4%	9.0%	14.2%	4.3%	15.0%	c	d	12.3%	26.0%

Source:

U.S. Department of Energy, Alternative Fuels Data Center website, “U.S. Alternative Fueling Stations by Fuel Type,” www.afdc.energy.gov/data/10332. (Additional resources: www.afdc.energy.gov)

^a Stations selling biodiesel blends less than B20 are included in the station count for years 2005-2007 only.

^b Starting in 2011, electric stations are counted by the plug rather than by the geographical location. This is different from the other fuels, which count only the geographical location regardless of how many dispensers or nozzles are on site.

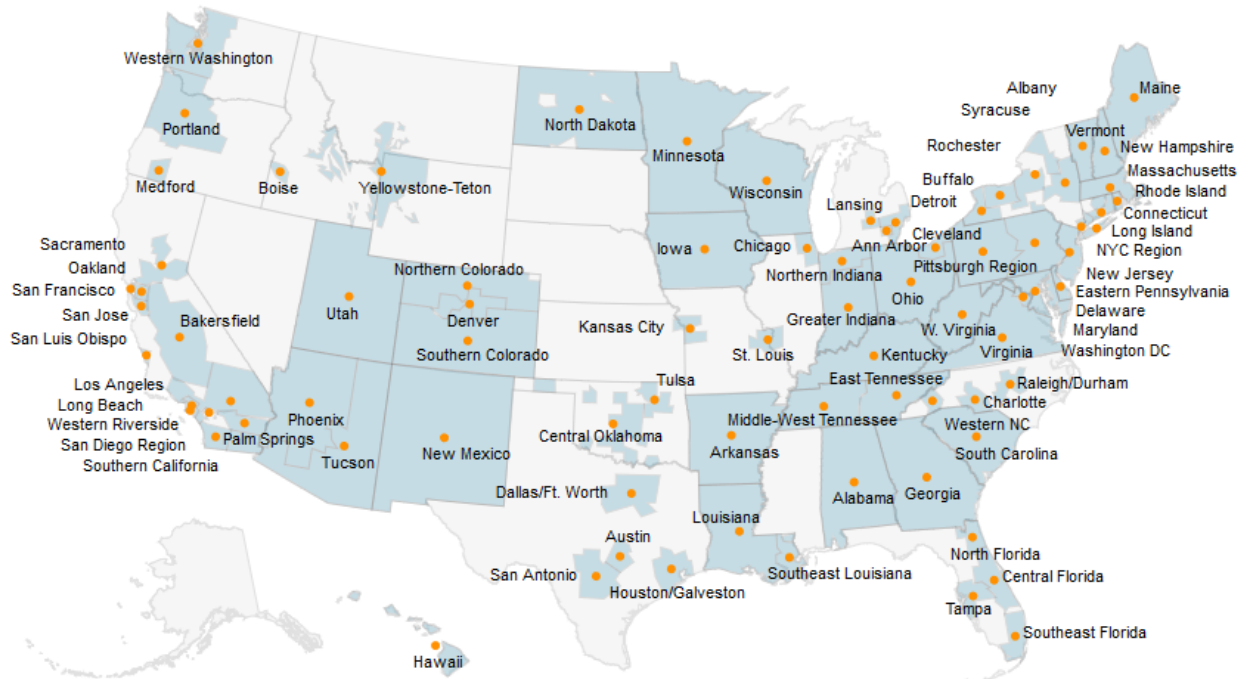
^c Data are not available.

^d Because data are not comparable from 2006 to 2016, an average annual percentage change is not provided.



Clean Cities is a locally-based government/industry partnership, coordinated by the U.S. Department of Energy to expand the use of alternatives to gasoline and diesel fuel. By combining the decision-making with voluntary action by partners, the "grass-roots" approach of Clean Cities departs from traditional "top-down" Federal programs.

Figure 6.1. Clean Cities Coalitions



Source:

U.S. Department of Energy, Clean Cities website, "Clean Cities Coalition Locations," cleancities.energy.gov/coalitions/locations, August 2017. (Additional resources: cleancities.energy.gov)



Table 6.13
Properties of Conventional and Alternative Liquid Fuels

Property	Liquid Fuels			
	Gasoline	Low-sulfur diesel	Methanol	Ethanol (E100)
Standard chemical formula ^a	C ₄ to C ₁₂	C ₈ to C ₂₅	CH ₃ OH	CH ₃ CH ₂ OH
Physical state	Liquid	Liquid	Liquid	Liquid
Molecular weight	100–105	~200	32.04	46.07
Composition (weight %)				
Carbon	85–88	87	37.5	52.2
Hydrogen	12–15	13	12.6	13.1
Oxygen	0	0	49.9	34.7
Main fuel source(s)	Crude oil	Crude oil	Natural gas, coal, or woody biomass	Corn, grains, or agricultural waste
Gasoline gallon equivalent (GGE) (Fuel unit measured/GGE)	1.0 (E0 gasoline)	0.889 (Diesel gal/GGE)	2.04 Methanol gal/GGE)	1.20-1.37 (E85 ^b gal/GGE) 1.03 (E10 gal/GGE)
Specific gravity (60° F/ 60° F)	0.72–0.78	0.85	0.796	0.794
Density (lb./gal @ 60° F)	6.0–6.5	7.079	6.63	6.61
Boiling temperature (F°)	80–437	356–644	149	172
Freezing point (F°)	-40	-40–30	-143.5	-173.2
Autoignition temperature (F°)	495	~600	897	793
Reid vapor pressure (psi)	8–15	<0.2	4.6	2.3

Source:

U.S. Department of Energy, Alternative Fuels Data Center website, “Fuel Properties Comparison,” www.afdc.energy.gov/fuels/fuel_comparison_chart.pdf, July 2015, and communication with George Mitchell, National Renewable Energy Laboratory, July 2015.

^a Standard Chemical Formulas represent idealized fuels. Some table values are expressed in ranges to represent typical fuel variations that are encountered in the field.

^b 1 gallon of E85 has 73% to 83% of the energy of one gallon of gasoline (variation due to ethanol content in E85).



Table 6.14
Properties of Conventional and Alternative Gaseous Fuels

Property	Gaseous Fuels		
	Propane (LPG)	CNG	Hydrogen
Standard chemical formula ^a	C ₃ H ₈	CH ₄	H ₂
Physical state	Pressurized liquid	Compressed gas	Compressed gas or liquid
Molecular weight	44.1	16.04	2.02
Composition (weight %)			
Carbon	82	75	0
Hydrogen	18	25	100
Oxygen	n/a	n/a	0
Main fuel source(s)	Underground reserves	Underground reserves and renewable Bio-gas	Natural gas, methanol, electrolysis, and other energy sources
Gasoline gallon equivalent (GGE) (Fuel unit measured/GGE)	1.34-1.38 (LPG gal/GGE)	5.56-5.71 (lb. mass/GGE) ^b	0.991-1.017 (kg mass/GGE)
Diesel gallon equivalent (DGE) (Fuel unit measured/DGE)	1.54 (LPG gal/DGE)	6.38 (lb. mass/DGE)	n/a
Specific Gravity (60° F/60° F)	1.55	0.60	0.069
Density (lb./cu ft @ 60° F)	0.124	0.0458	0.0056
Freezing point (°F)	-305.8	-296	-435
Boiling Point (°F)	-44	-260	-423
Autoignition temperature (°F)	850-950	1,004	1,050-1,080
Reid vapor pressure (psi)	208	n/a	n/a

Note: n/a = not applicable.

Source:

U.S. Department of Energy, Alternative Fuels Data Center website, "Fuel Properties Comparison," www.afdc.energy.gov/fuels/fuel_comparison_chart.pdf, July 2015, and communication with George Mitchell, National Renewable Energy Laboratory, July 2015.

^a Standard Chemical Formulas represent idealized fuels.

^b CNG: 1 Gasoline Gallon Equivalent = 5.66 lb. (as referenced by NIST Special Publication 854; Report of the 78th NCWM (1993); p. 326; NG data derived from field sampling of pipeline natural gas by IGT/GRI).





Chapter 7

Fleet Vehicles and Characteristics

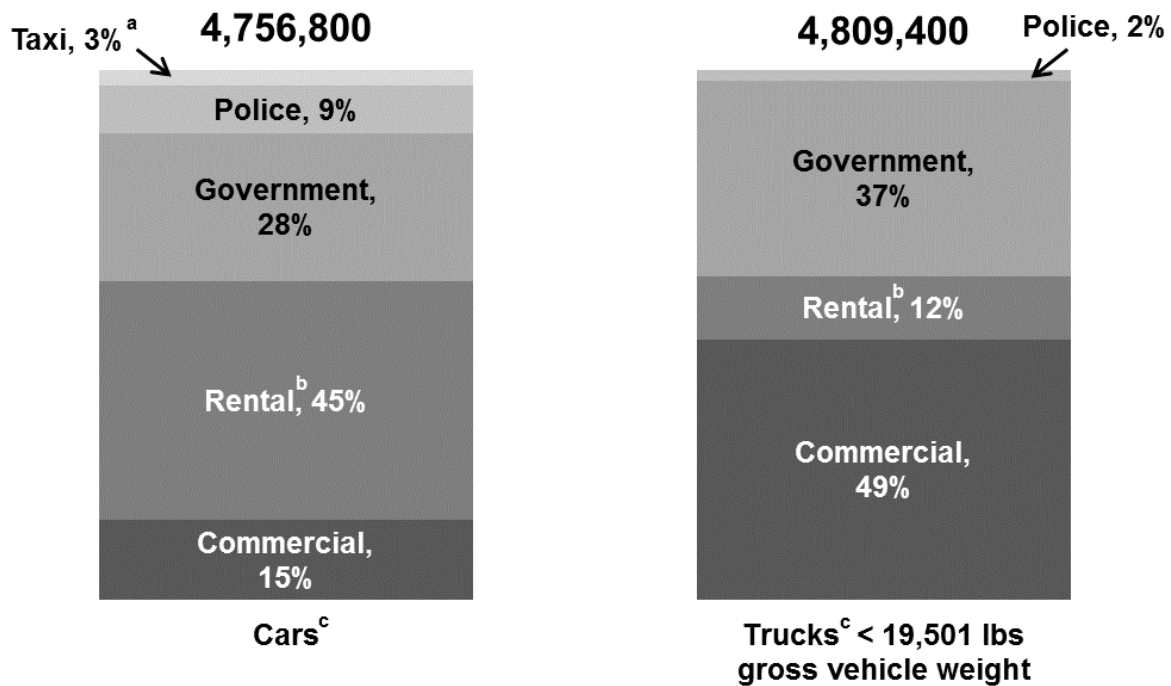
Summary Statistics from Tables in this Chapter

Source		
Figure 7.1	Fleet cars, 2016	4,756,800
Figure 7.1	Fleet trucks \leq 19,500 lbs. GVW, 2016	4,809,400
Table 7.3	Average annual miles per business fleet vehicle	
	<i>SUVs</i>	26,352
	<i>Intermediate cars</i>	24,540
	<i>Pickup trucks</i>	25,500
Figure 7.2	Average annual miles per Federal Government fleet vehicle, 2015	
	<i>Sedans</i>	9,855
	<i>SUVs</i>	9,508
	<i>Buses</i>	8,256
	<i>Heavy trucks</i>	6,730
	<i>Medium trucks</i>	6,600
	<i>Light trucks</i>	6,245
	<i>Ambulances</i>	5,403
Table 7.4	Federal government vehicles, FY 2015	640,304
	<i>Light trucks (<8,500 lbs. GVW)</i>	281,993
	<i>Cars and other passenger vehicles</i>	235,319
	<i>Medium trucks (8,500–26,000 lbs. GVW)</i>	79,421
	<i>Heavy trucks (>26,000 lbs. GVW)</i>	34,049
	<i>Buses and ambulances</i>	9,522



Vehicles in fleets of 15 or more are counted as fleet vehicles, as well as vehicles in fleets where five or more vehicles are purchased annually. There are more trucks in fleets than cars in 2016.

Figure 7.1. Fleet Vehicles in Service as of January 1, 2016



Source:

Bobit Publishing Company, Automotive Fleet Research Department, *Automotive Fleet Factbook 2016*, Redondo Beach, CA, 2017.

^a Taxi category includes taxis that are vans in addition to cars.

^b Rental category includes vans and sports utility vehicles under cars, not trucks.

^c Fleets of 15 or more in operation or 5 or more fleet vehicles purchased annually.



Data for fleet vehicles (cars and trucks less than 19,501 pounds) show that rental fleets are the largest share of cars and commercial fleets are the largest share of trucks. Government fleets are the second largest share for both cars and trucks.

Table 7.1
Fleet Vehicles in Service, 2006-2016
(thousands of vehicles)

Year	Commercial	Rental ^a	Government	Police & Taxi ^b	Total
Cars ^c					
2006	896.9	1,623.0	1,195.9	555.2	4,271.0
2007	911.8	1,650.0	1,215.8	564.5	4,342.0
2008	879.1	1,465.1	1,255.8	586.0	4,186.0
2009	791.0	1,289.0	1,299.0	607.0	3,986.0
2010	741.2	1,175.0	1,352.0	575.7	3,843.8
2011	803.9	1,553.2	1,330.0	578.6	4,265.7
2012	834.7	1,745.0	1,240.0	556.6	4,376.3
2013	727.7	1,850.0	1,290.0	570.6	4,438.3
2014	688.5	1,920.0	1,245.2	582.4	4,443.2
2015	659.2	2,040.0	1,325.0	595.8	4,620.0
2016	685.0	2,156.0	1,340.0	575.8	4,756.8
Trucks ^c <19,501 lbs.					
2006	2,362.4	499.7	1,635.5	45.4	4,543.0
2007	2,383.2	560.8	1,682.3	46.7	4,673.0
2008	2,318.5	500.1	1,682.0	45.5	4,546.0
2009	2,224.0	381.0	1,701.0	59.0	4,365.0
2010	1,999.5	380.0	1,751.0	55.4	4,185.8
2011	2,136.3	391.0	1,684.0	58.4	4,269.7
2012	2,236.8	417.0	1,512.0	62.0	4,227.8
2013	2,186.9	465.0	1,560.0	66.5	4,278.4
2014	2,136.4	480.0	1,631.5	74.9	4,322.8
2015	2,231.8	535.0	1,727.4	77.4	4,571.6
2016	2,340.0	582.0	1,810.0	77.4	4,809.0

Source:

Bobit Publishing Company, Automotive Fleet Research Department, *Automotive Fleet Factbook 2016*, and annual, Redondo Beach, CA. (Additional resources: www.fleet-central.com)

^a Rental category includes vans and sports utility vehicles under cars, not trucks.

^b Taxi category includes vans.

^c Fleets of 15 or more in operation or 5 or more fleet vehicles purchased annually.



In commercial fleets, full size vans stay in service the longest—an average of 63 months. Most commercial fleet vehicles drive about 25,000 miles in a year.

Table 7.2
Average Length of Time Commercial Fleet Vehicles Are in Service, 2015

Vehicle type	Average months in service
Compact cars	35
Intermediate cars	33
Pickup trucks	56
Minivans	42
Sport utility vehicles	35
Full-size vans	63

Note: Based on data collected from four leading Fleet Management companies.

Source:

Bobit Publishing Company, *Automotive Fleet Factbook 2016*, www.automotive-fleet.com. (Additional resources: www.fleet-central.com)

Table 7.3
**Average Annual Vehicle-Miles of Travel
for Commercial Fleet Vehicles, 2015**

Business fleet vehicles	Average annual miles of travel
Compact cars	24,408
Intermediate cars	24,540
Pickup trucks	25,500
Minivans	26,616
Sport utility vehicles	26,352
Full-size vans	25,152

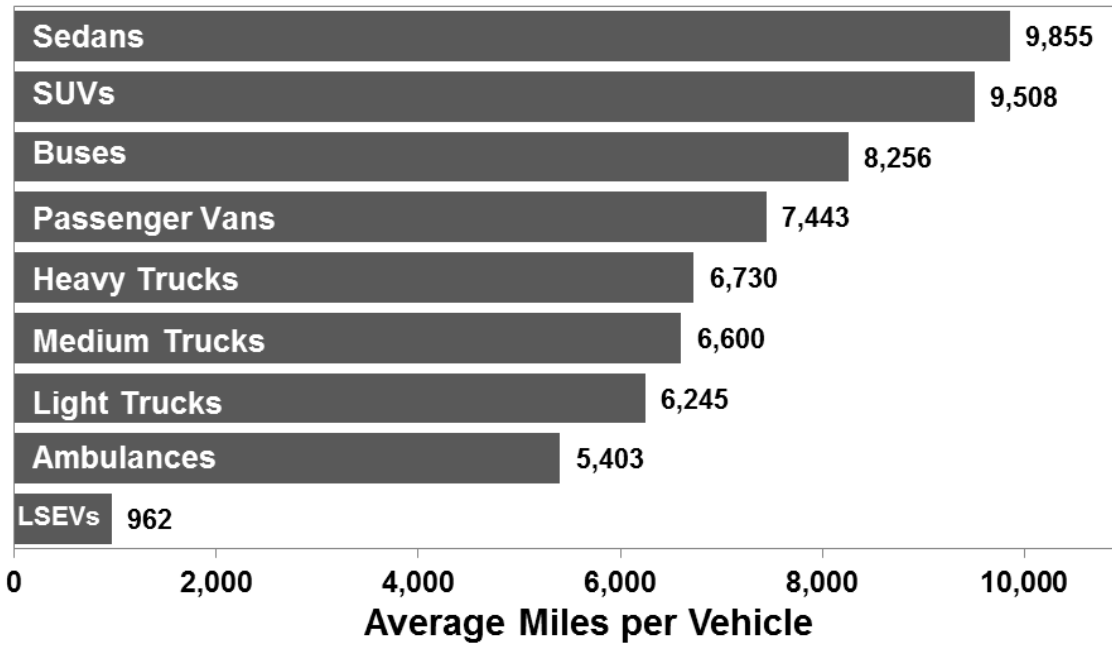
Source:

Bobit Publishing Company, *Automotive Fleet Factbook 2016*, www.automotive-fleet.com. (Additional resources: www.fleet-central.com)



These data, which apply to domestic Federal fleet vehicles, indicate that sedans now have the highest average annual miles per vehicle, followed closely by sport utility vehicles (SUVs).

Figure 7.2. Average Miles per Domestic Federal Vehicle by Vehicle Type, 2015



Note: Light trucks = less than 8,500 pounds gross vehicle weight ratio (GVWR).
 Medium trucks = 8,501-23,999 pounds GVWR.
 Heavy trucks = 24,000 pounds GVWR or more.
 LSEVs = low-speed electric vehicles.

Source:

U.S. General Services Administrations, Federal Vehicle Policy Division, *FY 2015 Federal Fleet Report*, Washington, DC, 2016, Table 4-2. (Additional resources: www.gsa.gov)



The Federal Government vehicle inventory includes 20% more light trucks than passenger vehicles.

Table 7.4
Federal Government Vehicles, 2001-2015

Vehicle Type	2001	2005	2010	2011	2012	2013	2014	2015
Passenger vehicles								
Low-speed electric vehicle	0	0	3,029	3,869	3,893	3,729	3,830	3,686
Subcompact	5,462	2,401	6,797	10,658	13,867	20,368	25,076	27,356
Compact	60,938	58,284	46,489	49,657	47,999	41,564	39,079	38,766
Midsize	36,921	36,656	48,242	38,057	33,321	30,659	28,271	24,775
Large	11,107	15,966	10,063	9,146	8,571	6,753	5,760	7,150
Limousines	116	191	412	158	130	123	126	83
Light duty passenger vans	56,563	42,109	41,676	40,964	39,518	38,409	37,439	37,448
Medium duty passenger vans	727	13,252	15,218	16,633	15,740	14,115	14,515	14,617
Light duty SUVs	40,842	50,445	66,316	68,807	73,356	70,371	70,235	73,203
Medium duty SUVs	0	6,096	11,117	11,448	9,405	9,533	9,978	8,235
Total passenger vehicles	212,676	225,400	249,359	249,397	245,800	235,624	234,309	235,319
Trucks and other vehicles								
Light trucks 4x2	227,937	243,477	241,011	238,261	233,629	231,886	231,215	232,914
Light trucks 4x4	29,975	35,417	40,105	47,035	48,690	46,830	46,528	49,079
Medium trucks	88,993	83,747	89,253	81,791	78,630	77,325	78,372	79,421
Heavy trucks	27,988	35,230	32,760	33,951	33,642	34,624	33,996	34,049
Ambulances	1,819	1,580	1,480	1,445	1,401	1,363	1,231	1,349
Buses	6,726	7,837	8,186	7,978	8,269	8,186	8,200	8,173
Total trucks and other vehicles	383,438	407,288	412,795	410,461	404,261	400,124	399,542	404,985
GRAND TOTAL ALL VEHICLES	596,114	632,688	662,154	659,858	650,061	635,748	633,851	640,304

Note: Light trucks = less than 8,500 pounds gross vehicle weight rating (GVWR).

Medium trucks = 8,501-23,999 pounds GVWR.

Heavy trucks = 24,000 pounds GVWR or more.

Source:

U.S. General Services Administration, Federal Supply Service, *FY 2015 Federal Fleet Report*, Washington, DC, 2016, Tables 2-5 and 2-6. (Additional resources: www.gsa.gov)



Table 7.5
Federal Fleet Vehicle Acquisitions
by Fuel Type, FY 2002–2015

Fuel type	Acquisitions by year							
	2002	2005	2007	2010	2012	2013	2014	2015
Gasoline	44,850	41,247	32,089	26,547	15,660	15,994	18,412	17,080
Gasoline hybrid	^a	222	458	4,853	1,254	1,364	4,124	2,500
Gasoline LGHG ^b	0	0	0	0	745	369	562	224
Gasoline plug-in hybrid	0	0	0	0	144	258	283	263
Diesel	8,107	6,049	5,809	4,136	4,383	4,625	5,974	6,215
Diesel hybrid	^c	1	4	27	36	51	8	7
Diesel LGHG ^b	0	0	0	0	10	0	1	0
CNG	1,267	188	129	60	106	123	87	241
E-85	8,054	16,892	26,581	26,789	24,214	21,644	26,267	24,651
Electric	7	13	7	1,376	258	284	349	231
LNG	3	0	0	0	0	0	0	0
LPG	59	1	4	2	15	23	7	6
M-85	25	0	0	0	0	0	0	0
Hydrogen	0	0	0	4	0	2	5	0
Grand total	62,372	64,613	65,081	63,794	46,825	44,737	56,079	51,418

Source:

U.S. General Services Administrations, Federal Vehicle Policy Division, *FY 2015 Federal Fleet Report*, Washington, DC, 2016, Table 5-4. (Additional resources: www.gsa.gov)

Table 7.6
Fuel Consumed by Federal Government Fleets, FY 2000–2015
(thousand gasoline equivalent gallons)

	FY00	FY05	FY07	FY09	FY10	FY12	FY13	FY14	FY15
Gasoline	284,480	300,261	293,848	301,437	322,023	302,089	295,076	296,083	310,416
Diesel	70,181	53,363	74,806	76,456	75,329	73,228	67,332	65,168	66,736
CNG	865	1,245	889	499	504	421	369	333	400
Electricity	1	6	5	4	36	85	88	142	197
Biodiesel (B20)	569	8,052	9,515	7,393	8,258	6,353	5,619	5,329	4,722
Biodiesel (B100) ^d	0	0	0	5	0	344	358	17	11
Methanol/M-85	14	0	0	0	0	0	0	0	0
LPG	34	231	322	208	195	211	257	231	150
Ethanol/E-85	347	3,060	3,854	7,923	8,201	12,261	14,158	12,911	13,512
LNG	0	102	95	35	0	0	0	3	7
Hydrogen	0	0	0	0	1	1	0	0	0
Total	356,491	366,320	383,334	393,961	414,548	394,994	383,257	380,217	396,152

Source:

U.S. General Services Administrations, Federal Vehicle Policy Division, *FY 2015 Federal Fleet Report*, Washington, DC, 2016, Table 5-1. (Additional resources: www.gsa.gov)

^a Combined with gasoline.

^b Low greenhouse gas emissions.

^c Combined with diesel.

^d B100 cannot be separated from B20 from 2000-2007.



In FY 2005, the General Services Administration owned 143,948 vehicles which they leased to other agencies. In FY 2015, they owned 967 vehicles. The U.S. Postal Service owned 67.5% of all federal light trucks.

Table 7.7
Federal Government Vehicles by Agency, FY 2015

Department or agency	Cars	Light trucks	Medium trucks	Heavy trucks	Other*	Total
CIVILIAN						
American Battle Monuments Commission	27	8	6	0	0	41
Broadcasting Board of Governors	76	39	24	18	7	164
Consumer Product Safety Commission	91	1	3	0	0	95
Court Services and Offender Supervision Agency	75	1	0	0	0	76
Department of Agriculture	13,805	16,210	8,087	2,388	85	40,575
Department of Commerce	1,157	442	352	70	9	2,030
Department of Education	91	0	0	0	1	92
Department of Energy	4,761	3,432	3,785	2,078	241	14,297
Department of Health and Human Services	3,824	559	295	105	78	4,861
Department of Homeland Security	37,440	10,056	3,404	838	451	52,189
Department of Housing and Urban Development	348	1	0	0	0	349
Department of Justice	36,188	4,614	1,583	957	199	43,541
Department of Labor	3,220	247	205	21	298	3,991
Department of State	10,156	1,605	1,367	666	166	13,960
Department of the Interior	11,333	9,256	9,100	3,144	675	33,508
Department of Transportation	4,145	730	1,023	144	5	6,047
Department of the Treasury	3,147	121	45	9	0	3,322
Department of Veterans Affairs	14,736	1,942	989	728	1,127	19,522
Environmental Protection Agency	755	72	127	25	7	986
Equal Employment Opportunity Commission	81	1	0	0	0	82
Federal Communications Commission	93	0	0	0	0	93
Federal Housing Finance Agency	7	0	0	0	0	7
Federal Maritime Commission	9	0	0	0	0	9
General Services Administration	893	46	25	1	2	967
Government Printing Office	12	19	6	5	0	42
Library of Congress	9	0	1	4	1	15
National Aeronautics and Space Administration	1,385	665	600	318	59	3,027
National Archives & Records Administration	36	4	10	7	0	57
National Gallery of Art	6	2	2	1	0	11
National Labor Relations Board	34	0	1	0	0	35
National Science Foundation	165	91	183	90	17	546
National Transportation Safety Board	5	0	0	0	0	5
Nuclear Regulatory Commission	14	1	0	2	0	17
Office of Personnel Management	1,538	2	2	0	0	1,542
Peace Corps	590	67	0	0	14	671
Pretrial Services Agency for the Dist of Columbia	3	0	0	0	0	3
Small Business Administration	157	2	1	0	0	160
Smithsonian Institution	209	149	57	39	10	464
Social Security Administration	422	5	6	22	5	460
Tennessee Valley Authority	969	541	992	58	1	2,561
US International Trade Commission	1	1	0	0	0	2
TOTAL CIVILIAN AGENCIES	152,013	50,932	32,281	11,738	3,458	250,422
MILITARY						
Corps of Engineers, Civil Works	2,162	2,739	1,791	658	2	7,352
Defense Agencies	4,625	611	572	596	370	6,774
Department of Air Force	11,199	13,399	15,049	6,116	1,794	47,557
Department of Army	31,873	11,682	12,046	5,366	2,520	63,487
Department of Navy	17,240	10,113	7,660	3,385	851	39,249
United States Marine Corps	7,189	2,032	2,064	1,293	525	13,103
TOTAL MILITARY AGENCIES	74,288	40,576	39,182	17,414	6,062	177,522
U. S. POSTAL SERVICE	9,018	190,485	7,958	4,897	2	212,360
TOTAL ALL FLEETS	235,319	281,993	79,421	34,049	9,522	640,304

* Other = Buses and ambulances.

Note: Light trucks – Less than 8,500 pounds gross vehicle weight ratio (GVWR) (Includes ambulances). Medium trucks – 8,501–23,999 pounds GVWR. Heavy trucks – 24,000 pounds GVWR or more. Does not include low-speed vehicles.

Source:

U.S. General Services Administration, Federal Supply Service, *FY 2015 Federal Fleet Report*, Washington, DC, 2016, Table 2-1.
(Additional resources: www.gsa.gov)



Demand response vehicles (also called paratransit or dial-a-ride) are widely used by transit agencies. The vehicles do not operate over a fixed route or on a fixed schedule. The vehicle may be dispatched to pick up several passengers at different pick-up points before taking them to their respective destinations and may even be interrupted en route to these destinations to pick up other passengers. Demand response service is provided primarily by vans. In 2007, the data changed substantially due to improved estimation methodologies. Unfortunately, those data are no longer comparable to the rest of the historical series.

Table 7.8
Summary Statistics on Demand Response Vehicles, 1994–2014

Year	Number of agencies	Number of active vehicles	Vehicle-miles (millions)	Average miles per vehicle	Passenger-miles (millions)	Average load factor ^a	Energy use (trillion Btu)
1994	5,214	28,729	463.7	16.14	577		9.5
1995	5,214	29,352	506.5	17.26	607	1.41	9.2
1996	5,214	30,804	548.3	17.80	656	1.21	9.9
1997	5,214	32,509	585.3	18.00	754	1.36	9.8
1998	5,214	29,646	670.9	22.63	735	1.21	10.4
1999	5,252	31,884	718.4	22.53	813	1.34	10.6
2000	5,252	33,080	758.9	22.94	839	1.30	10.8
2001	5,251	34,661	789.3	22.77	855	1.28	11.3
2002	5,251	34,699	802.6	23.13	853	1.24	11.6
2003	5,346	35,954	864.0	24.03	930	1.27	12.9
2004	5,960	37,078	889.5	23.99	962	1.25	13.3
2005	5,960	41,958	978.3	23.32	1,058	1.25	14.8
2006	5,960	43,509	1,013.0	23.28	1,078	1.24	15.5 ^b
2007	7,300	64,865	1,471.4	22.68	1,502	1.18	24.7
2008	7,200	65,799	1,495.2	22.72	1,412	1.09	24.7
2009	6,700	68,957	1,529.2	22.18	1,477	1.12	23.1
2010	6,741	68,621	1,693.6	24.68	1,494	1.03	22.8
2011	6,600	65,336	1,611.8	24.67	1,580	1.13	24.1
2012	6,511	68,632	1,618.1	23.58	1,756	1.24	24.8
2013	6,270	68,559	1,565.1	22.83	2,171	1.59	26.4
2014	6,370	71,359	1,595.1	22.35	2,267	1.65	32.0

Note: See Glossary for a detailed definition of demand response.

Source:

American Public Transportation Association, *2016 Public Transportation Fact Book*, Washington, DC, April 2016.
(Additional resources: www.apta.com)

^a Data are not available.

^b Data are not continuous between 2006 and 2007 due to changes in estimation methodology. See source document for details.



In 2007, the data changed substantially due to improved estimation methodologies. Unfortunately, those data are no longer comparable to the rest of the historical series.

Table 7.9
Summary Statistics on Transit Buses and Trolleybuses, 1994–2015

Year	Number of active buses	Vehicle-miles (millions)	Passenger- miles (millions)	Btu/passenger- mile	Energy use (trillion Btu)
1994	68,766	2,176	19,019	4,262	81.1
1995	67,802	2,198	19,005	4,307	81.9
1996	72,353	2,234	19,280	4,340	83.7
1997	73,425	2,259	19,793	4,434	87.8
1998	72,788	2,188	20,542	4,399	90.4
1999	74,885	2,290	21,391	4,344	92.9
2000	75,665	2,329	21,433	4,531	97.1
2001	76,675	2,389	22,209	4,146	92.1
2002	76,806	2,425	22,029	4,133	91.1
2003	78,000	2,435	21,438	4,213	90.3
2004	81,630	2,484	21,550	4,364	94.0
2005	82,642	2,498	21,998	4,250	93.5
2006	83,689	2,507	22,985	4,316	99.2 ^a
2007	65,808	2,314	21,132	4,372	92.4
2008	67,096	2,388	21,918	4,348	95.3
2009	65,363	2,345	21,645	4,242	91.8
2010	66,810	2,425	21,172	4,118	87.2
2011	69,654	2,425	21,574	4,240	91.5
2012	70,757	2,417	21,251	4,030	89.7
2013	71,699	2,425	22,306	4,071	90.8
2014	71,603	2,445	22,614	3,829	86.6
2015	64,184	2,205	20,239	4,051	82.0

Source:

American Public Transportation Association, *2016 Public Transportation Fact Book*, Washington, DC, April 2016, Appendix A. Data for 2015 are from the U.S. Department of Transportation, Federal Transit Administration, Federal Transit Database. (Additional resources: www.apta.com)

^a Data are not continuous between 2006 and 2007 due to changes in estimation methodology. See source document for details.



Chapter 8

Household Vehicles and Characteristics

Summary Statistics from Tables/Figures in this Chapter

Source		
Table 8.2	Vehicles per capita, 2015	0.823
	Vehicles per licensed driver, 2015	1.21
	Vehicles per household, 2015	2.10
Table 8.3	Share of households owning 3 or more vehicles	
	<i>1960</i>	2.5%
	<i>1970</i>	5.5%
	<i>1980</i>	17.5%
	<i>1990</i>	17.3%
	<i>2000</i>	18.3%
	<i>2010</i>	19.5%
	<i>2015</i>	20.3%
Figure 8.1	Average occupancy rates by vehicle type, 2009	
	<i>Van</i>	2.35
	<i>Sport Utility Vehicle</i>	1.90
	<i>Car</i>	1.55
	<i>Pickup</i>	1.49
Table 8.8	Average annual miles per household vehicle, 2009	11,300
Table 8.14	Share of workers who car pooled, 2015	9.0%
Table 8.19	Long-distance trips in the United States, 2001	
	<i>Person-trips</i>	2,554 million
	<i>Person-miles</i>	1,138 billion



The number of vehicles in the United States is growing faster than the population. The growth in vehicle-miles has slowed to 0.3% from 2005-2015. See Table 8.2 for vehicles per capita and vehicle-miles per capita.

Table 8.1
Population and Vehicle Profile, 1950–2015

Year	Resident population ^a (thousands)	Total households (thousands)	Number of vehicles in operation (thousands)	Total vehicle-miles (millions)	Number of licensed drivers (thousands)	Number of civilian employed persons (thousands)
1950	151,868	43,554	43,501	458,246	62,194	58,920
1955	165,069	47,874	56,540	605,646	74,686	62,171
1960	179,979	52,799	67,906	718,762	87,253	65,778
1965	193,526	57,436	82,066	887,812	98,502	71,088
1970	205,052	63,401	98,136	1,109,724	111,543	78,628
1975	215,973	71,120	120,054	1,327,664	129,791	85,846
1980	227,226	80,776	139,831	1,527,295	145,295	99,303
1985	238,466	86,789	157,048	1,774,826	156,868	107,150
1990	250,132	93,347	179,299	2,144,362	167,015	118,793
1991	253,493	94,312	181,438	2,172,050	168,995	117,718
1992	256,894	95,669	181,519	2,247,151	173,125	118,492
1993	260,255	96,391	186,315	2,296,378	173,149	120,259
1994	263,436	97,107	188,714	2,357,588	175,403	123,060
1995	266,557	98,990	193,441	2,422,696	176,628	124,900
1996	269,667	99,627	198,294	2,485,848	179,539	126,708
1997	272,912	101,018	201,071	2,561,695	182,709	129,558
1998	276,115	102,528	205,043	2,631,522	184,980	131,463
1999	279,295	103,874	209,509	2,691,056	187,170	133,488
2000	282,385	104,705	213,300	2,746,925	190,625	136,891
2001	285,309	108,209	216,683	2,797,287	191,276	136,933
2002	288,105	109,297	221,027	2,855,508	194,296	136,485
2003	290,820	111,278	225,882	2,890,450	196,166	137,736
2004	293,463	112,000	232,167	2,964,788	198,889	139,252
2005	296,186	113,343	238,384	2,989,430	200,549	141,730
2006	298,996	114,384	244,643	3,014,371	202,810	144,427
2007	302,004	116,011	248,701	3,031,124	205,742	146,047
2008	304,798	116,783	249,813	2,976,528	208,321	145,362
2009	307,439	117,181	248,972	2,956,764	209,618	139,877
2010	309,347	117,538	248,231	2,967,266	210,115	139,064
2011	311,719	118,682	248,932	2,950,402	211,875	139,869
2012	314,103	121,084	251,497	2,969,433	211,815	142,469
2013	316,427	122,459	252,715	2,988,280	212,160	143,929
2014	318,907	123,027	258,027	3,025,656	214,092	146,305
2015	320,897	125,819	264,194	3,095,373	218,084	148,834
<i>Average annual percentage change</i>						
1950–2015	1.2%	1.6%	2.8%	3.0%	1.9%	1.4%
2005–2015	0.8%	1.0%	1.0%	0.3%	0.8%	0.5%

Sources:

Resident population and civilian employed persons – U.S. Department of Commerce, Bureau of the Census, Online Data Retrieval, Washington, DC, 2017. (Additional resources: www.census.gov)

Vehicles in operation – IHS Automotive. FURTHER REPRODUCTION PROHIBITED. (Additional resources: <https://www.ihs.com/industry/automotive.html>)

Licensed drivers and vehicle-miles – U.S. Department of Transportation, Federal Highway Administration, *Highway Statistics 2015*, Tables DL-20 and VM-1, and annual. (Additional resources: www.fhwa.dot.gov)

^a Estimates as of July 1. Includes Armed Forces in the United States.



Vehicle-miles per capita were over 10,000 miles from 2004 to 2007 but were 9,646 miles in 2015. There were 1.78 vehicles for every employed civilian in the United States in 2015.

Table 8.2
Vehicles and Vehicle-Miles per Capita, 1950–2015^a

Year	Vehicles per capita	Vehicle-miles per capita	Licensed drivers per household	Vehicles per household	Vehicles per licensed driver	Vehicles per civilian employed persons
1950	0.286	3,017	1.43	1.00	0.70	0.74
1955	0.343	3,669	1.56	1.18	0.76	0.91
1960	0.377	3,994	1.65	1.29	0.78	1.03
1965	0.424	4,588	1.71	1.43	0.83	1.15
1970	0.479	5,412	1.76	1.55	0.88	1.25
1975	0.556	6,147	1.82	1.69	0.92	1.40
1980	0.614	6,707	1.80	1.73	0.96	1.41
1985	0.659	7,443	1.81	1.81	1.00	1.47
1990	0.717	8,573	1.79	1.92	1.07	1.51
1991	0.716	8,568	1.79	1.92	1.07	1.54
1992	0.707	8,747	1.81	1.90	1.05	1.53
1993	0.716	8,824	1.80	1.93	1.08	1.55
1994	0.716	8,949	1.81	1.94	1.08	1.53
1995	0.726	9,089	1.78	1.95	1.10	1.55
1996	0.735	9,218	1.80	1.99	1.10	1.56
1997	0.737	9,387	1.81	1.99	1.10	1.55
1998	0.743	9,531	1.80	2.00	1.11	1.56
1999	0.750	9,635	1.80	2.02	1.12	1.57
2000	0.755	9,728	1.82	2.04	1.12	1.56
2001	0.759	9,804	1.77	2.00	1.13	1.58
2002	0.767	9,911	1.78	2.02	1.14	1.62
2003	0.777	9,939	1.76	2.03	1.15	1.64
2004	0.791	10,103	1.78	2.07	1.17	1.67
2005	0.805	10,093	1.77	2.10	1.19	1.68
2006	0.818	10,082	1.77	2.14	1.21	1.69
2007	0.824	10,037	1.77	2.14	1.21	1.70
2008	0.820	9,766	1.78	2.14	1.20	1.72
2009	0.810	9,617	1.79	2.12	1.19	1.78
2010	0.802	9,592	1.79	2.11	1.18	1.79
2011	0.799	9,467	1.79	2.10	1.17	1.78
2012	0.801	9,457	1.75	2.08	1.19	1.77
2013	0.799	9,450	1.73	2.06	1.19	1.76
2014	0.810	9,498	1.74	2.09	1.21	1.76
2015	0.823	9,646	1.73	2.10	1.21	1.78
<i>Average annual percentage change</i>						
1950–2015	1.6%	1.8%	0.3%	1.1%	0.8%	1.4%
2005–2015	0.2%	-0.5%	-0.2%	0.0%	0.2%	0.6%

Sources:

Resident population and civilian employed persons – U.S. Department of Commerce, Bureau of the Census, Online Data Retrieval, Washington, DC, 2017. (Additional resources: www.census.gov)

Vehicles in operation – IHS Automotive. FURTHER REPRODUCTION PROHIBITED. (Additional resources: <https://www.ihs.com/industry/automotive.html>)

Vehicle-miles – U.S. Department of Transportation, Federal Highway Administration, *Highway Statistics 2015*, Table VM-1 and annual. (Additional resources: www.fhwa.dot.gov)

^a Includes all vehicles (light and heavy).



Household vehicle ownership shows a dramatic increase from 1960 to 1990. In 1960, nearly 79% of households owned less than two vehicles; by 1990, it declined to 45%. Census data prior to 1990 indicated that the majority of households owned one vehicle; in 1990 that changed to two vehicles. Since 2000, less than 10% of households had no vehicles. The American Community Survey now collects these data on an annual basis, thus annual data are available after 2010.

Table 8.3
Household Vehicle Ownership, 1960–2015 Census
(percentage)

	No vehicles	One vehicle	Two vehicles	Three or more vehicles
1960	21.5%	56.9%	19.0%	2.5%
1970	17.5%	47.7%	29.3%	5.5%
1980	12.9%	35.5%	34.0%	17.5%
1990	11.5%	33.7%	37.4%	17.3%
2000	9.4%	33.8%	38.6%	18.3%
2010	9.1%	33.8%	37.6%	19.5%
2011	9.3%	34.1%	37.5%	19.1%
2012	9.2%	34.1%	37.3%	19.3%
2013	9.1%	33.9%	37.3%	19.7%
2014	9.1%	33.7%	37.3%	19.9%
2015	8.9%	33.5%	37.2%	20.3%

Source:

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

2000 data – U.S. Bureau of the Census, American Fact Finder, factfinder.census.gov, Table QT-04, August 2001.
(Additional resources: www.census.gov)

2010-2015 data – U.S. Bureau of the Census, American Community Survey, Table CP04, 2017.



2009 National Household Travel Survey Daily Trip Data

The Department of Transportation (DOT) collected data on daily trips in 1969, 1977, 1983, 1990 and 1995 via the Nationwide Personal Transportation Survey (NPTS). For 2001, the DOT combined the collection of long trip and daily trip data into one survey – the 2001 National Household Travel Survey (NHTS). The long trip data were not included in the 2009 NHTS.

The NHTS is the nation's inventory of daily travel. The survey includes demographic characteristics of households, people, vehicles, and detailed information on daily travel for all purposes by all modes. NHTS survey data are collected from a sample of U.S. households and expanded to provide national estimates of trips and miles by travel mode, trip purpose, and a host of household attributes.

The NHTS was designed to continue the NPTS series, but as with all data surveys, caution should be used when comparing statistics from one survey to another due to changes in terminology, survey procedures, and target population. The 2001 and 2009 surveys collected data on trips of children under 5 years of age, while the previous NPTS did not. Improved methodologies first used in the collection of trip information in the 1995 NPTS make it difficult to compare these data with past NPTS survey data. Thus, the 1990 NPTS trip data have been adjusted to make it comparable with the later surveys.

The next NHTS is being conducted in 2016 and data will be available in 2018.

Table 8.4
Demographic Statistics from the 1969, 1977, 1983, 1990, 1995 NPTS and 2001, 2009 NHTS

	1969	1977	1983	1990	1995	2001	2009	Percent change 1969–2009
Persons per household	3.16	2.83	2.69	2.56	2.63	2.58	2.50	-21%
Vehicles per household	1.16	1.59	1.68	1.77	1.78	1.89	1.87	61%
Workers per household	1.21	1.23	1.21	1.27	1.33	1.35	1.34	11%
Licensed drivers per household	1.65	1.69	1.72	1.75	1.78	1.77	1.88	14%
Vehicles per worker	0.96	1.29	1.39	1.40	1.34	1.39	1.40	46%
Vehicles per licensed driver	0.70	0.94	0.98	1.01	1.00	1.06	1.00	42%
Average vehicle trip length (miles)	8.89	8.34	7.90	8.98	9.06	9.87	9.72	9%

Note: Average vehicle trip length for 1990 and 1995 is calculated using only those records with trip mileage information present. The 1969 survey does not include pickups and other light trucks as household vehicles. Data on vehicles per household and licensed drivers per household will not match Table 8.2 because they come from a different source.

Sources:

U.S. Department of Transportation, Federal Highway Administration, *1990 Nationwide Personal Transportation Survey: Summary of Travel Trends*, FHWA-PL-92-027, Washington, DC, March 1992, Table 2. Data for 1995, 2001 and 2009 were generated from the 2009 National Household Travel Survey website nhts.ornl.gov. (Additional resources: www.fhwa.dot.gov)



Due to methodology improvements in collecting trip information, the 2001 and 1995 data should be compared only to the 1990 adjusted data. The original 1990 data are comparable to all previous surveys; however, comparisons should always be made with caution because of differing survey methodologies.

Table 8.5
Average Annual Vehicle-Miles, Vehicle Trips and Trip Length per Household
1969, 1977, 1983, 1990, 1995 NPTS and 2001, 2009 NHTS

	Journey-to-work ^a	All trips
<i>Average annual vehicle-miles per household</i>		
1969	4,183	12,423
1977	3,815	12,036
1983	3,538	11,739
1990 original	4,853	15,100
1990 adjusted	4,853	18,161
1995	6,492	20,895
2001	5,724	21,171
2009	5,513	19,850
<i>Average annual vehicle trips per household</i>		
1969	445	1,396
1977	423	1,442
1983	414	1,486
1990 original	448	1,702
1990 adjusted	448	2,077
1995	553	2,321
2001	479	2,171
2009	457	2,068
<i>Average vehicle trip length (miles)</i>		
1969	9.4	8.9
1977	9.0	8.4
1983	8.5	7.9
1990 original	11.0	9.0
1990 adjusted	11.0	8.9
1995	11.8	9.1
2001	12.2	9.9
2009	12.2	9.7

Sources:

U.S. Department of Transportation, Federal Highway Administration, *1990 Nationwide Personal Transportation Survey: Summary of Travel Trends*, FHWA-PL-92-027, Washington, DC, March 1992, Table 7. 1990 adjusted data – Oak Ridge National Laboratory, Oak Ridge, TN, August 1998. 1995 NPTS, 2001, 2009 NHTS data were generated from the 2009 National Household Travel Survey website nhts.ornl.gov. (Additional resources: www.fhwa.dot.gov, nhts.ornl.gov)

^a It is believed that the methodology changes in the 1995 NPTS did not affect journey-to-work trips; therefore, no adjustment is necessary.



In 2001 and 2009 annual vehicle-miles traveled (vmt) for a three-person household is around 28,000 miles. The number of drivers in a household makes a big difference in vmt, as does the presence of children in the household. Households with children have more than double the vmt of households without children.

Table 8.6
Average Number of Vehicles and Vehicle Travel per Household,
1990 NPTS and 2001 and 2009 NHTS

Number of licensed drivers	Average number of vehicles per household			Average vehicle-miles traveled per household		
	1990	2001	2009	1990	2001	2009
1	1.5	1.2	1.1	15,200	9,700	8,800
2	2.1	2.2	2.2	22,900	25,800	23,500
3	2.9	3.0	3.0	29,400	37,900	37,700
4 or more	3.8	3.8	3.9	40,500	47,200	55,200
Household size						
1 person	1.2	1.0	1.0	11,400	7,500	7,100
2 persons	1.9	2.0	2.0	19,300	21,200	17,500
3 persons	2.2	2.3	2.3	23,700	28,400	27,900
4 persons	2.4	2.4	2.4	25,300	28,600	33,200
5 persons	2.4	2.4	2.4	24,900	33,200	33,700
6 or more persons	2.7	2.5	2.4	29,200	33,800	33,600
Household urban status						
Urban	1.9	1.8	1.7	19,000	19,300	17,600
Rural	2.1	2.3	2.4	22,200	28,400	27,700
Household composition						
With children	2.2	2.2	2.2	24,100	28,300	30,400
Without children	1.8	1.7	1.7	17,600	16,700	14,400
All households	1.8	1.9	1.9	18,300	21,200	19,900

Source:

Generated from the Department of Transportation, Federal Highway Administration, Nationwide Personal Transportation Survey Public Use Files, Washington, DC, 2000 and the 2009 National Household Travel Survey website nhts.ornl.gov. (Additional resources: nhts.ornl.gov)



In 2009, 22% of vehicle trips were traveling to and from work. Another 22% of trips were for shopping. Shopping is done close to home, as the average trip length for shopping was only 6.5 miles.

Table 8.7
Trip Statistics^a by Trip Purpose, 2001 and 2009 NHTS

Trip purpose	Share of trips		Share of vehicle-miles traveled		Trip length (miles)		Trip length (minutes)	
	2001	2009	2001	2009	2001	2009	2001	2009
To/from work	22.1%	22.3%	27.0%	28.7%	12.1	12.2	22.3	22.9
Work-related business	4.1%	3.9%	8.4%	7.2%	20.3	17.2	30.9	27.5
Shopping	21.1%	22.8%	14.5%	15.5%	6.7	6.5	14.4	14.4
Other family/personal business	24.7%	21.9%	18.7%	15.7%	7.5	6.8	15.2	14.8
School/church	4.9%	5.0%	3.7%	4.6%	7.5	8.8	15.8	17.5
Medical/dental	2.2%	2.6%	2.2%	2.6%	9.9	9.9	20.7	21.2
Vacation	0.4%	0.7%	1.8%	2.3%	47.4	31.4	59.6	41.3
Visit friends/relatives	6.3%	5.7%	9.4%	9.4%	14.9	15.7	24.4	24.6
Other social/recreational	13.7%	14.9%	13.2%	13.5%	9.6	8.6	18.2	17.2
Other	0.5%	0.3%	1.0%	0.6%	18.1	19.0	31.4	29.7
All	100.0%	100.0%	100.0%	100.0%	9.9	9.7	18.7	18.6

Note: The "All" category for average trip length and duration includes records for which trip purpose was not identified.

Source:

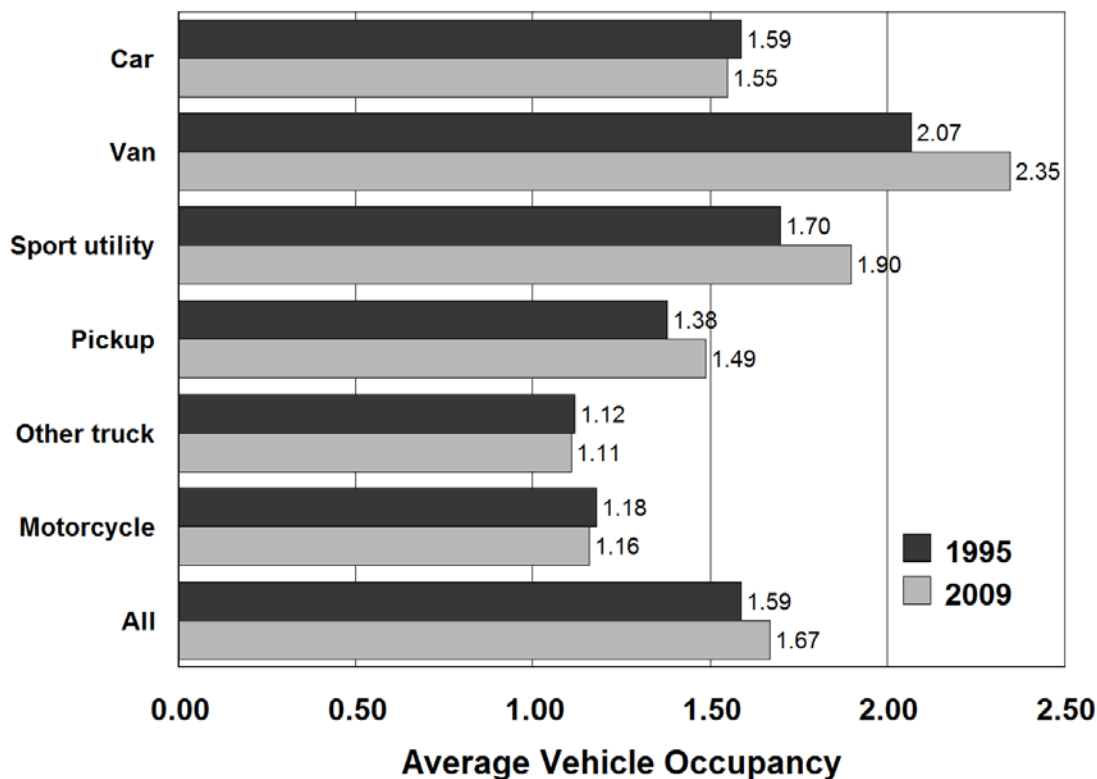
Generated from the 2009 National Household Travel Survey website nhts.ornl.gov.

^a Percentages may not sum to totals due to rounding.



While car occupancy stayed nearly constant from 1995 to 2009, most other vehicle types showed increased occupancy. Vans and sport utility vehicles have higher vehicle occupancies than cars.

Figure 8.1. Average Vehicle Occupancy by Vehicle Type, 1995 NPTS and 2009 NHTS



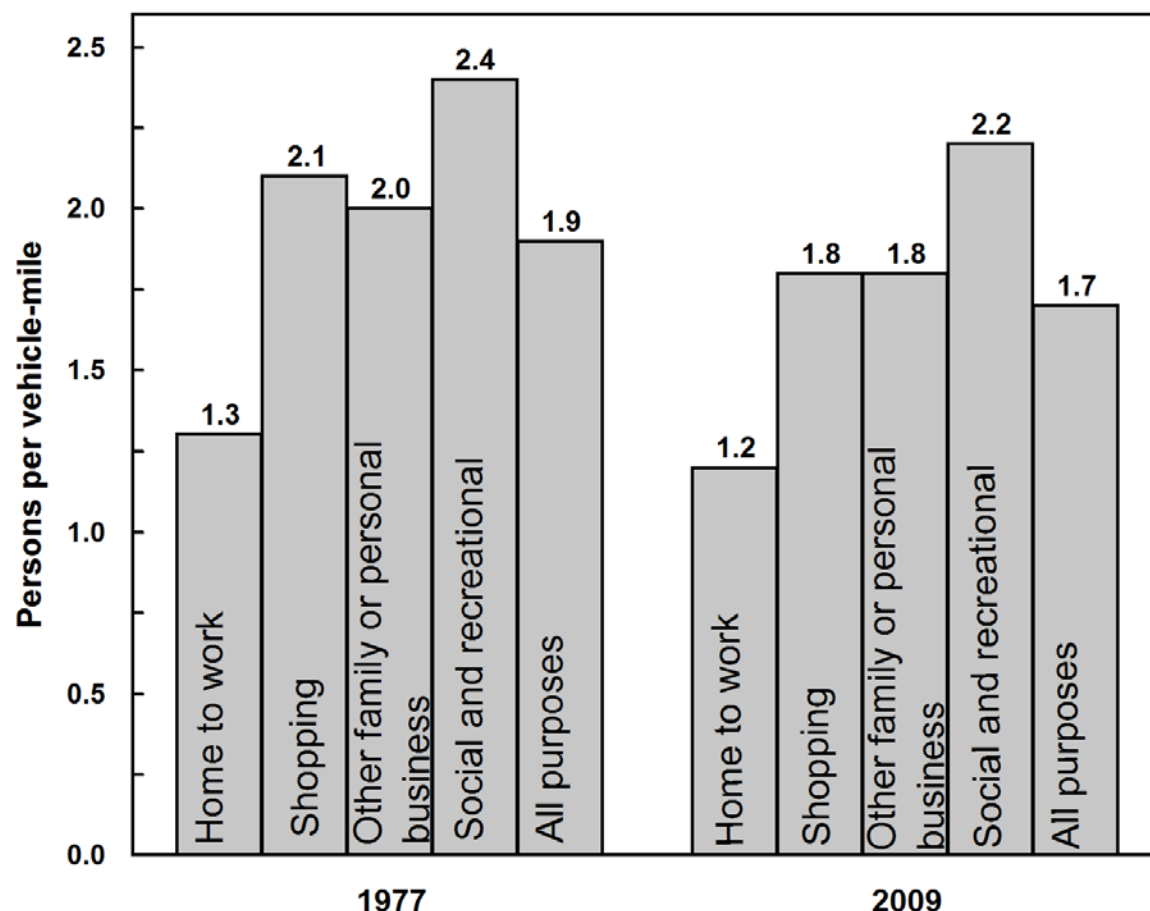
Sources:

U.S. Department of Transportation, Federal Highway Administration, 1995 Nationwide Personal Transportation Survey, Washington, DC, 1997, and 2009 National Household Travel Survey, Washington, DC. (Additional resources: www.fhwa.dot.gov, nhts.ornl.gov)



The average vehicle occupancy, calculated as person-miles per vehicle-mile, is highest for social and recreational purposes. The highest vehicle occupancy levels for all purposes were in 1977. The increase in number of vehicles per household and the decrease in average household size could have contributed to the decline since then.

**Figure 8.2. Average Vehicle Occupancy by Trip Purpose
1977 NPTS and 2009 NHTS**



Sources:

U.S. Department of Transportation, Federal Highway Administration, *1990 Nationwide Personal Transportation Survey: Summary of Travel Trends*, FHWA-PL-92027, Washington, DC, March 1992, Figure 6. Data from 2009 NHTS were generated from the 2009 National Household Travel Survey website nhts.ornl.gov, March 2011. (Additional resources: www.fhwa.dot.gov, nhts.ornl.gov)



The 1990 household survey reports the highest average annual miles per vehicle and the 1983 survey reports the lowest. These data show that younger vehicles are typically driven more miles than older vehicles.

Table 8.8
Average Annual Miles per Household Vehicle by Vehicle Age

Vehicle age (years)	1983 self-reported	1990 self-reported	1995 self-reported	2001 self-reported	2009 self-reported
Under 1	8,200	19,600	15,900	15,500	13,200
1	15,200	16,800	16,800	14,300	14,600
2	16,800	16,600	15,500	14,000	13,900
3	14,500	14,700	14,400	13,100	12,700
4	13,000	13,600	14,100	12,500	12,600
5	12,100	12,900	13,500	12,000	12,800
6	11,300	13,200	13,200	11,800	12,100
7	10,000	12,400	12,800	11,600	11,900
8	9,800	12,600	12,200	10,900	11,500
9	9,000	11,500	12,200	10,800	11,300
10 and older	7,300	9,200	8,900	7,400	9,300
All household vehicles	10,400	12,500	12,200	11,100	11,300

Note: Data include all household vehicles, and have been rounded to the nearest hundred.

Sources:

Nationwide Personal Transportation Study—1983: 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: Generated from the *1990 Nationwide Personal Transportation Study Public Use Tape*, March 1992. 1995, 2001 and 2009: Generated from the 2009 NHTS datasets, version 2, February 2011. (Additional resources: nhts.ornl.gov)



Historically, the data from the Nationwide Personal Transportation Survey (NPTS) are based on estimates reported by survey respondents. For the 1995 NPTS and the 2001 National Household Travel Survey (NHTS), odometer data were also collected. The 1995 data indicate that respondents overestimate the number of miles they drive in a year, but the 2001 data do not show that same trend.

Table 8.9
Self-Reported vs. Odometer Average Annual Miles, 1995 NPTS and 2001 NHTS

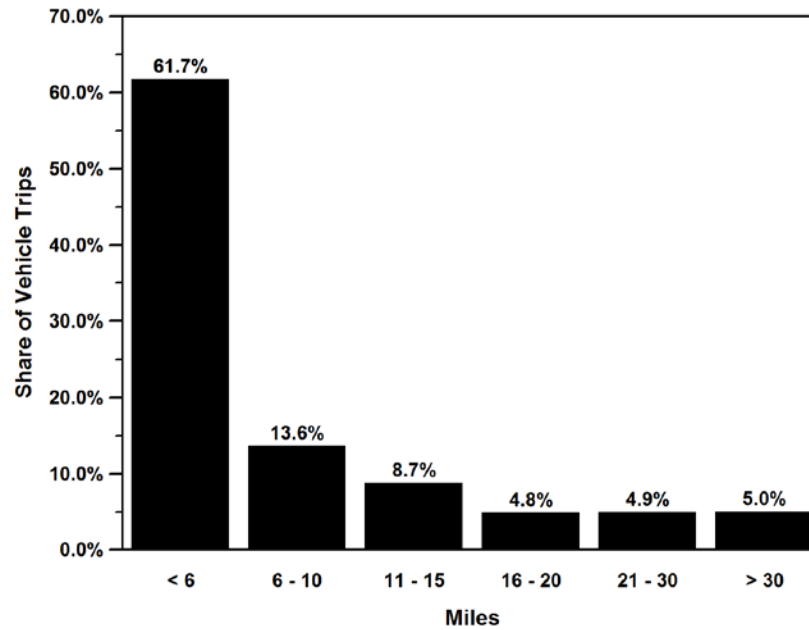
Vehicle age (years)	1995 self-reported	1995 odometer	2001 self-reported	2001 odometer
Under 1	15,900	15,600	15,500	14,500
1	16,800	14,500	14,300	14,200
2	15,500	14,800	14,000	13,700
3	14,400	13,800	13,100	14,100
4	14,100	12,900	12,500	13,400
5	13,500	12,700	12,000	12,900
6	13,200	12,400	11,800	12,400
7	12,800	11,600	11,600	12,100
8	12,200	11,300	10,900	11,300
9	12,200	11,200	10,800	10,500
10 and older	8,900	9,000	7,400	8,100
All household vehicles	12,200	11,800	11,000	11,800

Note: The 2009 NHTS did not collect similar data. Survey methodology on odometer reading data differs from 1995 to 2001 data.

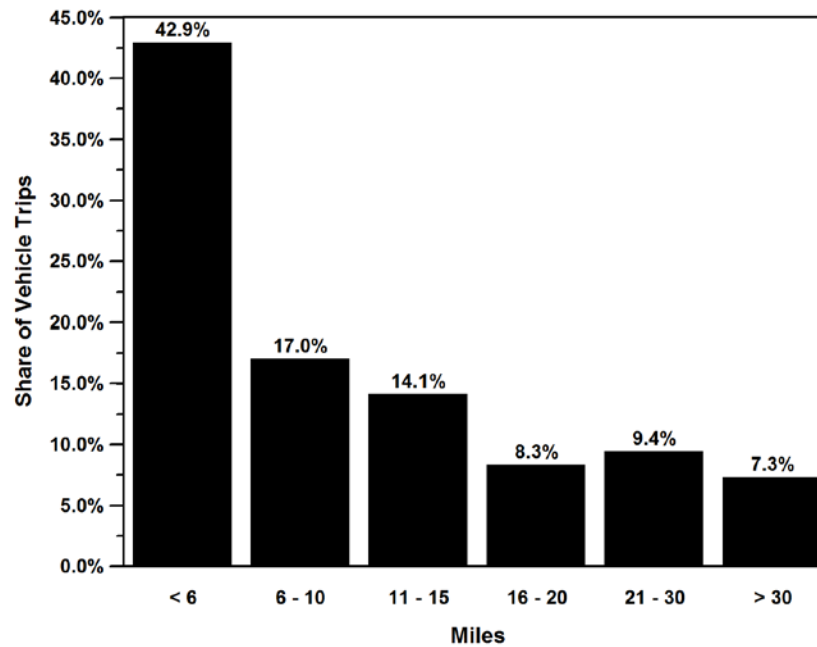
Source:

Generated from the 2009 National Household Travel Survey website nhts.ornl.gov and 2001 NHTS public use file.



Figure 8.3. Share of Vehicle Trips by Trip Distance, 2009 NHTS**Source:**

Generated from the 2009 National Household Travel Survey website nhts.ornl.gov.

Figure 8.4. Share of Vehicle Trips to Work by Trip Distance, 2009 NHTS**Source:**

Generated from the 2009 National Household Travel Survey website nhts.ornl.gov.



Nineteen percent of new vehicles (1-year-old and under) travel over 20,000 miles per year. Almost half of the vehicles over 20 years old travel less than 4,000 miles in a year.

Table 8.10
Share of Vehicles by Annual Miles of Travel and Vehicle Age, 2009 NHTS

Annual vehicle miles of travel	Vehicle age (years)						
	1 and under	2	3	4	5	6	7
< 1,000 miles	2%	3%	3%	3%	3%	4%	3%
1 - 2,000 miles	2%	3%	2%	3%	3%	3%	3%
2 - 4,000 miles	5%	6%	7%	7%	6%	7%	9%
4 - 6,000 miles	7%	10%	9%	8%	8%	10%	10%
6 - 8,000 miles	10%	10%	11%	11%	10%	12%	12%
8 - 10,000 miles	11%	11%	11%	11%	11%	12%	12%
10 - 12,000 miles	9%	11%	11%	11%	12%	11%	11%
12 - 15,000 miles	16%	15%	14%	15%	15%	14%	13%
15 - 20,000 miles	18%	15%	17%	17%	16%	14%	14%
20 - 30,000 miles	13%	11%	12%	11%	11%	10%	9%
>30,000 miles	6%	5%	4%	3%	4%	4%	3%
All	100%	100%	100%	100%	100%	100%	100%
	Vehicle age (years)						
	8	9	10	11-15	16-20	Over 20	
< 1,000 miles	4%	4%	4%	6%	9%	19%	
1 - 2,000 miles	4%	4%	4%	5%	7%	8%	
2 - 4,000 miles	9%	9%	10%	11%	16%	19%	
4 - 6,000 miles	11%	12%	12%	14%	14%	14%	
6 - 8,000 miles	12%	12%	11%	14%	13%	12%	
8 - 10,000 miles	13%	11%	12%	12%	10%	7%	
10 - 12,000 miles	11%	11%	11%	10%	8%	6%	
12 - 15,000 miles	13%	13%	12%	10%	8%	5%	
15 - 20,000 miles	12%	13%	14%	9%	7%	5%	
20 - 30,000 miles	9%	8%	7%	7%	4%	3%	
>30,000 miles	3%	3%	3%	3%	2%	2%	
All	100%	100%	100%	100%	100%	100%	

Source:

Generated from the 2009 National Household Travel Survey website nhts.ornl.gov. (Additional resources: nhts.ornl.gov)



The average driver makes three trips per day with an average of 9.7 miles for each trip.

Table 8.11
Household Vehicle Trips, 2009 NHTS

	Number of daily vehicle trips (per driver)	Average vehicle trip length (miles)	Daily vehicle miles of travel (per driver)
1990	3.3	8.9	28.5
1995	3.6	9.1	32.1
2001	3.4	9.9	32.7
2009	3.0	9.7	29.0

Source:

Generated from the 2009 National Household Travel Survey website nhts.ornl.gov.

Figure 8.5. Average Daily Miles Driven (per Driver), 2009 NHTS

Source:

Generated from the 2009 National Household Travel Survey website nhts.ornl.gov.



Table 8.12
Daily Vehicle Miles of Travel (per Vehicle) by Number of Vehicles
in the Household, 2009 NHTS

Number of household vehicles	Daily miles per vehicle	
	2001	2009
1	25.6	29.1
2	27.5	32.7
3	24.2	31.3
4	23.0	30.2
5	21.1	27.6
More than 5	18.4	27.2
All	25.2	31.1

Source:

Generated from the 2009 National Household Travel Survey website nhts.ornl.gov.

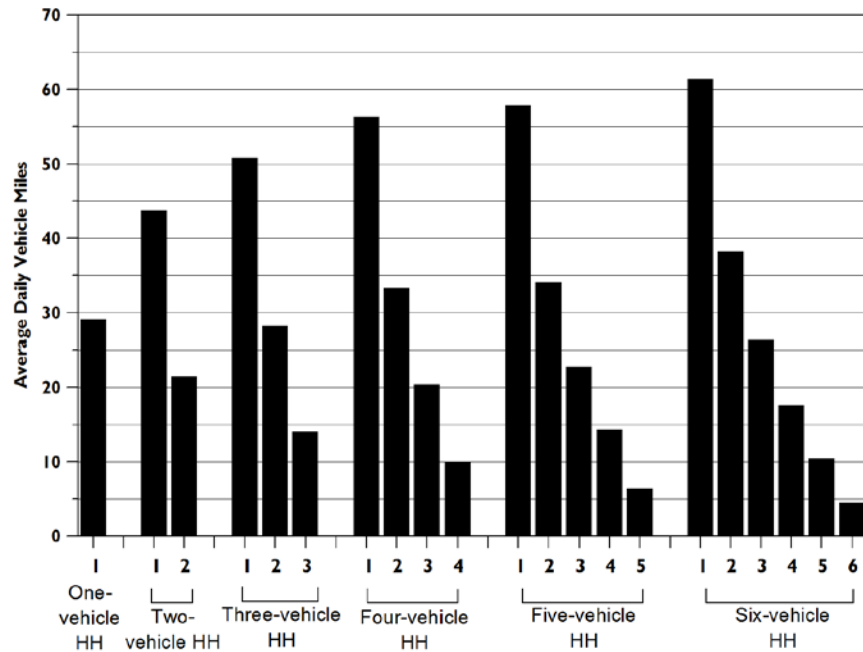
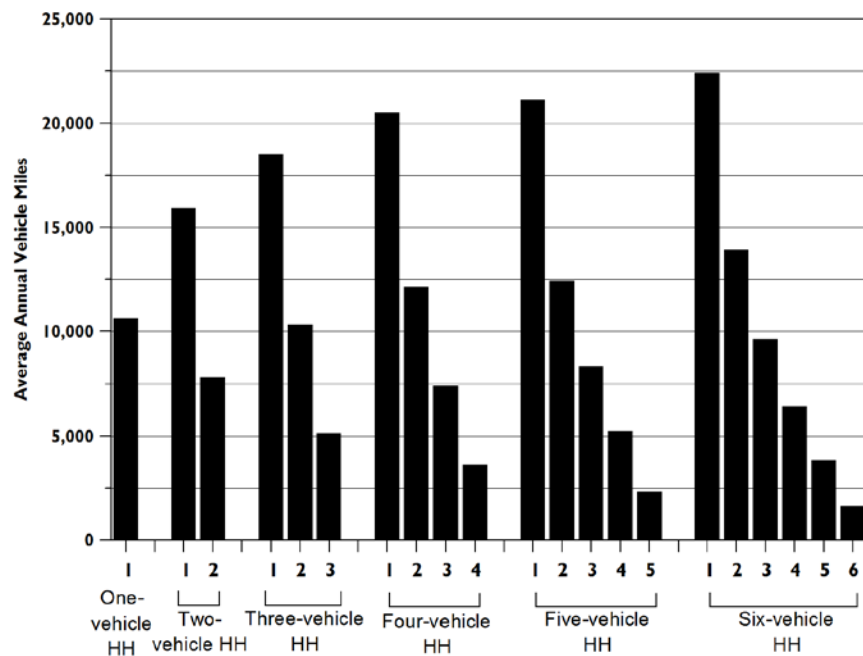
Table 8.13
Daily and Annual Vehicle Miles of Travel and Average Age for
Each Vehicle in a Household, 2009 NHTS

Vehicle number	Average daily miles	Average annual miles	Average age (years)
One-vehicle household			
1	29.0	10,600	9.0
Two-vehicle household			
1	43.6	15,900	7.6
2	21.4	7,800	9.0
Three-vehicle household			
1	50.7	18,500	7.9
2	28.2	10,300	9.1
3	14.0	5,100	11.8
Four-vehicle household			
1	56.2	20,500	8.5
2	33.2	12,100	8.8
3	20.3	7,400	11.4
4	9.9	3,600	13.2
Five-vehicle household			
1	57.8	21,100	8.5
2	34.0	12,400	9.4
3	22.7	8,300	12.3
4	14.2	5,200	12.7
5	6.3	2,300	16.8
Six-vehicle household			
1	61.4	22,400	10.2
2	38.1	13,900	9.8
3	26.3	9,600	12.2
4	17.5	6,400	12.5
5	10.4	3,800	14.5
6	4.4	1,600	17.9

Source:

Generated from the 2009 National Household Travel Survey website nhts.ornl.gov.



Figure 8.6. Daily Vehicle Miles of Travel for Each Vehicle in a Household, 2009 NHTS**Source:**Generated from the 2009 National Household Travel Survey website nhts.ornl.gov.**Figure 8.7. Annual Vehicle Miles of Travel for Each Vehicle in a Household, 2009 NHTS****Source:**Generated from the 2009 National Household Travel Survey website nhts.ornl.gov.

According to the U.S. Census data, the percentage of workers who car pooled has dropped from 19.7% in 1980 to 9.0% in 2015. The percent of workers using public transit declined from 6.4% to 5.3% in the ten-year period between 1980 and 1990, but stayed relatively the same from 1990 to 2014 (~5.0%). The average travel time increased by 4.2 minutes from 1980 to 2015. The American Community Survey (ACS) now collects journey-to-work data on an annual basis. It shows the average commute time as 25.9 minutes in 2015.

Table 8.14
Means of Transportation to Work, 1980, 1990, 2000, and 2015

Means of transportation	1980 Census		1990 Census		2000 Census		2015 ACS	
	Number of workers (thousands)	Share	Number of workers (thousands)	Share	Number of workers (thousands)	Share	Number of workers (thousands)	Share
Private vehicle	81,258	84.1%	99,593	86.5%	112,737	87.9%	126,924	85.6%
<i>Drove alone</i>	62,193	64.4%	84,215	73.2%	97,102	75.7%	113,576	76.6%
<i>Car pooled</i>	19,065	19.7%	15,378	13.4%	15,635	12.2%	13,348	9.0%
Public transportation	6,175	6.4%	6,068	5.3%	6,068	4.7%	7,949	5.4%
<i>Bus or trolley bus^a</i>	3,925	4.1%	3,445	3.0%	3,207	2.5%	3,882	2.6%
<i>Streetcar or trolley car^a</i>	^b	^b	78	0.1%	73	0.1%	89	0.1%
<i>Subway or elevated</i>	1,529	1.6%	1,755	1.5%	1,886	1.5%	2,851	1.9%
<i>Railroad</i>	554	0.6%	574	0.5%	658	0.5%	881	0.6%
<i>Ferryboat</i>	^b	^b	37	0.0%	44	0.0%	59	0.0%
Taxicab	167	0.2%	179	0.2%	200	0.2%	188	0.1%
Motorcycle	419	0.4%	237	0.2%	142	0.1%	266	0.2%
Bicycle	468	0.5%	467	0.4%	488	0.4%	885	0.6%
Walked only	5,413	5.6%	4,489	3.9%	3,759	2.9%	4,114	2.8%
Other means	703	0.7%	809	0.7%	901	0.7%	1,343	0.9%
Worked at home	2,180	2.3%	3,406	3.0%	4,184	3.3%	6,843	4.6%
Total workers	96,616	100.0%	115,069	100.0%	128,279	100.0%	148,324	100.0%
Average travel time (minutes)	21.7		22.4		25.5		25.9	

Sources:

1980-1990 data – Provided by the Journey-to-Work and Migration Statistics Branch, Population Division, U.S. Bureau of the Census.

2000 data – U.S. Bureau of the Census, *Journey to Work: 2000*, Tables 1 and 2, 1990-2000, March 2004 (www.census.gov/population/www/socdemo/journey.html).

2015 data – U.S. Bureau of the Census, *2009-2015 American Community Survey Five-Year Estimates*, Tables B08301 and GCT0801. (Additional resources: www.census.gov)

^a This category was "Bus or streetcar" in 1980.

^b Data are not available.



Table 8.15
Characteristics of U.S. Daily per Vehicle Driving vs. Dwelling Unit Type and Density

	Share of vehicles in density type	Hours per vehicle per day	Average vehicle speed (miles/hour)	Miles per vehicle per day
All classes detached single house	77.0%	0.92	32.0	29.6
All classes other	23.0%	0.99	27.7	27.4
<1,000/sq. mile detached single house	81.6%	0.91	34.7	31.6
<1,000/sq. mile all other	18.4%	0.91	32.5	29.5
1,000-4,000/sq. mile detached single house	75.5%	0.94	27.5	26.0
1,000-4,000/sq. mile all other	24.5%	1.03	25.1	25.9
4,000-10,000/sq. mile detached single house	42.5%	0.96	26.1	25.1
4,000-10,000/sq. mile all other	57.5%	1.15	21.5	24.6
10,000-25,000/sq. mile detached single house	17.8%	1.02	18.2	18.5
10,000-25,000/sq. mile all other	82.2%	1.05	21.3	22.3
>25,000/sq. mile detached single house	9.8%	0.72	20.5	14.8
>25,000/sq. mile all other	90.2%	1.23	21.9	26.9

Source:

Generated from the 2009 National Household Travel Survey website nhts.ornl.gov.

Table 8.16
Housing Unit Characteristics, 2015

	Share of occupied housing units	Percent with garage or carport
Type of housing unit		
New construction (< = 4 years)	3.2%	70.8%
Manufactured/mobile homes	5.9%	33.0%
Geographic location (Census Region)		
Northeast	18.1%	49.3%
Midwest	22.3%	71.9%
South	37.2%	56.0%
West	22.4%	76.3%
Tenure		
Owner	62.7%	78.3%
Renter	37.3%	36.8%
All occupied units	118,290 units	62.9%

Note: The American Housing Survey is updated every two years. The 2015 data are the latest available.

Source:

U.S. Bureau of the Census, *2015 American Housing Survey*, Table Creator, accessed July 28, 2017.

(Additional information: www.census.gov/programs-surveys/ahs)



The average one-way commute time was 25.9 minutes in 2015. More than 63% of workers traveled less than 30 minutes to work in 2015. In 1990, 32.5% of workers commuted less than 15 minutes; in 2015 that number dropped to 27.0%.

Table 8.17
Workers by Commute Time, 1990, 2000 and 2015

Commute time (one-way)	1990	2000	2015
Less than 15 minutes	32.5%	29.4%	27.0%
15–29 minutes	37.0%	36.1%	36.4%
30–39 minutes	15.2%	15.8%	16.5%
40–59 minutes	9.2%	10.7%	11.6%
60 minutes or more	6.1%	8.0%	8.5%
Average travel time (minutes)	22.4	25.5	25.9

Sources:

1990-2000 – U.S. Bureau of the Census, *Journey to Work: 2000*, Tables 1 and 2, 1990-2000, March 2004.

2015 – U.S. Bureau of the Census, *2009-2015 American Community Survey, 5-Year Estimates*, Tables S0802 and B08303. (Additional resources: www.census.gov)



Sales of bicycles with wheel sizes of 20 inches and over have grown at an average annual rate of 1.0% from 1981 to 2015. Bicycle sales experienced a large decline in 2009, which brought total sales to 14.9 million—a new low in the 18-year series. Sales in 2015 were 17.4 million.

Table 8.18
Bicycle Sales, 1981–2015
(millions)

	Wheel sizes under 20 inches	Wheel sizes of 20 inches and over	All wheel sizes
1981	^a	8.9	^a
1982	^a	6.8	^a
1983	^a	9.0	^a
1984	^a	10.1	^a
1985	^a	11.4	^a
1986	^a	12.3	^a
1987	^a	12.6	^a
1988	^a	9.9	^a
1989	^a	10.7	^a
1990	^a	10.8	^a
1991	^a	11.6	^a
1992	3.7	11.6	15.3
1993	3.8	13.0	16.8
1994	4.2	12.5	16.7
1995	4.1	12.0	16.1
1996	4.5	10.9	15.4
1997	4.2	11.0	15.2
1998	4.7	11.1	15.8
1999	5.9	11.6	17.5
2000	9.0	11.9	20.9
2001	5.4	11.3	16.7
2002	5.9	13.6	19.5
2003	5.6	12.9	18.5
2004	5.3	13.0	18.3
2005	5.8	14.0	19.8
2006	5.5	12.7	18.2
2007	5.4	12.8	18.2
2008	5.1	13.4	18.5
2009	4.7	10.2	14.9
2010	6.3	13.5	19.8
2011	4.7	11.0	15.7
2012	5.7	13.0	18.7
2013	4.9	11.3	16.2
2014	5.6	12.4	18.0
2015 ^b	4.9	12.5	17.4
<i>Average annual percentage change</i>			
1981–2015	^a	1.0%	^a
2005–2015	-1.7%	-1.1%	-1.3%

Source:

1981–1996: Bicycle Manufacturers Association. 1997–on: National Bicycle Dealers Association. (Additional resources: www.nbda.com)

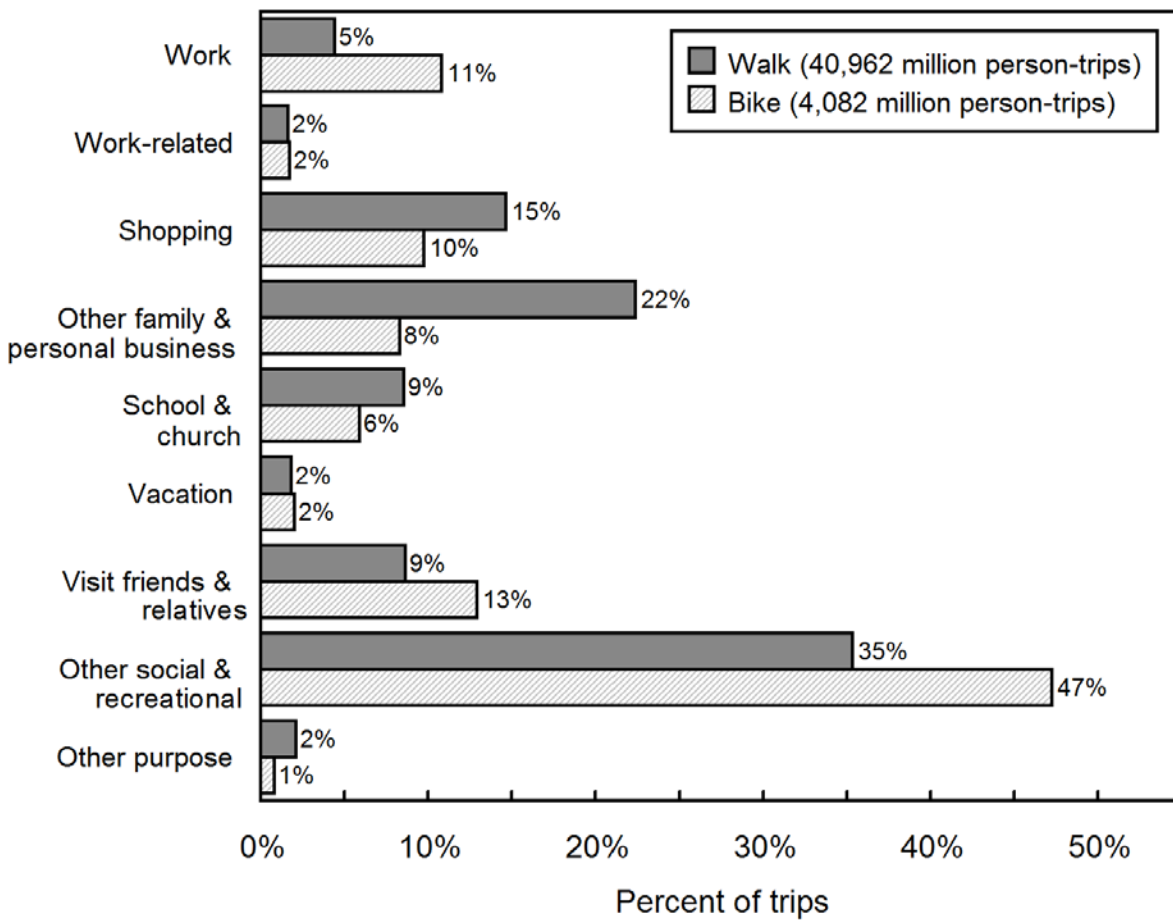
^a Data are not available.

^b Latest year available.



In 2009, 4.5% of walk trips and 10.9% of bike trips were to/from work. Forty-seven percent of all bike trips were for social/recreational purposes. Nearly 15% of walk trips were shopping trips.

Figure 8.8. Walk and Bike Trips by Trip Purpose, 2009 NHTS



Note: Percentages may not sum to totals due to rounding.

Source:

Generated from the 2009 National Household Travel Survey website nhts.ornl.gov.



After 2001 only data on daily trips were collected in the NHTS. The 2001 data are still the latest available on long-distance trips.

Long Distance Trips – 2001 National Household Travel Survey

The 2001 National Household Travel Survey (NHTS) collected data on long-distance trips as well as everyday travel. The everyday travel data is a continuation of the Nationwide Personal Transportation Survey (NPTS), while the long-distance travel data is a continuation of the American Travel Survey (ATS) which was collected in 1977 and 1985. The survey collected trip-related data such as mode of transportation, duration, distance and purpose of trip. It also gathered demographic, geographic, and economic data for analysis purposes.

A long-distance trip is defined as a trip of 50 miles or more, one-way. Long-trip data from the 2001 NHTS were released in the summer of 2004. For additional information about the 2001 NHTS data, contact the Bureau of Transportation Statistics at 202-366-3282 or visit the following website: nhts.ornl.gov.



Table 8.19
Long-Distance Trip^a Characteristics, 2001 NHTS

Trip characteristic	Person trips		Person miles	
	(thousands)	(percent)	(thousands)	(percent)
Total	2,554,068	100.0	1,138,322,697	100.0
Principal means of transportation:				
Personal use vehicles	2,310,376	90.5	735,882,255	64.7
Airplane	165,039	6.5	367,888,741	32.3
Commercial airplane	158,880	6.2	361,717,015	31.8
Bus ^b	52,962	2.1	23,747,433	2.1
Intercity bus	3,456	0.1	1,765,696	0.2
Charter, tour, or school bus	45,952	1.8	21,019,942	1.9
Train	20,672	0.8	9,266,373	0.8
Round trip distance:				
100 to 300 miles	1,688,358	66.1	284,586,370	25.0
300 to 499 miles	373,550	14.6	143,571,597	12.6
500 to 999 miles	261,802	10.3	180,669,482	15.9
1,000 to 1,999 miles	125,665	4.9	178,629,838	15.7
2,000 miles or more	104,694	4.1	350,865,409	30.8
Mean (miles)	446	^c	^c	^c
Median (miles)	206	^c	^c	^c
Calendar quarter:				
1st quarter	566,502	22.2	246,556,190	21.7
2nd quarter	653,310	25.6	298,154,812	26.2
3rd quarter	734,878	28.8	341,021,290	30.0
4th quarter	599,378	23.5	252,590,405	22.2
Main purpose of trip:				
Commuting	329,395	12.9	65,877,968	5.8
Other business	405,866	15.9	242,353,212	21.3
Personal/leisure	1,406,411	55.1	667,471,358	58.7
Personal business	322,645	12.6	130,020,982	11.4
Other	88,230	3.5	32,031,679	2.8
Nights away from home:				
None	1,454,847	57.0	304,469,524	26.8
1 to 3 nights	808,281	31.7	414,219,147	36.4
4 to 7 nights	214,464	8.4	269,265,597	23.7
8 or more nights	76,475	3.0	150,368,429	13.2
Destination:				
Within Census division	2,077,810	81.4	549,651,116	48.3
Across Census division, within Census	196,890	7.7	134,930,113	11.9
Across Census region	279,367	10.9	453,741,468	39.9

Note: Long-distance trips were not included in the 2009 NHTS.

Source:

U.S. Bureau of Transportation Statistics and the U.S. Federal Highway Administration, *2001 National Household Transportation Survey*. (Additional resources: nhts.ornl.gov)

^a A long-distance trip is defined as a trip of 50 miles or more, one-way.

^b Includes other types of buses.

^c Not applicable.



Chapter 9

Nonhighway Modes

Summary Statistics from Tables in this Chapter

Source		
	Passenger-miles	(millions)
Table 9.2	<i>Domestic and international air carrier, 2016</i>	939,222
Table 9.10	<i>Amtrak, 2015</i>	6,536
Table 9.11	<i>Commuter rail, 2015</i>	11,804
Table 9.12	<i>Transit rail, 2015</i>	20,710
	Freight ton-miles	(millions)
Table 9.5	<i>Domestic waterborne commerce, 2015</i>	491,000
Table 9.8	<i>Class I railroad, 2015</i>	1,744,731
	Passenger energy use	(trillion Btu)
Table 9.2	<i>Domestic and international air carrier, 2016</i>	2,385.2
Table 9.3	<i>General aviation, 2015</i>	208.9
Table 9.6	<i>Recreational boats, 2015</i>	246.0
Table 9.10	<i>Amtrak, 2015</i>	10.9
Table 9.11	<i>Commuter rail, 2015</i>	19.4
Table 9.12	<i>Transit rail, 2015</i>	16.1
	Freight energy use	(trillion Btus)
Table 9.8	<i>Class I railroad, 2015</i>	516.4



Nonhighway transportation modes accounted for 18.0% of total transportation energy use in 2015.

Table 9.1
Nonhighway Energy Use Shares, 1970–2015

Year	Share of transportation energy use					Transportation total (trillion Btu) ^a
	Air	Water	Pipeline	Rail	Nonhighway total	
1970	8.5%	5.5%	5.4%	3.5%	22.9%	15,192
1971	8.2%	4.9%	5.4%	3.4%	21.8%	15,819
1972	7.8%	4.7%	5.2%	3.3%	21.0%	16,845
1973	7.7%	5.1%	4.7%	3.3%	20.8%	17,670
1974	7.2%	5.2%	4.5%	3.5%	20.5%	16,968
1975	7.2%	5.4%	4.0%	3.1%	19.7%	17,204
1976	7.0%	5.9%	3.5%	3.1%	19.6%	18,266
1977	7.1%	6.2%	3.3%	3.0%	19.7%	18,951
1978	7.1%	6.9%	3.1%	2.9%	20.1%	19,922
1979	7.6%	5.9%	3.6%	3.0%	20.2%	19,473
1980	7.6%	7.4%	3.9%	3.0%	22.0%	18,760
1981	7.8%	6.8%	4.0%	2.9%	21.6%	18,558
1982	8.0%	5.9%	3.8%	2.5%	20.3%	18,055
1983	7.9%	5.4%	3.2%	2.5%	19.0%	18,188
1984	8.6%	5.1%	3.3%	2.7%	19.7%	18,773
1985	8.8%	4.6%	3.1%	2.5%	19.0%	19,017
1986	9.1%	6.6%	2.9%	2.3%	20.8%	20,086
1987	9.2%	6.7%	3.0%	2.3%	21.2%	20,578
1988	9.4%	6.7%	3.4%	2.3%	21.7%	21,131
1989	9.2%	7.1%	3.4%	2.2%	21.9%	21,487
1990	9.6%	6.7%	3.6%	2.2%	22.1%	21,383
1991	9.1%	7.3%	3.3%	2.1%	21.8%	20,985
1992	9.0%	7.4%	3.2%	2.1%	21.6%	21,646
1993	9.0%	6.5%	3.3%	2.1%	20.9%	22,125
1994	9.1%	6.1%	3.5%	2.2%	20.9%	22,729
1995	9.2%	6.3%	3.5%	2.2%	21.2%	23,263
1996	9.3%	5.9%	3.4%	2.3%	20.9%	23,773
1997	9.5%	5.2%	3.5%	2.2%	20.5%	24,126
1998	9.3%	5.0%	3.0%	2.2%	19.5%	24,461
1999	9.6%	5.3%	2.9%	2.2%	20.0%	25,758
2000	9.8%	5.6%	2.8%	2.1%	20.4%	26,069
2001	9.3%	4.6%	2.8%	2.2%	18.9%	25,741
2002	8.5%	4.7%	2.9%	2.1%	18.3%	26,331
2003	8.5%	4.0%	2.6%	2.2%	17.3%	26,512
2004	9.1%	4.8%	2.5%	2.3%	18.6%	26,970
2005	9.2%	5.0%	2.5%	2.2%	19.0%	27,377
2006	9.1%	5.3%	2.5%	2.3%	19.1%	27,554
2007	8.6%	5.4%	2.5%	2.1%	18.6%	29,013
2008	8.4%	5.1%	2.6%	2.1%	18.3%	28,381
2009	7.9%	5.0%	2.9%	1.8%	17.6%	26,895
2010	8.0%	5.5%	2.9%	2.0%	18.3%	26,974
2011	8.2%	5.3%	3.0%	2.1%	18.6%	26,388
2012	8.0%	4.5%	3.2%	2.1%	17.9%	26,001
2013	7.9%	4.1%	3.6%	2.2%	17.7%	25,905
2014	7.9%	3.5%	3.1%	2.2%	16.7%	26,109
2015	8.2%	4.0%	3.0%	2.2%	17.4%	25,880

Source:

See Appendix A, Section 2.3. Nonhighway Energy Use.

^a Only end-use energy was counted for electricity. Previous editions included primary energy use for electricity which included generation and distribution losses.



These data include ALL international and domestic certificated route air carrier statistics; therefore, the data are different than those in Chapter 2. Revenue aircraft-miles, passenger-miles, and seat-miles began to rise in 2010. Passenger load factor was 83.0% in 2016.

Table 9.2
Summary Statistics for U.S. Domestic and International Certificated
Route Air Carriers (Combined Totals), 1970–2016^a

Year	Revenue aircraft-miles (millions)	Revenue passenger-miles (millions)	Available seat-miles (millions)	Available seats per aircraft ^b	Passenger load factor (percentage) ^c	Revenue cargo ton-miles (millions)	Energy use (trillion Btu) ^d
1970	2,542	148,137	264,904	104	55.9%	3,755	1,363.4
1975	2,241	173,324	315,823	141	54.9%	5,062	1,283.4
1980	2,924	267,722	448,479	153	59.7%	7,885	1,386.0
1985	3,462	351,073	565,677	163	62.1%	9,048	1,701.4
1990	4,724	472,236	753,211	159	62.7%	16,403	2,180.2
1995	5,627	558,794	832,081	148	67.2%	23,375	2,338.6
1996	5,855	596,164	859,721	147	69.3%	24,892	2,409.1
1997	6,025	620,029	880,715	146	70.4%	27,610	2,513.6
1998	6,220	634,933	899,029	145	70.6%	28,015	2,459.5
1999	6,558	668,626	942,311	144	71.0%	25,147	2,665.0
2000	6,946	708,926	981,080	141	72.3%	30,221	2,750.4
2001	6,814	664,849	950,519	139	69.9%	27,882	2,592.5
2002	6,834	655,215	913,898	134	71.7%	30,507	2,430.1
2003	7,367	674,160	922,440	125	73.1%	32,446	2,470.6
2004	7,479	752,341	1,000,193	134	75.2%	37,958	2,657.2
2005	7,716	795,117	1,029,316	133	77.2%	39,286	2,693.3
2006	8,220	810,086	1,027,526	125	78.8%	38,251	2,661.1
2007	8,415	842,007	1,060,093	126	79.4%	38,433	2,684.6
2008	8,142	823,783	1,040,840	128	79.1%	35,227	2,547.8
2009	7,534	779,997	975,307	129	80.0%	30,317	2,303.2
2010	7,666	809,051	991,934	129	81.6%	35,209	2,335.3
2011	7,783	825,916	1,012,597	130	81.6%	35,713	2,370.3
2012	7,727	832,733	1,012,261	131	82.3%	34,937	2,287.7
2013	7,725	848,000	1,025,616	133	82.7%	33,561	2,271.3
2014	7,740	869,688	1,048,107	135	83.0%	34,471	2,265.3
2015	7,877	908,794	1,090,198	138	83.4%	35,011	2,342.1
2016	8,076	939,222	1,131,912	140	83.0%	35,912	2,385.2
<i>Average annual percentage change</i>							
1970–2016	2.5%	4.1%	3.2%	0.6%		5.0%	1.2%
2006–2016	-0.2%	1.5%	1.0%	1.1%		-0.6%	-1.1%

Sources:

U.S. Department of Transportation, Bureau of Transportation Statistics, www.transtats.bts.gov. (Additional resources: www.rita.dot.gov/bts)

1970–76 Energy Use – Department of Transportation, Civil Aeronautics Board, *Fuel Cost and Consumption*, Washington, DC, 1981, and annual.

^a Data are for all U.S. air carriers reporting on Form 41.

^b Available seats per aircraft is calculated as the ratio of available seat-miles to revenue aircraft-miles.

^c Passenger load factor is calculated as the ratio of revenue passenger-miles to available seat-miles for scheduled and nonscheduled services.

^d Energy use includes fuel purchased abroad for international flights.



General aviation includes: (1) aircraft operating under general operating and flight rules; (2) not-for-hire airplanes with a seating capacity of 20 or more or a maximum payload capacity of 6,000 lbs. or more; (3) rotorcraft external load operations; (4) on-demand and commuter operations not covered under Federal Aviation Regulations Part 121; and (5) agricultural aircraft operations.

Table 9.3
Summary Statistics for General Aviation, 1970–2015

Calendar year	Total number of aircraft	Aircraft hours flown (thousands)	Energy use (trillion Btu)
1970	131,700 ^a	26,030 ^b	94.3
1975	168,475	30,298	110.7
1980	211,045	41,016	165.9
1985	196,500	31,456	143.9
1986	205,300	31,782	147.9
1987	202,700	30,883	139.1
1988	196,200	31,114	148.5
1989	205,000	32,332	134.1
1990	198,000	32,096	131.8
1991	196,874	29,862	120.0
1992	185,650	26,747	103.7
1993	177,120	24,455	93.6
1994	172,935	24,092	95.3
1995	188,089	26,612	106.6
1996	191,129	26,909	111.0
1997	192,414	27,713	121.1
1998	204,710	28,100	147.4
1999	219,464	31,231	172.1
2000	217,533	29,960	175.2
2001	211,446	27,017	165.1
2002	211,244	27,040	141.5
2003	209,708	27,329	141.4
2004	219,426	28,126	175.9
2005	224,352	26,982	242.4
2006	221,943	27,705	256.3
2007	231,607	27,852	243.6
2008	228,663	26,009	265.7
2009	223,877	23,763	210.3
2010	223,370	24,802	221.2
2011	220,770	24,570	227.1
2012	209,034	24,403	228.8
2013	199,927	22,876	203.6
2014	204,408	23,271	221.0
2015	210,030	24,142	208.9
<i>Average annual percentage change</i>			
1970–2015	1.0%	-0.2%	1.8%
2005–2015	-0.7%	-1.1%	-1.5%

Sources:

U.S. Department of Transportation, Federal Aviation Administration, *General Aviation and Part 135 Activity Surveys, CY 2015*, Tables 1.1, 1.4, 5.1, and annual. 2011 Data: *Aviation Forecasts*, Tables 28 and 29, May 2013. (Additional resources: www.faa.gov/data-research/aviation_data_statistics/general_aviation)

^a Active fixed-wing general aviation aircraft only.

^b Includes rotorcraft.



In the early seventies, domestic waterborne commerce accounted for over 60% of total tonnage, but by 1994 foreign tonnage grew to more than half of all waterborne tonnage. Total foreign and domestic tons shipped were about 2.28 billion tons in 2015, down from a peak of 2.59 billion tons in 2006.

Table 9.4
Tonnage Statistics for Domestic and International Waterborne Commerce, 1970–2015
(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%
1975	1,695	749	946	55.8%
1980	1,999	921	1,077	53.9%
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%
1990	2,164	1,042	1,122	51.8%
1991	2,092	1,014	1,079	51.6%
1992	2,132	1,037	1,095	51.4%
1993	2,128	1,060	1,068	50.2%
1994	2,215	1,116	1,099	49.6%
1995	2,240	1,147	1,093	48.8%
1996	2,284	1,183	1,101	48.2%
1997	2,333	1,221	1,113	47.7%
1998	2,340	1,245	1,094	46.8%
1999	2,323	1,261	1,062	45.7%
2000	2,425	1,355	1,070	44.1%
2001	2,393	1,351	1,042	43.5%
2002	2,340	1,319	1,021	43.6%
2003	2,394	1,378	1,016	42.4%
2004	2,552	1,505	1,047	41.0%
2005	2,527	1,499	1,029	40.7%
2006	2,588	1,565	1,023	39.5%
2007	2,564	1,543	1,022	39.9%
2008	2,477	1,521	956	38.6%
2009	2,211	1,354	857	38.8%
2010	2,335	1,441	894	38.3%
2011	2,368	1,480	888	37.5%
2012	2,307	1,422	885	38.4%
2013	2,274	1,383	891	39.2%
2014	2,346	1,409	937	39.9%
2015	2,279	1,374	905	39.7%
<i>Average annual percentage change</i>				
1970–2015	0.9%	1.9%	-0.1%	
2005–2015	-1.0%	-0.9%	-1.3%	

Source:

U.S. Department of the Army, Corps of Engineers, *The U.S. Waterway System, Transportation Facts and Information Fact Card*, December 2016. (Additional resources: www.navigationdatacenter.us/index.htm)

^a All movements between the United States and foreign countries and between Puerto Rico and the 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 United States, Puerto Rico, and the Virgin Islands, excluding the Panama Canal. Beginning in 1996, fish was excluded for internal and intra-port domestic traffic.



The U.S. Army Corps of Engineers Navigation Data Center collects a wealth of waterborne commerce data. Energy use data, however, have never been collected as part of this effort. The energy use data collected by the Energy Information Administration (EIA) on vessel bunkering was formerly displayed on this table. The EIA data include different uses of fuel, not just fuel for domestic waterborne commerce; therefore it was misleading to display those data together.

Table 9.5
Summary Statistics for Domestic Waterborne Commerce, 1970–2015

Year	Number of vessels ^a	Ton-miles (billions)	Tons shipped ^b (millions)	Average length of haul (miles)
1970	25,832	596	949	628.2
1975	31,666	566	944	599.9
1980	38,792	922	1,074	856.4
1985	41,672	893	1,011	883.5
1990	41,119	834	1,118	745.7
1995	39,445	808	1,086	743.6
1996	41,104	765	1,093	699.4
1997	41,419	707	1,106	639.5
1998	42,032	673	1,087	619.0
1999	41,766	656	1,056	621.1
2000	39,641	646	1,064	606.8
2001	41,588	622	1,037	599.7
2002	41,002	612	1,016	602.5
2003	39,983	606	1,010	600.3
2004	40,290	621	1,042	596.4
2005	41,354	591	1,024	577.4
2006	41,109	562	1,018	548.7
2007	40,695	553	1,016	544.2
2008	40,301	521	952	546.7
2009	40,109	477	852	559.7
2010	40,512	503	894	562.8
2011	40,521	500	888	563.5
2012	40,530	475	885	536.5
2013	39,999	465	891	521.8
2014	40,082	505	937	538.4
2015	40,555	491	905	542.2
<i>Average annual percentage change</i>				
1970–2015	1.0%	-0.4%	-0.1%	-0.3%
2005–2015	-0.2%	-1.8%	-1.2%	-0.6%

Sources:

Number of vessels 1970–92, 1995–2010 – U.S. Department of the Army, Corps of Engineers, *Waterborne Transportation Lines of the United States, 2011*, New Orleans, LA, 2012, Table 2, p. 6, and annual. 1993–94 – U.S. Department of the Army, Corps of Engineers, *The U.S. Waterway System-Facts*, Navigation Data Center, New Orleans, Louisiana, January 1996.

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 2011, Part 5: National Summaries*, New Orleans, LA, 2012, Table 1-4, pp. 1-6, 1-7, and annual. (Additional resources: www.navigationdatacenter.us/index.htm)

Number of vessels, ton-miles, tons shipped and average length of haul, 2011–2015 – U.S. Department of the Army, Corps of Engineers, *The U.S. Waterway System, Transportation Facts and Information Fact Card*, December 2016.

^a Grand total for self-propelled and non-self-propelled.

^b These figures are not consistent with the figures on Table 9.4 because intra-territory tons are not included in this table. Intra-territory traffic is traffic between ports in Puerto Rico and the Virgin Islands.



The data displayed in this table come from the Environmental Protection Agency's MOVES2014a model.

Table 9.6
Recreational Boat Energy Use, 1970–2015

Year	Number of boats (thousands)	Diesel fuel	Gasoline (trillion Btu)	Total energy use
1970	10,087	5.5	151.7	157.2
1975	10,337	10.7	156.4	167.1
1976	10,387	11.8	157.4	169.1
1977	10,437	12.8	158.3	171.1
1978	10,487	13.9	159.3	173.1
1979	10,537	14.9	160.2	175.1
1980	10,587	16.0	161.2	177.1
1981	10,637	17.0	162.1	179.1
1982	10,687	18.0	163.1	181.1
1983	10,737	19.1	164.0	183.1
1984	10,787	20.1	165.0	185.1
1985	10,837	21.2	165.9	187.1
1986	10,887	22.2	166.9	189.1
1987	10,937	23.3	167.8	191.1
1988	11,030	24.3	170.4	194.7
1989	11,122	25.4	172.9	198.3
1990	11,215	26.4	175.4	201.8
1991	11,327	27.5	178.7	206.2
1992	11,440	28.5	182.0	210.5
1993	11,553	29.5	185.3	214.8
1994	11,770	30.6	192.5	223.1
1995	11,988	31.6	199.7	231.3
1996	12,206	32.7	206.8	239.5
1997	12,244	33.7	207.2	240.9
1998	12,283	34.8	207.4	242.2
1999	12,321	35.8	207.1	243.0
2000	12,359	36.8	206.6	243.4
2001	12,464	37.9	206.9	244.9
2002	12,568	39.0	206.7	245.7
2003	12,673	40.2	206.0	246.2
2004	12,777	41.3	205.0	246.2
2005	12,882	42.4	203.7	246.1
2006	12,984	43.5	202.5	245.9
2007	13,086	44.6	201.2	245.8
2008	13,189	45.7	200.0	245.7
2009	13,291	46.8	198.8	245.6
2010	13,393	47.9	197.3	245.2
2011	13,497	49.0	195.9	244.9
2012	13,602	50.1	194.7	244.8
2013	13,707	51.2	193.8	245.0
2014	13,811	52.3	193.1	245.4
2015	13,916	53.4	192.6	246.0
<i>Average annual percentage change</i>				
1970–2015	0.7%	5.2%	0.5%	1.0%
2005–2015	0.8%	2.3%	-0.6%	0.0%

Source:

U.S. Environmental Protection Agency, MOVES2014a model, www3.epa.gov/otaq/models/moves.



The Interstate Commerce Commission designates Class I railroads on the basis of annual gross revenues. In 2015, seven railroads were given this designation. The number of railroads designated as Class I has changed considerably in the last 30 years; in 1976 there were 52 railroads given Class I designation.

Table 9.7
Class I Railroad Freight Systems in the United States
Ranked by Revenue Ton-Miles, 2015

Railroad	Revenue ton-miles (billions)	Percent
Burlington Northern and Santa Fe Railway Company	702	40.2%
Union Pacific Railroad Company	485	27.8%
CSX Transportation	230	13.2%
Norfolk Southern Railway	200	11.4%
Canadian National, Grand Trunk Corporation	61	3.5%
Canadian Pacific Soo Railway	36	2.1%
Kansas City Southern Railway Company	31	1.8%
Total	1,745	100.0%

Source:

Association of American Railroads, *Railroad Facts, 2016 Edition*, Washington, DC, September 2016, p. 68.
 (Additional resources: www.aar.org)



Revenue ton-miles for Class I freight railroads was over 1.7 trillion in 2015. Though there are many regional and local freight railroads, the Class I freight railroads accounted for 94% of the railroad industry's freight revenue in 2015 and 69% of the industry's mileage operated. The energy intensity of Class I railroads hit an all-time low of 289 Btu/ton-mile in 2010 and continued to be below 300 Btu/ton-mile in 2015.

Table 9.8
Summary Statistics for Class I Freight Railroads, 1970–2015

Year	Number of locomotives in service ^a	Number of freight cars (thousands) ^b	Train-miles (millions)	Car-miles (millions)	Tons originated ^c (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	1,485	515	764,809	691	528.1
1975	27,846	1,359	403	27,656	1,395	541	754,252	687	518.3
1980	28,094	1,168	428	29,277	1,492	616	918,958	597	548.7
1985	22,548	867	347	24,920	1,320	665	876,984	497	436.1
1986	20,790	799	347	24,414	1,306	664	867,722	486	421.5
1987	19,647	749	361	25,627	1,372	688	943,747	456	430.3
1988	19,364	725	379	26,339	1,430	697	996,182	443	441.4
1989	19,015	682	383	26,196	1,403	723	1,013,841	437	442.6
1990	18,835	659	380	26,159	1,425	726	1,033,969	420	434.7
1991	18,344	633	375	25,628	1,383	751	1,038,875	391	405.8
1992	18,004	605	390	26,128	1,399	763	1,066,781	393	419.2
1993	18,161	587	405	26,883	1,397	794	1,109,309	389	431.6
1994	18,505	591	441	28,485	1,470	817	1,200,701	388	465.4
1995	18,812	583	458	30,383	1,550	843	1,305,688	372	485.9
1996	19,269	571	469	31,715	1,611	842	1,355,975	368	499.4
1997	19,684	568	475	31,660	1,585	851	1,348,926	370	499.7
1998	20,261	576	475	32,657	1,649	835	1,376,802	365	502.0
1999	20,256	579	490	33,851	1,717	835	1,433,461	363	520.0
2000	20,028	560	504	34,590	1,738	843	1,465,960	352	516.0
2001	19,745	500	500	34,243	1,742	859	1,495,472	346	517.3
2002	20,506	478	500	34,680	1,767	853	1,507,011	345	520.3
2003	20,774	467	516	35,555	1,799	862	1,551,438	344	533.9
2004	22,015	474	535	37,071	1,844	902	1,662,598	341	566.2
2005	22,779	475	548	37,712	1,899	894	1,696,425	337	571.4
2006	23,732	475	563	38,995	1,957	906	1,771,897	330	584.5
2007	24,143	460	543	38,186	1,940	913	1,770,545	320	566.9
2008	24,003	450	524	37,226	1,934	919	1,777,236	305	542.5
2009	24,045	416	436	32,115	1,668	919	1,532,214	291	446.6
2010	23,893	398	476	35,541	1,851	914	1,691,004	289	488.1
2011	24,250	381	493	36,649	1,885	917	1,729,256	298	514.6
2012	24,707	381	500	36,525	1,760	973	1,712,567	294	504.0
2013	25,033	374	504	35,253	1,758	990	1,740,687	296	514.9
2014	25,916	372	518	37,193	1,840	1,006	1,851,229	292	540.5
2015	26,574	331	495	35,861	1,731	1,008	1,744,731	296	516.4
<i>Average annual percentage change</i>									
1970–2015	0.0%	-3.2%	0.3%	0.4%	0.3%	1.5%	1.8%	-1.9%	0.0%
2005–2015	1.6%	-3.5%	-1.0%	-0.5%	-0.9%	1.2%	0.3%	-1.3%	-1.0%

Source:

Association of American Railroads, *Railroad Facts, 2016 Edition*, Washington, DC, September 2016, pp. 30, 31, 36, 37, 39, 51, and 69. (Additional resources: www.aar.org)

^a Does not include self-powered units.

^b Does not include private or shipper-owned cars. Beginning in 2001, Canadian-owned U.S. railroads are excluded.

^c Tons originated is a more accurate representation of total tonnage than revenue tons. Revenue tons often produces double-counting of loads switched between rail companies.

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



According to the 2012 Commodity Flow Survey, 7% of all freight ton-miles are rail intermodal shipments (truck/rail or rail/water). See Table 5.16 for details. The number of trailers and containers moved by railroads has increased more than eight-fold from 1965 to 2015. Containerization has increased in the last two decades, evidenced by the 432% increase in the number of containers from 1988 to 2015. The number of trailers moved by rail fell to an all-time low in 2013 but has increased for the last two years.

Table 9.9
Intermodal Rail Traffic, 1965–2015^a

Year	Trailers & containers	Trailers	Containers
1965	1,664,929	b	b
1970	2,363,200	b	b
1975	2,238,117	b	b
1980	3,059,402	b	b
1985	4,590,952	b	b
1986	4,997,229	b	b
1987	5,503,819	b	b
1988	5,779,547	3,481,020	2,298,527
1989	5,987,355	3,496,262	2,491,093
1990	6,206,782	3,451,953	2,754,829
1991	6,246,134	3,201,560	3,044,574
1992	6,627,841	3,264,597	3,363,244
1993	7,156,628	3,464,126	3,692,502
1994	8,128,228	3,752,502	4,375,726
1995	7,936,172	3,492,463	4,443,709
1996	8,143,258	3,302,128	4,841,130
1997	8,698,308	3,453,907	5,244,401
1998	8,772,663	3,353,032	5,419,631
1999	8,907,626	3,207,407	5,700,219
2000	9,176,890	2,888,630	6,288,260
2001	8,935,444	2,603,423	6,332,021
2002	9,312,360	2,531,338	6,781,022
2003	9,955,605	2,625,837	7,329,768
2004	10,993,662	2,928,123	8,065,539
2005	11,693,512	2,979,906	8,713,606
2006	12,282,221	2,882,699	9,399,522
2007	12,026,631	2,600,635	9,425,996
2008	11,499,978	2,478,890	9,021,088
2009	9,875,967	1,639,603	8,236,364
2010	11,283,151	1,684,684	9,598,467
2011	11,892,418	1,698,615	10,193,803
2012	12,267,416	1,518,323	10,749,093
2013	12,831,311	1,483,938	11,347,373
2014	13,496,822	1,550,124	11,946,698
2015	13,710,646	1,475,754	12,234,892
<i>Average annual percentage change</i>			
1965–2015	4.3%	b	b
2005–2015	1.6%	-6.8%	3.5%

Source:

Association of American Railroads, *Railroad Facts, 2016 Edition*, Washington, DC, September 2016, p. 29.
(Additional resources: www.aar.org)

^a Beginning in 1995, the Grand Trunk Western Railroad and the Soo Line Railroad Company are excluded. Beginning in 1999, the Illinois Central data are excluded. Beginning in 2002, the Wisconsin Central data are excluded.

^b Data are not available.



The National Railroad Passenger Corporation, known as Amtrak, began operation in 1971. Amtrak revenue passenger-miles have grown at an average annual rate of 2.7% from 1971 to 2015.

Table 9.10
Summary Statistics for the National Railroad Passenger Corporation (Amtrak), 1971–2015

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) ^a
1971	^a	1,165	16,537	140,147	1,993	188	^b	^b
1975	355	1,913	30,166	253,898	3,753	224	3,311	12.4
1980	448	2,128	29,487	235,235	4,503	217	2,859	12.9
1985	382	1,818	30,038	250,642	4,785	238	2,237	10.7
1990	318	1,863	33,000	300,996	6,057	273	2,052	12.4
1991	316	1,786	34,000	312,484	6,273	285	2,011	12.6
1992	336	1,796	34,000	307,282	6,091	286	2,117	12.9
1993	360	1,853	34,936	302,739	6,199	280	2,142	13.3 ^c
1994	411	1,874	34,940	305,600	5,869	276	1,917	11.3
1995	422	1,907	31,579	282,579	5,401	266	2,071	11.2
1996	348	1,501	30,542	277,750	5,066	257	2,194	11.1
1997	292	1,572	32,000	287,760	5,166	255	2,289	11.8
1998	362	1,347	32,926	315,823	5,325	251	2,246	12.0
1999	385	1,285	34,080	349,337	5,289	245	2,362	12.5
2000	385	1,891	35,404	371,215	5,574	243	2,651	14.8
2001	401	2,084	36,512	377,705	5,571	238	2,690	15.0
2002	372	2,896	37,624	378,542	5,314	228	2,537	13.5
2003	442	1,623	37,459	331,864	5,680	231	2,145	12.2
2004	276	1,211	37,159	308,437	5,511	219	2,068	11.4
2005	258	1,186	36,199	264,796	5,381	215	2,025	10.9
2006	319	1,191	36,083	263,908	5,410	220	1,948	10.5
2007	270	1,164	37,484	266,545	5,784	218	1,824	10.5
2008	278	1,177	37,736	271,762	6,179	215	1,745	10.8
2009	274	1,214	38,300	282,764	5,914	217	1,773	10.5
2010	282	1,274	37,453	294,820	6,420	220	1,668	10.7
2011	287	1,301	37,090	296,315	6,568	213	1,628	10.7
2012	485	2,090	37,640	319,088	6,804	218	1,561	10.6
2013	418	1,447	38,410	324,949	6,810	218	1,559	10.6
2014	428	1,419	38,013	324,683	6,675	218	1,641	11.0
2015	423	1,428	37,798	319,464	6,536	218	1,663	10.9
<i>Average annual percentage change</i>								
1971–2015	^b	0.5%	1.9%	1.9%	2.7%	0.3%	^b	^a
2005–2015	5.1%	1.9%	0.4%	1.9%	2.0%	0.1%	-2.0%	0.0%

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.

1989–93 – Personal communication with the Corporate Accounting Office of Amtrak, Washington, DC.

1994–2015 – Number of locomotives in service, number of passenger cars, train-miles, car-miles, revenue passenger-miles, and average trip length - Association of American Railroads, *Railroad Facts*, 2016 Edition, Washington, DC, 2016, p. 77.

Energy use – Personal communication with the Amtrak, Washington, DC. (Additional resources: www.amtrak.com, www.aar.org)

^a Only end-use energy was counted for electricity. Previous editions included primary energy use for electricity which included generation and distribution losses.

^b Data are not available.

^c Energy use for 1994 on is not directly comparable to earlier years. Some commuter rail energy use may have been inadvertently included in earlier years.



Commuter rail, which is also known as regional rail or suburban rail, is long-haul rail passenger service operating between metropolitan and suburban areas, whether within or across state lines. Commuter rail lines usually have reduced fares for multiple rides and commutation tickets for regular, recurring riders.

Table 9.11
Summary Statistics for Commuter Rail Operations, 1984–2015

Year	Number of passenger vehicles	Vehicle-miles (millions)	Passenger trips (millions)	Passenger-miles (millions)	Average trip length (miles)	Energy intensity (Btu/passenger-mile) ^a	Energy use (trillion Btu) ^a
1984	4,075	167.9	267	6,207	23.2	1,798	11.2
1985	4,035	182.7	275	6,534	23.8	1,720	11.2
1986	4,440	188.6	306	6,723	22.0	1,720	11.6
1987	4,686	188.9	311	6,818	21.9	1,628	11.1
1988	4,649	202.2	325	6,964	21.4	1,666	11.4
1989	4,472	209.6	330	7,211	21.9	1,622	11.7
1990	4,982	212.7	328	7,082	21.6	1,622	11.5
1991	5,126	214.9	318	7,344	23.1	1,601	11.8
1992	5,164	218.8	314	7,320	23.3	1,565	11.5
1993	4,982	223.9	322	6,940	21.6	1,782	12.4
1994	5,126	230.8	339	7,996	23.6	1,605	12.8
1995	5,164	237.7	344	8,244	24.0	1,580	13.0
1996	5,240	241.9	352	8,351	23.7	1,541	12.9
1997	5,426	250.7	357	8,038	22.5	1,630	13.1
1998	5,536	259.5	381	8,704	22.8	1,612	14.0
1999	5,550	265.9	396	8,766	22.1	1,670	14.6
2000	5,498	270.9	413	9,402	22.8	1,542	14.5
2001	5,572	277.3	419	9,548	22.8	1,533	14.6
2002	5,724	283.7	414	9,504	22.9	1,542	14.7
2003	5,959	286.0	410	9,559	23.3	1,542	14.7
2004	6,228	294.7	414	9,719	23.5	1,536	14.9
2005	6,392	303.4	423	9,473	22.4	1,658	15.7
2006	6,403	314.7	441	10,361	23.5	1,539	15.9
2007	6,391	325.7	459	11,153	24.3	1,543	17.2
2008	6,617	310.2	472	11,049	23.4	1,579	17.4
2009	6,941	343.5	468	11,232	24.0	1,714	19.2
2010	6,927	345.3	464	10,874	23.4	1,753	19.1
2011	7,193	345.2	466	11,427	24.5	1,681	19.2
2012	7,059	346.4	471	11,181	23.7	1,703	19.0
2013	7,310	359.1	480	11,862	24.7	1,676	19.9
2014	7,337	370.8	490	11,718	23.9	1,638	19.2
2015	7,301	373.7	498	11,804	23.7	1,643	19.4
<i>Average annual percentage change</i>							
1984–2015	1.9%	2.6%	2.0%	2.1%	0.1%	-0.3%	1.8%
2005–2015	1.3%	2.1%	1.6%	2.2%	0.6%	-0.1%	2.1%

Sources:

1984–2014: American Public Transportation Association, *2016 Public Transportation Fact Book*, Washington, DC, April 2016, Appendix A. (Additional resources: www.apta.com)

2015: U.S. Department of Transportation, Federal Transit Administration, 2015 National Transit Database, accessed September 2017. (Additional resources: www.transit.gov/ntd)

^a Only end-use energy was counted for electricity. Previous editions included primary energy use for electricity which included generation and distribution losses.



This table on transit rail operations includes data on light rail and heavy rail systems. Light rail vehicles are usually single vehicles driven electrically with power drawn from overhead wires. Heavy rail is characterized by high speed and rapid acceleration of rail cars operating on a separate right-of-way.

Table 9.12
Summary Statistics for Rail Transit Operations, 1970–2015^a

Year	Number of passenger vehicles	Vehicle-miles (millions)	Passenger trips (millions) ^b	Passenger-miles (millions) ^c	Average trip length (miles) ^d	Energy intensity (Btu/passenger-mile) ^e	Energy use (trillion Btu) ^e
1970	10,548	440.8	2,116	12,273	^f	712	8.7
1975	10,617	446.9	1,797	10,423	^f	866	9.0
1980	10,654	402.2	2,241	10,939	4.9	763	8.3
1985	11,109	467.8	2,422	10,777	4.4	927	10.0
1990	11,332	560.9	2,521	12,046	4.8	998	12.0
1995	11,156	571.8	2,284	11,419	5.0	1,102	12.6
1996	11,341	580.7	2,418	12,487	5.2	996	12.4
1997	11,471	598.9	2,692	13,091	4.9	943	12.3
1998	11,521	609.5	2,669	13,412	5.0	931	12.5
1999	11,603	626.4	2,813	14,108	5.0	919	13.0
2000	12,168	648.0	2,952	15,200	5.1	923	14.0
2001	12,084	662.4	3,064	15,615	5.1	925	14.4
2002	12,479	681.9	3,025	15,095	5.0	948	14.3
2003	12,236	694.2	3,005	15,082	5.0	936	14.1
2004	12,480	709.7	3,098	15,930	5.1	907	14.5
2005	12,755	715.4	3,189	16,118	5.1	919	14.8
2006	12,853	726.4	3,334	16,587	5.0	893	14.8
2007	13,032	741.2	3,879	18,070	4.7	851	15.4
2008	13,346	762.8	4,001	18,941	4.7	832	15.8
2009	13,529	775.3	3,955	19,004	4.8	830	15.8
2010	13,614	759.6	4,007	18,580	4.6	832	15.5
2011	13,328	744.1	4,083	19,520	4.8	812	15.8
2012	12,455	749.5	4,192	19,835	4.7	791	15.7
2013	12,434	774.3	4,275	20,381	4.8	793	16.2
2014	12,608	780.9	4,411	20,829	4.7	786	16.4
2015	12,820	803.2	4,339	20,710	4.8	776	16.1
<i>Average annual percentage change</i>							
1970–2015	0.4%	1.3%	1.6%	1.2%	-0.1% ^g	0.2%	1.4%
2005–2015	0.1%	1.2%	3.1%	2.5%	-0.6%	-1.7%	0.8%

Sources:

1970–2014: American Public Transportation Association, *2016 Public Transportation Fact Book*, Washington, DC, April 2016, Appendix A. (Additional resources: www.apta.com)

2015: U.S. Department of Transportation, Federal Transit Administration, 2015 National Transit Database, accessed September 2017. (Additional resources: www.transit.gov/ntd)

Energy use – See Appendix A for Rail Transit Energy Use.

^a Heavy rail and light rail. 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 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 Only end-use energy was counted for electricity. Previous editions included primary energy use for electricity which included generation and distribution losses. Large system-to-system variations exist for energy intensities.

^f Data are not available.

^g Average annual percentage change is calculated for years 1980–2015.





Chapter 10

Transportation and the Economy

Summary Statistics from Tables/Figures in this Chapter

Source		
Table 10.1	Average household transportation expenditures, 2015	17.0%
Figure 10.2	Share of gasoline cost attributed to taxes, 2016	
	<i>Canada</i>	38%
	<i>France</i>	66%
	<i>Germany</i>	66%
	<i>Japan</i>	54%
	<i>United Kingdom</i>	70%
	<i>United States</i>	21%
Table 10.13	Average price of a new car, 2016 (current dollars)	25,774
	<i>Domestic</i>	24,414
	<i>Import</i>	29,913
Table 10.14	Car operating costs, 2016	
	<i>Variable costs (constant 2016 dollars per 10,000 miles)</i>	1,473
	<i>Fixed costs (constant 2016 dollars per 10,000 miles)</i>	6,072
Table 10.18	Transportation sector share of total employment	
	<i>2000</i>	8.3%
	<i>2016</i>	7.5%



Adjusting Dollar Amounts for Inflation

A dollar spent in 1970 does not have the purchasing power of a dollar spent in 2016 due to the inflation of prices for all goods and services. Thus, prices in a historical series must be adjusted in order to provide proper comparison. The term “current dollars” is used in this report for dollar amounts that were current as of the year listed – this can also be referred to as “nominal dollars.” The term “constant 2016 dollars” is used in this report for dollar amounts that have been adjusted to a constant purchasing power (2016, in this example) and thus the data are comparable historically – this can also be referred to as “real dollars.”

Appendix B, Table B.17 contains the Consumer Price Inflation Index and Table B.18 contains the Gross National Product Implicit Price Deflator for years 1970 to 2016. Tables in the report with constant dollars have a footnote indicating which of these inflation adjustment indices were used.



The Transportation Services Index (TSI) was created by the U.S. Department of Transportation Bureau of Transportation Statistics (BTS). It is an index that measures the movement of freight and passengers.

The Freight TSI consists of:

- for-hire trucking (parcel services are not included);
- freight railroad services (including rail-based intermodal shipments such as containers on flat cars);
- inland waterway traffic;
- pipeline movements (including principally petroleum and petroleum products and natural gas); and
- air freight.

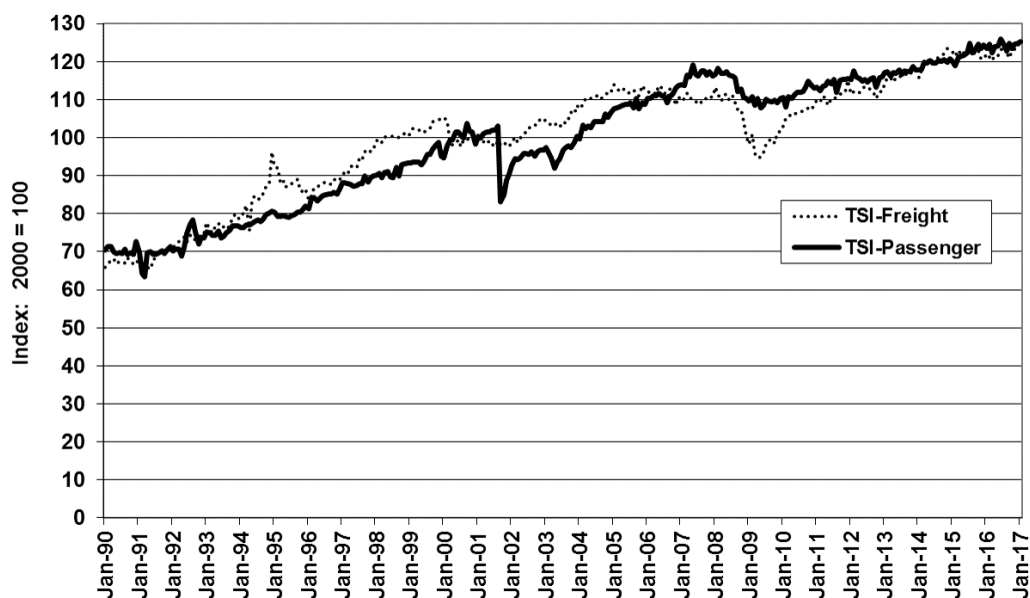
The index does not include international or coastal steamship movements, private trucking, courier services, or the United States Postal Services.

The Passenger TSI consists of:

- local mass transit;
- intercity passenger rail; and
- passenger air transportation.

The index does not include intercity bus, sightseeing services, taxi service, private car usage, or bicycling and other nonmotorized means of transportation.

Figure 10.1. Transportation Services Index, January 1990–January 2017



Source:

U.S. Department of Transportation, Bureau of Transportation Statistics, Transportation Services Index website, www.transtats.bts.gov/OSEA/TSI/. (Additional resources: www.bts.gov)



Table 10.1
Average Annual Expenditures of Households by Income, 2015^a

	All households	Income before taxes			
		Less than \$15,000	\$15,000–\$29,999	\$30,000–\$39,999	\$40,000–\$49,999
Total expenditures	\$55,978	\$23,479	\$30,974	\$38,634	\$42,529
Percentage of total expenditures ^b					
Food ^c	12.5%	16.0%	14.2%	14.4%	12.3%
Housing	32.9%	40.5%	38.2%	35.5%	35.5%
Apparel and services	3.3%	3.1%	3.2%	3.3%	2.7%
Transportation	17.0%	14.5%	16.4%	16.8%	19.3%
Vehicle purchases (net outlay)	7.1%	4.5%	6.0%	6.3%	8.6%
Gasoline and motor oil	3.7%	3.8%	4.2%	4.5%	4.7%
Other vehicle expenditures	4.9%	5.4%	5.3%	5.3%	5.2%
Public transportation	1.2%	0.8%	0.9%	0.7%	0.9%
Health care	7.8%	7.3%	9.7%	9.3%	8.8%
Entertainment	5.1%	4.9%	5.1%	5.0%	4.9%
Personal Insurance & pensions	11.3%	2.0%	3.8%	6.6%	7.6%
Others ^d	9.1%	10.8%	8.8%	8.5%	7.9%
Households ^e (thousands)	128,437	17,946	23,162	12,536	10,914
Percentage of households	100.0%	14.0%	18.0%	9.8%	8.5%
Average number of vehicles in HH	1.9	0.8	1.3	1.7	1.9

		Income before taxes			
		\$50,000–\$69,999	\$70,000–\$99,999	\$100,000–\$149,999	\$150,000–\$200,000 and over
Total expenditures	\$51,394	\$66,008	\$86,140	\$113,272	\$158,731
Percentage of total expenditures ^b					
Food ^c	12.8%	12.9%	12.0%	11.9%	9.6%
Housing	33.5%	31.6%	30.2%	29.3%	30.2%
Apparel and services	2.8%	3.2%	3.0%	3.7%	4.4%
Transportation	19.1%	18.0%	18.3%	14.9%	13.9%
Vehicle purchases (net outlay)	8.1%	8.0%	8.4%	5.9%	6.0%
Gasoline and motor oil	4.5%	4.0%	3.6%	2.8%	2.1%
Other vehicle expenditures	5.5%	5.0%	5.1%	4.7%	3.6%
Public transportation	1.0%	1.0%	1.2%	1.5%	2.2%
Health care	8.6%	8.2%	7.3%	6.5%	5.2%
Entertainment	4.7%	4.9%	5.2%	5.8%	5.2%
Personal Insurance & pensions	9.9%	12.1%	14.0%	16.4%	18.5%
Others ^d	7.7%	8.1%	9.2%	10.5%	12.0%
Households ^e (thousands)	18,112	18,168	15,616	6,020	5,964
Percentage of households	14.1%	14.1%	12.2%	4.7%	4.6%
Average number of vehicles in HH	2.1	2.4	2.7	2.8	2.8

Source:

U.S. Department of Labor, Bureau of Labor Statistics, website: www.bls.gov/cex, July 2017. (Additional resources: www.bls.gov)

^a Public assistance monies are included in reported income. Data for those reporting incomes.

^b Percentages may not sum to totals due to rounding.

^c Includes alcoholic beverages.

^d Includes personal care, reading, education, tobacco and smoking supplies, cash contributions, and miscellaneous items.

^e The term household refers to a “consumer unit,” which is defined differently than households on Table 8.1.



The average amount of money that a household spends in a year has changed very little between 1985 and 2015 in constant dollar terms. Expenditures on transportation were 19.4% of the total in 1985, but were 17.0% in 2015. Vehicle purchases made up more than one-third of transportation expenditures in 2015, while gas and oil were 22%.

Table 10.2
Annual Household Expenditures for Transportation, 1985-2015
(constant 2015 dollars)

Year	Transportation expenditures					Average annual household expenditures	Transportation share of annual expenditures
	Vehicle purchases	Gas & Oil	Other vehicle expenses ^a	Public transportation	Total transportation		
1985	4,544	2,304	2,811	584	10,241	52,813	19.4%
1986	5,056	1,996	2,971	541	10,564	52,851	20.0%
1987	4,206	1,838	2,986	540	9,572	51,693	18.5%
1988	4,784	1,871	3,111	533	10,298	52,871	19.5%
1989	4,488	1,887	3,181	531	10,087	54,137	18.6%
1990	3,937	1,911	3,025	549	9,423	52,702	17.9%
1991	3,748	1,737	3,091	536	9,110	53,054	17.2%
1992	3,661	1,644	3,051	485	8,839	51,571	17.1%
1993	3,796	1,603	3,097	522	9,015	51,563	17.5%
1994	4,323	1,583	3,181	629	9,717	52,361	18.6%
1995	4,162	1,577	3,208	571	9,520	52,251	18.2%
1996	4,414	1,671	3,243	647	9,973	53,765	18.5%
1997	4,218	1,639	3,414	576	9,848	53,378	18.5%
1998	4,425	1,498	3,323	621	9,866	54,179	18.2%
1999	4,847	1,524	3,322	580	10,275	55,688	18.5%
2000	4,771	1,811	3,228	607	10,417	55,384	18.8%
2001	5,056	1,726	3,275	542	10,598	55,400	19.1%
2002	4,977	1,650	3,360	532	10,519	56,069	18.8%
2003	4,986	1,743	3,112	515	10,358	55,058	18.8%
2004	4,262	2,005	2,967	553	9,788	54,449	18.0%
2005	4,301	2,443	2,839	544	10,126	56,322	18.0%
2006	4,022	2,618	2,769	594	10,003	56,901	17.6%
2007	3,708	2,725	2,963	615	10,011	56,742	17.6%
2008	3,033	2,989	2,885	565	9,472	55,578	17.0%
2009	2,935	2,194	2,802	529	8,460	54,208	15.6%
2010	2,813	2,317	2,678	536	8,345	52,292	16.0%
2011	2,812	2,798	2,586	544	8,738	52,374	16.7%
2012	3,314	2,845	2,571	560	9,289	53,105	17.5%
2013	3,328	2,657	2,629	546	9,161	51,991	17.6%
2014	3,305	2,471	2,726	582	9,084	53,558	17.0%
2015	3,997	2,090	2,756	661	9,503	55,978	17.0%

Source:

U.S. Department of Labor, Bureau of Labor Statistics, Consumer Expenditure Survey, www.bls.gov/cex, July 2017.
(Additional resources: www.bls.gov)

^a Other vehicle expenses include vehicle finance charges, maintenance and repairs, insurance, licenses, and other vehicle charges.



The United States prices are the lowest of these listed countries. Those in France, the United Kingdom, and Germany paid, on average, over \$5 per gallon in 2016. Data for China and India have been discontinued by the International Energy Agency.

Table 10.3
Gasoline Prices^a for Selected Countries, 1990–2016

	Current dollars per gallon						Average annual percentage change
	1990	1995	2000	2005	2010	2016	1990–2016
China	b	1.03	b	1.70	3.71	b	b
Japan	3.16	4.43	3.65	4.28	5.73	4.53	1.5%
India	b	b	b	3.71	4.29	b	b
Korea	b	b	b	5.28	5.60	4.80	b
France ^c	3.63	4.26	3.80	5.46	6.74	5.47	1.7%
United Kingdom ^c	2.82	3.21	4.58	5.97	6.83	5.56	2.8%
Germany ^c	2.65	3.96	3.45	5.75	7.11	5.47	2.9%
Canada	1.87	1.53	1.86	2.89	3.79	2.94	1.8%
United States ^d	1.16	1.15	1.51	2.27	2.78	2.15	2.5%

	Constant 2016 dollars ^e per gallon						Average annual percentage change
	1990	1995	2000	2005	2010	2016	1990–2016
China	b	1.03	b	2.09	4.08	b	b
Japan	5.80	6.98	5.09	5.26	6.31	4.53	-1.0%
India	b	b	b	4.56	4.73	b	b
Korea	b	b	b	6.49	6.16	4.80	b
France ^c	6.67	6.71	5.30	6.71	7.42	5.47	-0.8%
United Kingdom ^c	5.18	5.06	6.38	7.33	7.52	5.56	0.3%
Germany ^c	4.87	6.24	4.81	7.07	7.82	5.47	0.5%
Canada	3.43	2.41	2.59	3.55	4.19	2.94	-0.6%
United States ^d	2.13	1.81	2.10	2.79	3.06	2.15	0.0%

Note: Comparisons between prices and price trends in different countries require care. They are of limited validity because of fluctuations in exchange rates; differences in product quality, marketing practices, and market structures; and the extent to which the standard categories of sales are representative of total national sales for a given period.

Source:

International Energy Agency, *Energy Prices and Taxes, First Quarter, 2017*, Paris, France, 2017. (Additional resources: www.iea.org)

^a Prices represent the retail prices (including taxes) for regular unleaded gasoline, except for France, Germany and the United Kingdom which are premium unleaded gasoline.

^b Data are not available.

^c Premium gasoline.

^d These estimates are 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.



Of these selected countries, the United Kingdom had the highest diesel fuel price average in 2016, while the United States had the lowest. All of the countries listed except the United States had diesel prices over \$3 per gallon in 2016.

Table 10.4
Diesel Fuel Prices^a for Selected Countries, 1990–2016

	Current dollars per gallon						Average annual percentage change
	1990	2000	2005	2010	2015	2016	1990–2016
China	^b	^b	1.69	3.65	^b	^b	^b
Japan	1.75	2.85	3.44	4.86	3.66	3.55	2.8%
Korea	^b	2.05	3.98	4.92	4.35	3.86	^b
France	1.78	2.95	4.81	5.74	4.83	4.63	3.7%
United Kingdom	2.04	4.66	6.25	6.97	6.65	5.63	4.0%
Germany	2.72	2.79	5.01	6.15	4.99	4.61	2.0%
United States ^c	0.99	1.50	2.40	2.99	2.71	2.31	3.3%
	Constant 2016 dollars ^d per gallon						Average annual percentage change
	1990	2000	2005	2010	2015	2016	1990–2016
China	^b	^b	2.08	4.02	^b	^b	^b
Japan	3.21	3.98	4.23	5.36	3.71	3.55	0.4%
Korea	^b	2.86	4.89	5.42	4.41	3.86	^b
France	3.27	4.11	5.91	6.32	4.89	4.63	1.3%
United Kingdom	3.75	6.49	7.69	7.68	6.73	5.63	1.6%
Germany	4.99	3.89	6.15	6.77	5.06	4.61	-0.3%
United States ^c	1.82	2.08	2.94	3.30	2.75	2.31	0.9%

Note: Comparisons between prices and price trends in different countries require care. They are of limited validity because of fluctuations in exchange rates; differences in product quality, marketing practices, and market structures; and the extent to which the standard categories of sales are representative of total national sales for a given period.

Source:

International Energy Agency, *Energy Prices and Taxes, First Quarter, 2017*, Paris, France, 2017. (Additional resources: www.iea.org)

^a Prices represent the retail prices (including taxes) for car diesel fuel for non-commercial (household) use.

^b Data are not available.

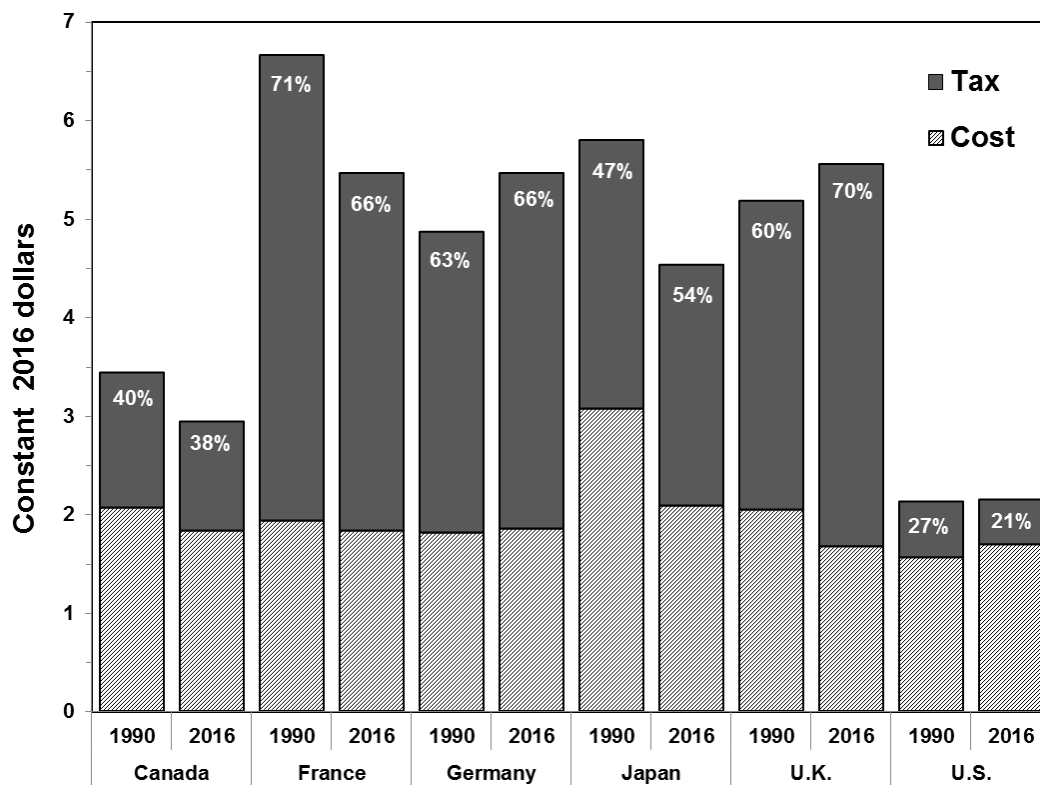
^c These estimates are for international comparisons only and do not necessarily correspond to gasoline price estimates in other sections of the book.

^d Adjusted by the U.S. Consumer Price Inflation Index.



In 2016 over sixty percent of the cost of gasoline in France, Germany, and the United Kingdom went for taxes. Of the listed countries, the United States has the lowest percentage of taxes.

Figure 10.2. Gasoline Prices for Selected Countries, 1990 and 2016



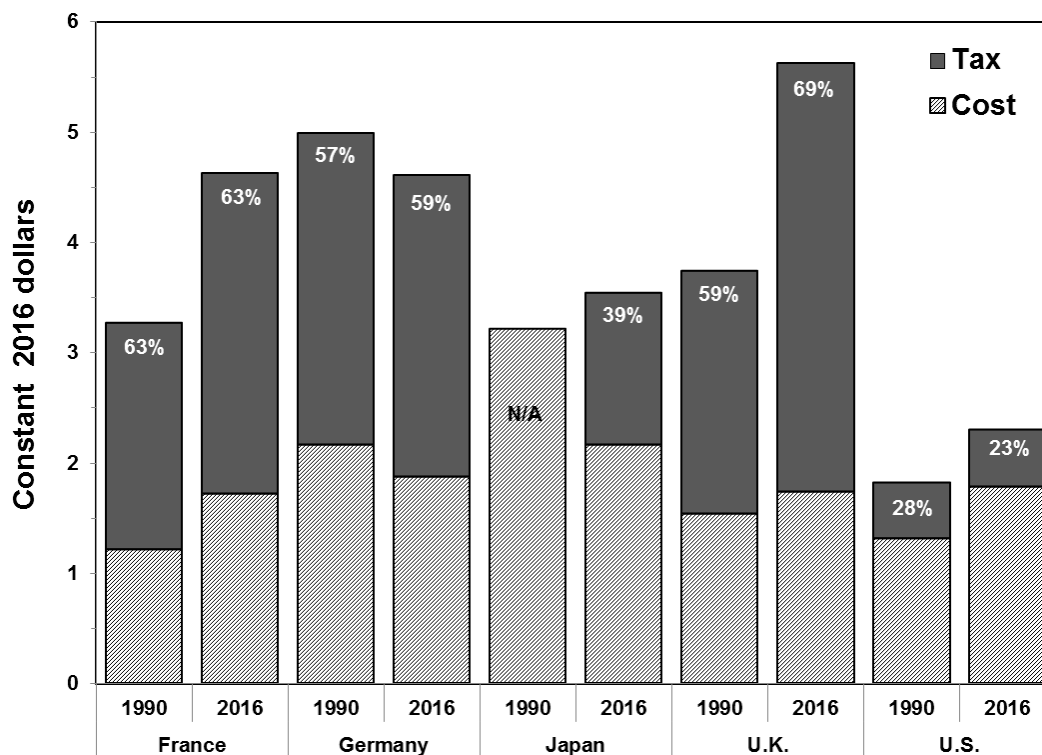
Source:

Table 10.3 and International Energy Agency, *Energy Prices & Taxes, First Quarter, 2017*, Paris, France, 2017.
(Additional resources: www.iea.org)



Diesel fuel is taxed heavily in the European countries shown here. The U.S. diesel fuel tax share is the lowest of the listed countries.

Figure 10.3. Diesel Prices for Selected Countries, 1990 and 2016



Note: Data for Canada are not available.

Source:

Table 10.4 and International Energy Agency, *Energy Prices & Taxes, First Quarter, 2017*, Paris, France, 2017.
(Additional resources: www.iea.org)



Though the cost of crude oil certainly influences the price of gasoline, it is not the only factor which determines the price at the pump. Processing cost, transportation cost, and taxes also play a major part of the cost of a gallon of gasoline. The average price of a barrel of crude oil (in constant 2016 dollars) increased by 3% from 2000 to 2016, while the average price of a gallon of gasoline increased 1% in this same time period.

Table 10.5
Prices for a Barrel of Crude Oil and a Gallon of Gasoline, 1978–2016

Year	Crude oil ^a (dollars per barrel)		Gasoline ^b (dollars per gallon)		Ratio of gasoline price to crude oil price
	Current	Constant 2016 ^c	Current	Constant 2016 ^c	
1978	12.5	45.9	0.65	2.4	2.2
1980	28.1	81.8	1.22	3.6	1.8
1985	26.8	59.7	1.20	2.7	1.9
1990	22.2	40.8	1.22	2.2	2.3
1991	19.1	33.6	1.20	2.1	2.6
1992	18.4	31.5	1.19	2.0	2.7
1993	16.4	27.3	1.17	1.9	3.0
1994	15.6	25.2	1.17	1.9	3.2
1995	17.2	27.1	1.21	1.9	2.9
1996	20.7	31.7	1.29	2.0	2.6
1997	19.0	28.5	1.29	1.9	2.8
1998	12.5	18.4	1.12	1.6	3.7
1999	17.5	25.2	1.22	1.8	2.9
2000	28.3	39.4	1.56	2.2	2.3
2001	23.0	31.1	1.53	2.1	2.8
2002	24.1	32.1	1.44	1.9	2.5
2003	28.5	37.2	1.64	2.1	2.4
2004	37.0	47.0	1.92	2.4	2.2
2005	50.2	61.7	2.34	2.9	2.0
2006	60.2	71.7	2.64	3.1	1.8
2007	67.9	78.7	2.85	3.3	1.8
2008	94.7	105.6	3.32	3.7	1.5
2009	59.3	66.3	2.40	2.7	1.7
2010	76.7	84.4	2.84	3.1	1.6
2011	101.9	108.7	3.58	3.8	1.5
2012	100.9	105.5	3.70	3.9	1.5
2013	100.5	103.5	3.58	3.7	1.5
2014	92.0	93.3	3.43	3.5	1.6
2015	48.4	49.0	2.51	2.5	2.2
2016	40.7	40.7	2.20	2.2	2.3
<i>Average annual percentage change</i>					
1978–2016	3.2%	-0.3%	3.3%	-0.2%	
2006–2016	-3.8%	-5.5%	-1.8%	-3.4%	

Sources:

Crude oil – U.S. Department of Energy, Energy Information Administration, *Monthly Energy Review*, July 2017, Washington, DC, Table 9.1.

Gasoline – U.S. Department of Energy, Energy Information Administration, *Monthly Energy Review*, July 2017, Washington, DC, Table 9.4. (Additional resources: www.eia.doe.gov)

^a Refiner acquisition cost of composite (domestic and imported) crude oil.

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

^c Adjusted by the Consumer Price Inflation Index.



The price of diesel fuel was lower than gasoline in constant dollars prior to 2005 but since that time the price of diesel fuel has increased to become higher than gasoline. Prices for both fuels declined substantially since 2015.

Table 10.6
Retail Prices for Motor Fuel, 1978–2016
(cents per gallon, including tax)

Year	Diesel fuel ^a		Average for all gasoline types ^b	
	Current ^d	Constant 2016 ^c	Current	Constant 2016 ^c
1978			65	240
1980	101	294	122	356
1985	122	272	120	267
1986	94	206	93	204
1987	96	203	96	202
1988	95	193	96	195
1989	102	197	106	205
1990	107	196	122	223
1991	91	160	120	211
1992	106	181	119	204
1993	98	163	117	195
1994	111	180	117	190
1995	111	175	121	190
1996	124	189	129	197
1997	120	179	129	193
1998	104	154	112	164
1999	112	162	122	176
2000	149	208	156	218
2001	140	190	153	207
2002	132	176	144	192
2003	151	197	164	214
2004	181	230	192	244
2005	240	295	234	287
2006	271	322	264	314
2007	289	334	285	330
2008	380	424	332	370
2009	247	276	240	269
2010	299	330	284	313
2011	384	410	358	382
2012	397	415	370	386
2013	392	404	358	369
2014	383	388	343	347
2015	271	274	251	254
2016	230	230	220	220
<i>Average annual percentage change</i>				
1978–2016	2.3% ^e	-0.7% ^c	3.3%	-0.2%
2006–2016	-1.6%	-3.3%	-1.8%	-3.5%

Sources:

Gasoline – U.S. Department of Energy, Energy Information Administration, *Monthly Energy Review*, July 2017, Washington, DC, Table 9.4.

Diesel – U.S. Department of Energy, Energy Information Administration, *International Energy Annual 2004*, Washington, DC, June 2004, Table 7.2. 2005–2016 data from EIA website. (Additional resources: www.eia.doe.gov)

^a 1980–1993: Collected from a survey of prices on January 1 of the current year. 1994–on: Annual average.

^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 percent of the total U.S. population.

^c Adjusted by the Consumer Price Inflation Index.

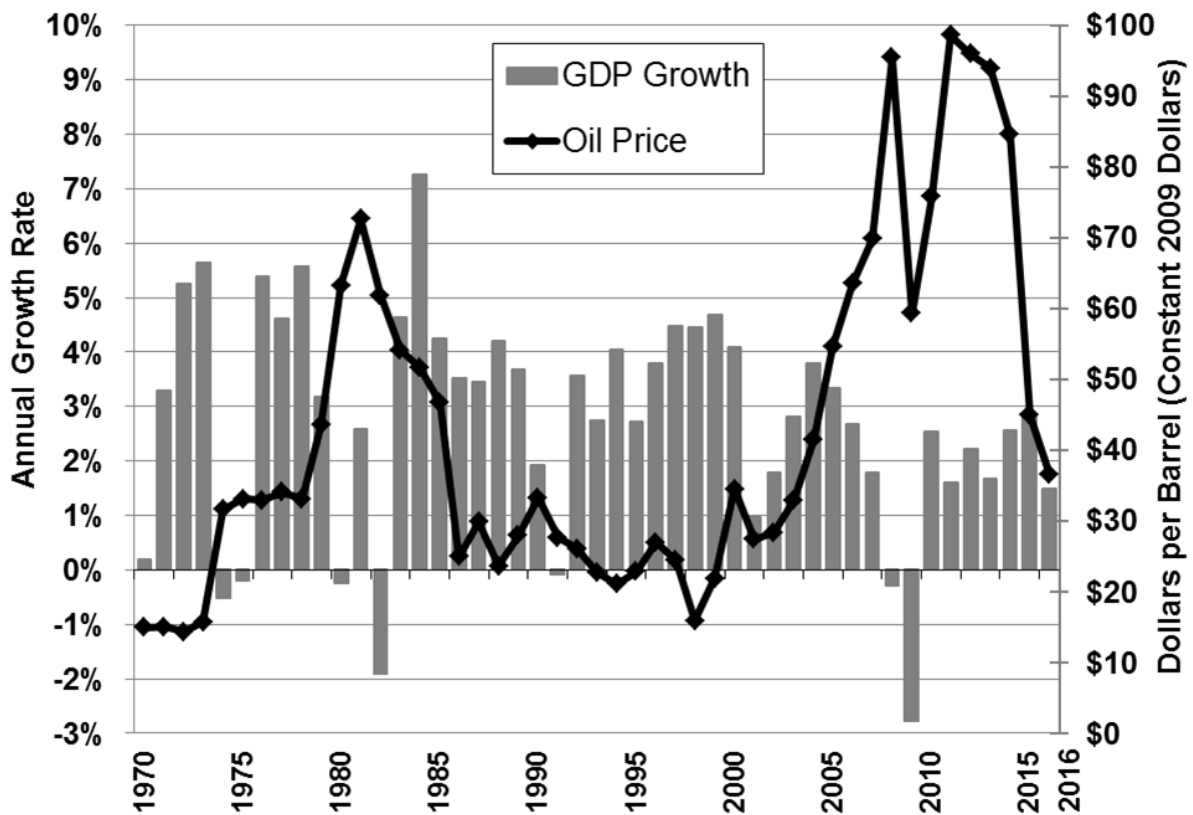
^d Data are not available.

^e Average annual percentage change is from the earliest year possible to 2016.



Major oil price shocks have disrupted world energy markets five times in the past 30 years (1973-74, 1979-80, 1990-91, 1999-2000, 2008). Most of the oil price shocks were followed by an economic recession in the United States.

Figure 10.4. Oil Price and Economic Growth, 1970–2016



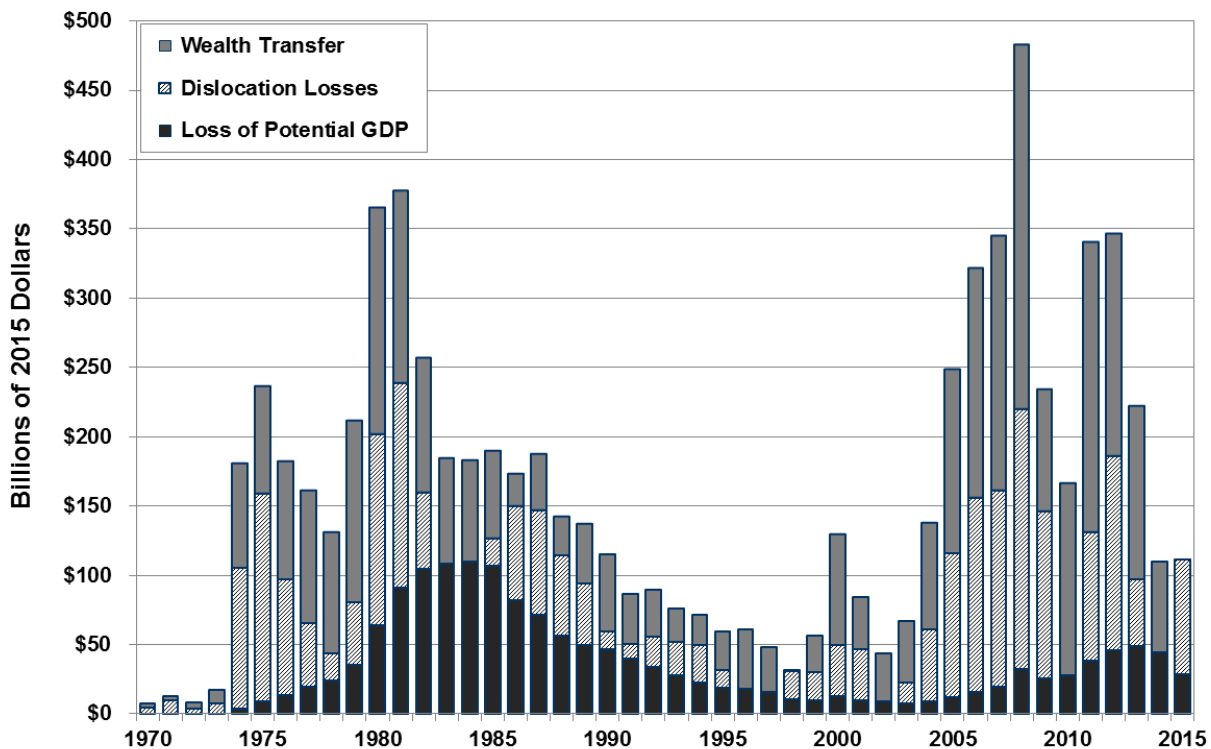
Source:

Greene, D.L. and N. I. Tishchishyna, *Costs of Oil Dependence: A 2000 Update*, Oak Ridge National Laboratory, ORNL/TM-2000/152, Oak Ridge, TN, 2000, and data updates, 2017. (Additional resources: cta.ornl.gov/cta/publications.shtml)



The United States has long recognized the problem of oil dependence and the economic problems that arise from it. Greene, Lee and Hopson define oil dependence as a combination of four factors: (1) a noncompetitive world oil market strongly influenced by the Organization of the Petroleum Exporting Countries (OPEC) cartel, (2) high levels of U.S. imports, (3) the importance of oil to the U.S. economy, and (4) the lack of economical and readily available substitutes for oil. The most recent study shows that the U.S. economy suffered the greatest losses in 2008 when wealth transfer and gross domestic product (GDP) losses (combined) amounted to nearly half a trillion dollars. However, when comparing oil dependence to the size of the economy, the year 1980 is the highest. Low oil prices in 2009-2010 and 2013-2014 caused total dependence cost to drop; in 2015, the total cost was about \$104 billion.

Figure 10.5. Costs of Oil Dependence to the U.S. Economy, 1970–2015



Notes:

Wealth Transfer is the product of total U.S. oil imports and the difference between the actual market price of oil (influenced by market power) and what the price would have been in a competitive market.

Dislocation Losses are temporary reductions in GDP as a result of oil price shocks.

Loss of Potential Gross Domestic Product (GDP) results because a basic resource used by the economy to produce output has become more expensive. As a consequence, with the same endowment of labor, capital, and other resources, our economy cannot produce quite as much as it could have at a lower oil price.

Source:

Greene, David L., Roderick Lee, and Janet L. Hopson, "OPEC and the Costs to the U.S. Economy of Oil Dependence: 1970-2010," Oak Ridge National Laboratory Memorandum, 2011, and updates from the ORNL Transportation Energy Evolution Modeling Team.



*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. Both propane and diesel prices fell drastically in 2015 and diesel continued to fall in 2016.*

Table 10.7
Refiner Sales Prices for Propane and No. 2 Diesel, 1978–2016
 (cents per gallon, excluding tax)

Year	Propane ^a		No 2. diesel fuel	
	Current	Constant 2016 ^b	Current	Constant 2016 ^b
1978	33.5	123.3	37.7	138.8
1980	48.2	140.4	81.8	238.3
1985	71.7	159.9	78.9	176.0
1986	74.5	163.1	47.8	104.7
1987	70.1	148.1	55.1	116.4
1988	71.4	144.9	50.0	101.4
1989	61.5	119.0	58.5	113.2
1990	74.5	136.8	72.5	133.1
1991	73.0	128.6	64.8	114.2
1992	64.3	110.0	61.9	105.9
1993	67.3	111.8	60.2	100.0
1994	53.0	85.8	55.4	89.7
1995	49.2	77.5	56.0	88.2
1996	60.5	92.5	68.1	104.2
1997	55.2	82.5	64.2	96.0
1998	40.5	59.6	49.4	72.7
1999	45.8	66.0	58.4	84.1
2000	60.3	84.0	93.5	130.3
2001	50.6	68.6	84.2	114.1
2002	41.9	55.9	76.2	101.7
2003	57.7	75.3	94.4	123.1
2004	83.9	106.6	124.3	157.9
2005	108.9	133.8	178.6	219.5
2006	135.8	161.7	209.6	249.5
2007	148.9	172.4	226.7	262.4
2008	189.2	210.9	315.0	351.1
2009	122.0	136.5	183.4	205.2
2010	148.1	163.0	213.4	234.9
2011	170.9	182.3	311.7	332.6
2012	113.9	119.1	320.2	334.7
2013	102.8	105.9	312.2	321.6
2014	109.7	111.2	292.3	296.3
2015	48.1	48.7	181.9	184.2
2016	49.8	49.8	151.1	151.1
<i>Average annual percentage change</i>				
1978–2016	1.0%	-2.4%	3.7%	0.2%
2006–2016	-9.5%	-11.1%	-3.2%	-4.3%

Source:

U.S. Department of Energy, Energy Information Administration, *Monthly Energy Review*, Washington, DC, July 2017, Table 9.7. (Additional resources: www.eia.doe.gov)

^a Consumer grade.

^b Adjusted by the Consumer Price Inflation Index.



Prices of finished aviation gasoline (current dollars) dropped in 2009 but then began to climb. In 2012 both finished aviation gasoline and kerosene-type jet fuel reached their all-time high.

Table 10.8
Refiner Sales Prices for Aviation Gasoline and Jet Fuel, 1978–2016
 (cents per gallon, excluding tax)

Year	Finished aviation gasoline		Kerosene-type jet fuel	
	Current	Constant 2016 ^a	Current	Constant 2016 ^a
1978	51.6	189.9	38.7	142.5
1980	108.4	315.8	86.8	252.8
1985	120.1	267.9	79.6	177.6
1986	101.1	221.4	52.9	115.9
1987	90.7	191.6	54.3	114.7
1988	89.1	180.8	51.3	104.1
1989	99.5	192.6	59.2	114.6
1990	112.0	205.6	76.6	140.6
1991	104.7	184.5	65.2	114.9
1992	102.7	175.7	61.0	104.4
1993	99.0	164.4	58.0	96.3
1994	95.7	154.9	53.4	86.5
1995	100.5	158.3	54.0	85.1
1996	111.6	170.7	65.1	99.6
1997	112.8	168.6	61.3	91.6
1998	95.7	140.9	45.2	66.5
1999	105.9	152.6	54.3	78.2
2000	130.6	182.1	89.9	125.3
2001	132.3	179.3	77.5	105.0
2002	128.8	171.8	72.1	96.2
2003	149.3	194.7	87.2	113.7
2004	181.9	231.2	120.7	153.4
2005	223.1	274.2	173.5	213.2
2006	268.2	319.4	199.8	238.0
2007	284.9	329.9	216.5	250.7
2008	327.3	364.9	305.2	340.3
2009	244.2	273.3	170.4	190.7
2010	302.8	333.4	220.1	242.3
2011	380.3	405.8	305.4	325.9
2012	397.1	415.0	310.4	324.4
2013	393.2	405.0	297.9	306.8
2014	398.6	404.2	277.2	281.1
2015	^b	^b	162.9	165.0
2016	^b	^b	131.9	131.9
<i>Average annual percentage change</i>				
1978–2016	5.8% ^c	2.1% ^c	3.3%	-0.2%
2006–2016	5.1% ^c	3.0% ^c	-4.1%	-5.7%

Source:

U.S. Department of Energy, Energy Information Administration, Petroleum Data Analysis Tools, *Refiner Petroleum Product Prices by Sales Type*, August 2017, Washington, DC. (Additional resources: www.eia.doe.gov)

^a Adjusted by the Consumer Price Inflation Index.

^b EIA withheld value to avoid disclosure of individual company data.

^c Data through 2014.



The federal government taxes highway motor fuel and uses the money to pay for roadway upkeep and improvement, as well as other related expenditures. Compressed natural gas (CNG) and liquefied petroleum gas (LPG) have the lowest taxes, while diesel fuel and liquefied natural gas (LNG) have the highest.

Table 10.9
Federal Excise Taxes on Motor Fuels, 2015

Fuel	Cents per gallon	Effective Date
Gasoline	18.4	October 1, 1997
Diesel and kerosene	24.4	October 1, 1997
Gasohol ^a	18.4	January 1, 2005
CNG	18.3 ^c	October 1, 2006
LNG	24.3	October 1, 2006
LPG	18.3	October 1, 2006
Other alternative fuels ^b	18.4	October 1, 1997

Source:

U.S. Department of Transportation, Federal Highway Administration, *Highway Statistics 2015*, Washington, DC, 2016, Table FE-21B. (Additional resources: www.fhwa.dot.gov)

^a All gasohol blends are taxed at the same rate.

^b Includes benzol, benzene, naphtha, and other liquids used as a motor fuel.

^c Compressed natural gas is 18.3 cents per energy equivalent of a gallon of gasoline.



Federal, state, and local jurisdictions have laws and incentives for alternative fuels production use.

Table 10.10
Federal, State, and Local Alternative Fuel Incentives, 2017
(number of incentives)

State (including jurisdictions in the State)	Biodiesel	Ethanol	Natural Gas	Liquefied petroleum gas (LPG)	Electric vehicles (EVs)	Neighborhood electric vehicles (NEVs)	Hydrogen fuel cells	Aftermarket conversions
Federal	30	26	28	27	26	3	23	6
Alabama	2	2	4	4	2	0	1	2
Alaska	1	2	1	1	1	1	1	1
Arizona	4	4	14	14	15	1	12	0
Arkansas	4	3	6	5	2	0	2	2
California	18	16	29	19	56	3	29	6
Colorado	10	9	18	13	17	1	8	2
Connecticut	3	4	4	2	15	0	6	3
Delaware	2	2	4	5	4	1	1	1
Dist. of Columbia	2	3	4	4	5	0	4	1
Florida	7	6	5	5	11	1	2	1
Georgia	4	4	5	4	10	0	4	1
Hawaii	8	8	4	4	10	2	7	0
Idaho	3	1	2	2	5	2	1	0
Illinois	13	11	8	8	18	1	6	4
Indiana	12	11	13	9	7	1	5	3
Iowa	8	10	5	4	5	1	2	1
Kansas	7	12	5	3	0	1	0	3
Kentucky	6	6	5	4	2	1	2	1
Louisiana	5	4	8	6	2	1	0	2
Maine	5	4	3	3	4	3	2	0
Maryland	3	3	3	3	15	2	2	2
Massachusetts	5	4	4	3	14	1	5	1
Michigan	2	1	6	5	8	0	5	0
Minnesota	8	13	5	2	11	4	2	0
Mississippi	2	2	6	5	1	0	1	2
Missouri	8	7	9	9	6	1	6	0
Montana	6	5	3	3	1	2	1	1
Nebraska	1	3	8	5	3	1	3	2
Nevada	4	2	7	7	8	1	6	0
New Hampshire	4	1	3	3	2	2	1	2
New Jersey	4	3	4	4	9	1	1	1
New Mexico	8	4	4	4	4	1	5	0
New York	3	3	7	2	12	1	4	2
North Carolina	10	9	7	6	12	0	5	1
North Dakota	11	9	3	2	1	1	2	0
Ohio	6	6	10	8	8	0	4	2
Oklahoma	9	11	16	9	8	1	8	7
Oregon	10	10	10	9	14	1	6	3
Pennsylvania	3	3	1	2	5	0	2	1
Rhode Island	5	4	5	4	12	2	5	2
South Carolina	9	7	5	6	5	2	7	3
South Dakota	5	7	2	2	0	0	0	0
Tennessee	6	6	7	3	2	1	1	0
Texas	6	6	15	9	11	1	7	4
Utah	2	1	15	8	12	1	7	3
Vermont	3	3	4	3	6	2	4	1
Virginia	17	12	16	10	14	1	11	3
Washington	12	9	9	6	20	1	4	2
West Virginia	4	4	8	7	5	1	5	2
Wisconsin	11	8	7	8	7	1	6	0
Wyoming	4	5	8	5	5	0	1	0
Totals	345	319	392	308	458	57	245	87

Source:

U.S. Department of Energy, Energy Efficiency and Renewable Energy, Alternative Fuels Data Center. Data downloaded August 2017. (Additional resources: www.eere.energy.gov/afdc/laws/matrix/tech)



Table 10.11
Federal, State, and Local Advanced Technology Incentives, 2017
(number of incentives)

State (including jurisdictions in the State)	Hybrid electric vehicles (HEV) or plug-in hybrid vehicles (PHEVs)	Fuel economy or efficiency	Idle reduction	Other ^a
Federal	38	13	7	6
Alabama	3	1	4	0
Alaska	1	1	1	0
Arizona	16	0	2	1
Arkansas	2	0	1	1
California	71	7	5	12
Colorado	22	2	3	3
Connecticut	15	1	2	2
Delaware	5	2	2	2
Dist. of Columbia	5	3	1	0
Florida	12	1	1	0
Georgia	11	0	2	1
Hawaii	13	1	1	1
Idaho	8	1	0	0
Illinois	15	3	5	0
Indiana	9	3	4	2
Iowa	5	0	1	0
Kansas	0	0	1	0
Kentucky	1	0	0	1
Louisiana	3	1	0	0
Maine	5	2	3	1
Maryland	11	1	3	2
Massachusetts	12	0	3	1
Michigan	7	0	0	0
Minnesota	11	1	3	1
Mississippi	2	1	1	0
Missouri	6	0	1	0
Montana	1	1	0	0
Nebraska	2	0	1	0
Nevada	11	0	1	0
New Hampshire	1	2	5	3
New Jersey	9	4	1	4
New Mexico	5	1	1	0
New York	13	3	3	4
North Carolina	12	1	3	0
North Dakota	0	0	0	1
Ohio	5	0	2	0
Oklahoma	9	0	1	3
Oregon	15	1	3	2
Pennsylvania	4	1	3	1
Rhode Island	12	3	5	6
South Carolina	10	1	3	1
South Dakota	0	0	0	1
Tennessee	3	1	1	0
Texas	11	1	3	1
Utah	11	3	3	5
Vermont	7	2	4	2
Virginia	16	2	2	3
Washington	18	2	2	3
West Virginia	4	0	2	1
Wisconsin	9	0	1	0
Wyoming	4	0	1	0
Totals	501	74	108	78

Source:

U.S. Department of Energy, Energy Efficiency and Renewable Energy, Alternative Fuels Data Center. Data downloaded August 2017. (Additional resources: www.eere.energy.gov/afdc/laws/matrix/tech)

^a Includes Clean Fuel Initiatives and Pollution Prevention.



The average price of a new car in 2016 (\$25,774) was close to the average price in 1916 (\$23,798) when adjusted for inflation. Average new car prices were at their lowest in 1940 (\$13,311). Since 1914 the highest average price was in the year 1998 (\$32,102).

Table 10.12
Average Price of a New Car, 1913–2016

Year	2016 Constant dollars	Year	2016 Constant dollars	Year	2016 Constant dollars	Year	2016 Constant dollars
1913	\$34,689	1939	\$14,319	1965	\$21,048	1991	\$27,270
1914	\$35,899	1940	\$13,311	1966	\$21,032	1992	\$28,459
1915	\$29,848	1941	\$13,483	1967	\$23,110	1993	\$28,022
1916	\$23,798	1942	\$13,656	1968	\$21,776	1994	\$28,994
1917	\$21,983	1943	\$13,829	1969	\$23,262	1995	\$28,283
1918	\$20,168	1944	\$14,001	1970	\$21,910	1996	\$28,723
1919	\$19,966	1945	\$14,174	1971	\$22,175	1997	\$31,442
1920	\$19,764	1946	\$14,346	1972	\$22,272	1998	\$32,102
1921	\$20,974	1947	\$14,519	1973	\$21,903	1999	\$31,297
1922	\$22,185	1948	\$15,206	1974	\$21,615	2000	\$29,860
1923	\$20,168	1949	\$17,719	1975	\$22,082	2001	\$28,879
1924	\$18,151	1950	\$18,159	1976	\$22,853	2002	\$28,291
1925	\$17,949	1951	\$18,468	1977	\$23,026	2003	\$27,417
1926	\$17,748	1952	\$20,005	1978	\$23,482	2004	\$27,277
1927	\$17,546	1953	\$20,030	1979	\$22,635	2005	\$27,594
1928	\$17,344	1954	\$19,666	1980	\$22,061	2006	\$27,485
1929	\$17,143	1955	\$19,559	1981	\$23,525	2007	\$26,986
1930	\$16,941	1956	\$20,123	1982	\$24,598	2008	\$25,421
1931	\$18,958	1957	\$22,354	1983	\$25,557	2009	\$24,894
1932	\$20,974	1958	\$23,648	1984	\$26,276	2010	\$26,485
1933	\$19,764	1959	\$23,698	1985	\$26,405	2011	\$26,156
1934	\$18,554	1960	\$22,804	1986	\$27,706	2012	\$25,653
1935	\$16,538	1961	\$21,714	1987	\$28,281	2013	\$25,194
1936	\$14,521	1962	\$21,586	1988	\$28,265	2014	\$24,703
1937	\$14,924	1963	\$21,348	1989	\$27,816	2015	\$24,662
1938	\$15,327	1964	\$21,454	1990	\$27,622	2016	\$25,774

Note: These data are based on an average car and do not include prices for pickups, vans, or sport utility vehicles. Estimations were used for years 1941-1946.

Sources:

Compiled by Jacob Ward, Vehicle Technologies Program, U.S. Department of Energy, from the following sources:
 Raff, D.M.G. & Trajtenberg, M. (1995), "Quality-Adjusted Prices for the American Automobile Industry: 1906-1940," National Bureau of Economic Research, Inc.; Gordon, R.J. (1990), *The Measurement of Durable Goods Prices*, National Bureau of Economic Research, Inc.; and U.S. Department of Commerce, Bureau of Economic Analysis (2017), National Income and Product Accounts.



In current dollars, import cars, on average, were less expensive than domestic cars until 1982. Since then, import prices have more than tripled, while domestic prices have more than doubled (current dollars).

Table 10.13
Average Price of a New Car (Domestic and Import), 1970–2016

Year	Domestic ^a		Import		Total	
	Current dollars	Constant 2016 dollars ^b	Current dollars	Constant 2016 dollars ^b	Current dollars	Constant 2016 dollars ^b
1970	3,708	22,938	2,648	16,381	3,542	21,911
1975	5,084	22,680	4,384	19,557	4,950	22,082
1980	7,609	22,165	7,482	21,795	7,574	22,063
1985	11,589	25,855	12,853	28,675	11,838	26,411
1986	12,319	26,979	13,670	29,937	12,652	27,708
1987	12,922	27,304	14,470	30,575	13,386	28,285
1988	13,418	27,225	15,221	30,883	13,932	28,268
1989	13,936	26,980	15,510	30,027	14,371	27,822
1990	14,489	26,602	16,640	30,551	15,042	27,617
1991	15,192	26,768	16,327	28,768	15,475	27,267
1992	15,644	26,767	18,593	31,813	16,636	28,464
1993	15,976	26,536	20,261	33,654	16,871	28,023
1994	16,930	27,410	21,989	35,600	17,903	28,985
1995	16,864	26,561	23,202	36,543	17,959	28,285
1996	17,468	26,726	26,205	40,094	18,777	28,729
1997	17,532	26,210	27,718	41,438	21,026	31,434
1998	18,501	27,233	28,695	42,239	21,802	32,093
1999	19,006	27,388	27,472	39,587	21,725	31,306
2000	19,561	27,268	26,008	36,255	21,424	29,865
2001	20,004	27,105	25,809	34,971	21,310	28,875
2002	20,431	27,255	25,612	34,166	21,206	28,289
2003	19,961	26,029	26,136	34,081	21,019	27,409
2004	20,509	26,067	25,942	32,972	21,469	27,287
2005	21,565	26,503	26,622	32,718	22,454	27,596
2006	22,139	26,368	27,061	32,230	23,087	27,497
2007	22,264	25,782	27,463	31,802	23,313	26,996
2008	22,192	24,744	25,902	28,881	22,804	25,426
2009	22,080	24,708	25,223	28,225	22,252	24,900
2010	23,768	26,169	27,232	29,982	24,063	26,493
2011	24,167	25,786	28,284	30,179	24,514	26,156
2012	24,131	25,217	28,973	30,277	24,540	25,644
2013	23,921	24,639	29,769	30,662	24,454	25,188
2014	23,787	24,120	29,935	30,354	24,366	24,707
2015	23,981	24,293	29,284	29,665	24,355	24,672
2016	24,414	24,414	29,913	29,913	25,774	25,774
<i>Average annual percentage change</i>						
1970–2016	4.2%	0.1%	5.4%	1.3%	4.4%	0.4%
2006–2016	1.0%	-0.8%	1.0%	-0.7%	1.1%	-0.6%

Note: These data are based on an average car and do not include prices for pickups, vans, or sport utility vehicles.

Source:

U.S. Department of Commerce, Bureau of Economic Analysis, *Average Transaction Price per New Car*, Washington, DC, 2017. (Additional resources: www.bea.gov)

^a Includes all vehicles produced in the United States regardless of manufacturer.

^b Adjusted by the Consumer Price Inflation Index.



The total cost of operating a car is the sum of the fixed cost (depreciation, insurance, finance charge, and license fee) and the variable cost (gas and oil, tires, and maintenance), which is related to the amount of travel. The gas and oil share of total cost was 11.2% in 2016 which is down from 18.4% in 2012.

Table 10.14
Car Operating Cost per Mile, 1985–2016

Model year	Constant 2016 dollars per 10,000 miles ^a			Total cost per mile ^b (constant 2016 cents ^a)	Percentage gas and oil of total cost
	Variable cost	Fixed cost	Total cost		
1985	1,655	4,597	6,252	62.52	19.9%
1986	1,428	5,052	6,480	64.80	15.1%
1987	1,416	4,918	6,334	63.34	14.7%
1988	1,603	6,147	7,750	77.50	13.6%
1989	1,548	5,652	7,200	72.00	14.2%
1990	1,543	5,979	7,522	75.22	13.2%
1991	1,709	6,284	7,993	79.93	14.6%
1992	1,540	6,473	8,013	80.13	12.6%
1993	1,528	6,182	7,710	77.10	12.7%
1994	1,474	6,212	7,686	76.86	11.8%
1995	1,512	6,307	7,819	78.19	11.7%
1996	1,468	6,414	7,882	78.82	10.9%
1997	1,615	6,502	8,117	81.17	12.2%
1998	1,576	6,667	8,243	82.43	11.1%
1999	1,527	6,713	8,240	82.40	9.8%
2000	1,700	6,584	8,285	82.85	11.6%
2001	1,843	6,262	8,105	81.05	13.2%
2002	1,574	6,502	8,077	80.77	9.7%
2003	1,709	6,371	8,079	80.79	11.6%
2004	1,601	7,157	8,758	87.58	9.4%
2005	1,733	6,651	8,384	83.84	12.0%
2006	1,798	5,579	7,376	73.76	15.3%
2007	1,678	5,516	7,194	71.94	14.3%
2008	1,891	6,018	7,909	79.09	16.4%
2009	1,725	6,182	7,907	79.07	14.3%
2010	1,841	6,295	8,136	81.36	15.4%
2011	1,893	6,249	8,142	81.42	16.2%
2012	2,053	6,007	8,060	80.60	18.4%
2013	2,104	5,967	8,071	80.71	18.4%
2014	1,929	5,855	7,784	77.84	16.9%
2015	1,752	5,925	7,677	76.77	14.80%
2016	1,473	6,072	7,545	75.45	11.20%
<i>Average annual percentage change</i>					
1985–2016	-0.4%	0.9%	0.6%	0.6%	
2006–2016	-2.0%	0.9%	0.2%	0.2%	

Source:

Ward's Communications, *Motor Vehicle Facts and Figures 2016*, Southfield, Michigan, 2016, p. 55, and annual. Original data from AAA "Your Driving Costs." (Additional resources: newsroom.aaa.com)

^a Adjusted by the Consumer Price Inflation Index.

^b Based on 10,000 miles per year.



While the previous table shows costs per mile, this table presents costs per year for fixed costs associated with car operation. For 2016 model year cars, the fixed cost is over \$17 per day.

Table 10.15
Fixed Car Operating Costs per Year, 1975–2016
(constant 2016 dollars)^a

Model year	Insurance ^b	License, registration & taxes	Depreciation	Finance charge	Total	Average fixed cost per day
1975	1,709	134	3,448	^c	5,291	14.50
1980	1,455	239	3,023	^c	5,922	16.22
1981	1,367	232	3,398	^c	6,271	17.19
1982	1,125	134	3,373	^c	5,964	16.34
1983	1,138	234	3,128	^c	5,769	15.81
1984	1,175	245	2,788	^c	5,419	14.85
1985	1,043	245	2,815	1,191	5,289	14.50
1986	1,118	285	2,891	1,395	5,685	15.57
1987	1,137	270	3,156	1,111	5,668	15.53
1988	1,170	282	3,619	1,146	6,210	17.02
1989	1,258	279	3,906	1,138	6,571	18.00
1990	1,247	303	4,328	1,249	7,116	19.50
1991	1,256	296	4,412	469	6,425	17.60
1992	1,353	298	4,648	1,362	7,654	20.97
1993	1,242	296	4,700	1,113	7,345	20.13
1994	1,250	314	4,761	1,049	7,370	20.19
1995	1,239	320	4,840	1,080	7,473	20.47
1996	1,299	329	4,849	1,098	7,569	20.74
1997	1,271	323	4,893	1,148	7,631	20.91
1998	1,328	333	4,953	1,197	7,808	21.39
1999	1,403	326	4,950	1,193	7,866	21.55
2000	1,360	311	4,867	1,183	7,713	21.13
2001	1,349	282	4,808	1,174	7,607	20.84
2002	1,356	268	4,964	1,105	7,690	21.07
2003	1,443	267	4,876	970	7,551	20.69
2004	2,037	527	4,805	941	8,311	22.77
2005	1,583	478	4,767	908	7,736	21.20
2006	1,102	637	4,038	852	6,630	18.17
2007	1,140	623	3,926	848	6,538	17.91
2008	1,051	618	3,702	845	6,216	17.03
2009	1,092	634	3,872	871	6,470	17.72
2010	1,135	644	3,912	887	6,578	18.02
2011	1,033	635	3,978	878	6,524	17.87
2012	1,046	638	3,705	884	6,273	17.19
2013	1,060	629	3,679	874	6,242	17.10
2014	1,037	650	3,558	859	6,104	16.73
2015	1,129	673	3,700	677	6,180	16.93
2016	1,222	687	3,759	683	6,351	17.40
<i>Average annual percentage change</i>						
1975–2016	-0.8%	4.1%	0.2%	^c	0.4%	0.4%
2006–2016	-1.0%	0.8%	-0.7%	-2.2%	-0.4%	-0.4%

Source:

Ward's Communications, *Motor Vehicle Facts and Figures 2016*, Southfield, Michigan, 2016, p. 55 and annual. Original data from AAA "Your Driving Costs." (Additional resources: newsroom.aaa.com)

^a Adjusted by the Consumer Price Inflation Index.

^b Fire & Theft: \$50 deductible 1975 through 1977; \$100 deductible 1978 through 1992; \$250 deductible for 1993 – 2003; \$100 deductible 2004–2015. Collision: \$100 deductible through 1979; \$250 deductible 1980–1992; \$500 deductible for 1993 – on. Property Damage & Liability: coverage = \$100,000/\$300,000.

^c Data are not available.



Table 10.16
Personal Consumption Expenditures, 1970–2016
(billion dollars)

Year	Personal consumption expenditures		Transportation personal consumption expenditures		Transportation PCE as a percent of PCE
	Current	Constant 2016 ^a	Current	Constant 2016 ^a	
1970	647.7	3,175.7	80.8	396.2	12.5%
1980	1,754.6	4,416.3	241.7	608.4	13.8%
1990	3,825.6	6,392.6	455.7	761.5	11.9%
2000	6,792.4	9,251.2	811.2	1,104.9	11.9%
2005	8,794.1	10,667.2	983.2	1,192.6	11.2%
2010	10,202.2	11,222.4	968.3	1,065.1	9.5%
2011	10,689.3	11,523.1	1,081.2	1,165.5	10.1%
2012	11,050.6	11,702.6	1,132.2	1,199.0	10.2%
2013	11,361.2	11,838.4	1,162.8	1,211.6	10.2%
2014	11,863.7	12,148.4	1,197.2	1,225.9	10.1%
2015	12,332.3	12,492.6	1,151.5	1,166.5	9.3%
2016	12,820.7	12,820.7	1,147.0	1,147.0	8.9%

Note: Transportation PCE includes the following categories: transportation, motor vehicles and parts, and gasoline and oil.

Source:

U.S. Department of Commerce, Bureau of Economic Analysis, National Income and Product Accounts, Table 2.3.5, www.bea.gov

Table 10.17
Consumer Price Indices, 1970–2016
(1970 = 1.000)

Year	Consumer price index	Transportation consumer price index ^b	New car consumer price index	Used car consumer price index	Gross national product index
1970	1.000	1.000	1.000	1.000	1.000
1980	2.124	2.216	1.667	1.997	2.676
1990	3.369	3.213	2.286	3.769	5.557
2000	4.438	4.088	2.689	4.994	9.537
2005	5.034	4.637	2.597	4.468	12.184
2010	5.620	5.157	2.599	4.587	14.017
2011	5.797	5.663	2.672	4.776	14.566
2012	5.917	5.796	2.716	4.818	15.146
2013	6.004	5.798	2.745	4.804	15.648
2014	6.101	5.758	2.755	4.779	16.319
2015	6.109	5.308	2.771	4.715	16.932
2016	6.186	5.197	2.775	4.599	17.390

Sources:

Bureau of Labor Statistics, Consumer Price Index Table 1A for 2016, and annual.

(Additional resources: www.bls.gov)

GNP – U.S. Department of Commerce, Bureau of Economic Analysis, National Income and Product Accounts, Table 1.7.5. (Additional resources: www.bea.gov)

^a Adjusted by the GNP price deflator.

^b Transportation Consumer Price Index includes new and used cars, gasoline, car insurance rates, intracity mass transit, intracity bus fare, and airline fares.



The data below were summarized from the Bureau of Labor Statistics (BLS) Current Employment Statistics Survey data using the North American Industry Classification System (NAICS). Transportation-related employment was 7.5% of total employment in 2016.

Table 10.18
Transportation-Related Employment, 2000 and 2016^a
(thousands)

	2000	2016	Percent change
Truck transportation (includes drivers)	1,405.8	1,453.6	3.4%
Transit and ground transportation	372.1	478.4	28.6%
Air transportation	614.4	475.9	-22.5%
Rail transportation	231.7	214.7	-7.3%
Water transportation	56.0	65.5	17.0%
Pipeline transportation	46.0	49.5	7.6%
Motor vehicle and parts - retail	1,846.9	1,981.8	7.3%
Motor vehicles and parts - wholesale	355.7	331.9	-6.7%
Gasoline stations - retail	935.7	925.7	-1.1%
Automotive repair and maintenance	888.1	913.3	2.8%
Automotive equipment rental and leasing	208.3	206.4	-0.9%
Manufacturing	2,143.9	1,679.8	-21.6%
<i>Cars and light trucks</i>	237.4	180.9	-23.8%
<i>Heavy-duty trucks</i>	54.0	27.9	-48.3%
<i>Motor vehicle bodies and trailers</i>	182.7	151.2	-17.2%
<i>Motor vehicle parts</i>	839.5	580.0	-30.9%
<i>Aerospace products and parts</i>	516.7	489.0	-5.4%
<i>Railroad rolling stock & other transportation equipment</i>	72.7	60.6	-16.6%
<i>Ship & boat building</i>	154.1	135.2	-12.3%
<i>Tires</i>	86.8	55.0	-36.6%
Oil and gas pipeline construction	72.2	124.7	72.7%
Highway street and bridge construction	340.1	321.5	-5.5%
Scenic & sightseeing	27.5	34.6	25.8%
Support activities for transportation	537.4	660.1	22.8%
Couriers and messengers	605.0	641.9	6.1%
Travel arrangement and reservation services	298.6	216.3	-27.6%
Total transportation-related employment	10,985.4	10,775.6	-1.9%
Total nonfarm employment	132,019.0	144,306.0	9.3%
Transportation-related to total employment	8.3%	7.5%	

Source:

Bureau of Labor Statistics website query system: www.bls.gov/data/. (Additional resources: www.bls.gov)

^a Not seasonally adjusted.



The total number of employees involved in the manufacture of motor vehicles decreased by over 74% from 1990 to 2016 and by almost 89% for those involved in the manufacture of motor vehicle parts. Beginning in 2008, the share of production workers fell below 80% for manufacturers of both vehicles and parts and remained below 80% for motor vehicle parts.

Table 10.19
U.S. Employment for Motor Vehicles and Motor Vehicle Parts Manufacturing, 1990–2016^a

Year	All employees (thousands)	Production workers (thousands)	Share of production workers to total employees
Motor vehicles			
1990	271.4	243.4	89.7%
1995	294.7	273.7	92.9%
1996	285.3	271.2	95.1%
1997	286.8	273.6	95.4%
1998	283.6	254.8	89.8%
1999	291.3	254.3	87.3%
2000	291.4	251.0	86.1%
2001	278.7	236.4	84.8%
2002	265.4	220.8	83.2%
2003	264.6	217.1	82.0%
2004	255.9	208.0	81.3%
2005	247.6	198.6	80.2%
2006	236.5	191.8	81.1%
2007	220.0	177.3	80.6%
2008	191.6	151.1	78.9%
2009	146.4	114.2	78.0%
2010	152.6	120.7	79.1%
2011	157.9	124.7	79.0%
2012	167.6	134.7	80.4%
2013	181.5	150.1	82.7%
2014	194.0	160.8	82.9%
2015	200.8	161.6	80.5%
2016	208.9	166.5	79.7%
Motor vehicle parts			
1990	653.0	527.4	80.8%
1995	786.9	647.7	82.3%
1996	799.9	657.4	82.2%
1997	808.9	662.4	81.9%
1998	818.2	660.3	80.7%
1999	837.1	674.2	80.5%
2000	839.5	676.7	80.6%
2001	774.7	624.9	80.7%
2002	733.6	590.9	80.5%
2003	707.8	567.6	80.2%
2004	692.1	561.6	81.1%
2005	678.1	553.9	81.7%
2006	654.7	533.7	81.5%
2007	607.9	488.9	80.4%
2008	543.7	430.6	79.2%
2009	413.7	317.8	76.8%
2010	418.9	323.3	77.2%
2011	445.5	345.0	77.4%
2012	482.8	365.3	75.7%
2013	508.7	385.2	75.7%
2014	537.0	415.9	77.4%
2015	564.9	436.7	77.3%
2016	580.0	447.7	77.2%

Source:

Tabulated from the U.S. Department of Labor, Bureau of Labor Statistics, www.bls.gov, August 2017.

^a Not seasonally adjusted.





Chapter 11

Greenhouse Gas Emissions

Summary Statistics from Tables/Figures in this Chapter

Source			
Table 11.1	Carbon dioxide emissions (million metric tons)	1990	2016
	<i>United States</i>	4,989	5,436
	<i>OECD Europe</i>	4,149	4,100
	<i>China</i>	2,293	9,285
	<i>Russia</i>	2,393	1,734
	<i>Japan</i>	1,054	1,194
	<i>Non-OECD Europe and Eurasia</i>	4,246	2,804
	<i>India</i>	573	1,982
Table 11.5	Transportation share of U.S. carbon dioxide emissions from fossil fuel consumption		
	<i>1990</i>		31.8%
	<i>2005</i>		33.2%
	<i>2015</i>		34.7%
Table 11.7	Motor gasoline share of transportation carbon dioxide emissions, 2015		61.5%
Table 11.11	Average annual carbon footprint, 2016 (metric tons of CO ₂)		
	<i>New Cars</i>		5.9
	<i>New Light trucks</i>		7.9



The U.S. accounted for 23% of the World's carbon dioxide emissions in 1990, 21% in 2005, and only 16% in 2016. About 42% of the U.S. carbon emissions are from oil use.

Table 11.1
World Carbon Dioxide Emissions, 1990, 2005, and 2016

Country/Region	1990		2005		2016	
	Million metric tons	Percent of emissions from oil use	Million metric tons	Percent of emissions from oil use	Million metric tons	Percent of emissions from oil use
OECD ^a Americas						
United States	4,989	44%	5,985	44%	5,436	42%
Canada	471	48%	620	49%	558	52%
Mexico/Chile	302	77%	461	66%	495	59%
Total	5,762	46%	7,066	46%	6,490	44%
OECD ^a Europe	4,149	45%	4,488	49%	4,100	45%
OECD ^a Asia						
Japan	1,054	65%	1,241	52%	1,194	41%
Australia/New Zealand	298	38%	438	55%	439	39%
Other	243	59%	494	30%	717	37%
Total	1,595	59%	2,173	47%	2,350	40%
Non-OECD Europe & Eurasia						
Russia	2,393	33%	1,548	25%	1,734	25%
Other	1,853	32%	1,120	26%	1,070	30%
Total	4,246	32%	2,668	25%	2,804	27%
Non-OECD Asia						
China	2,293	15%	5,490	16%	9,285	16%
India	573	28%	1,182	27%	1,982	27%
Other	811	57%	1,665	53%	2,199	51%
Total	3,677	26%	8,337	25%	13,465	23%
Other Non-OECD						
Middle East	704	70%	1,333	59%	2,156	56%
Africa	659	46%	978	43%	1,309	43%
Central & South America	695	76%	1,011	72%	1,290	72%
Total	2,058	64%	3,322	58%	4,755	57%
Total World	21,487	42%	28,054	40%	33,964	36%

Source:

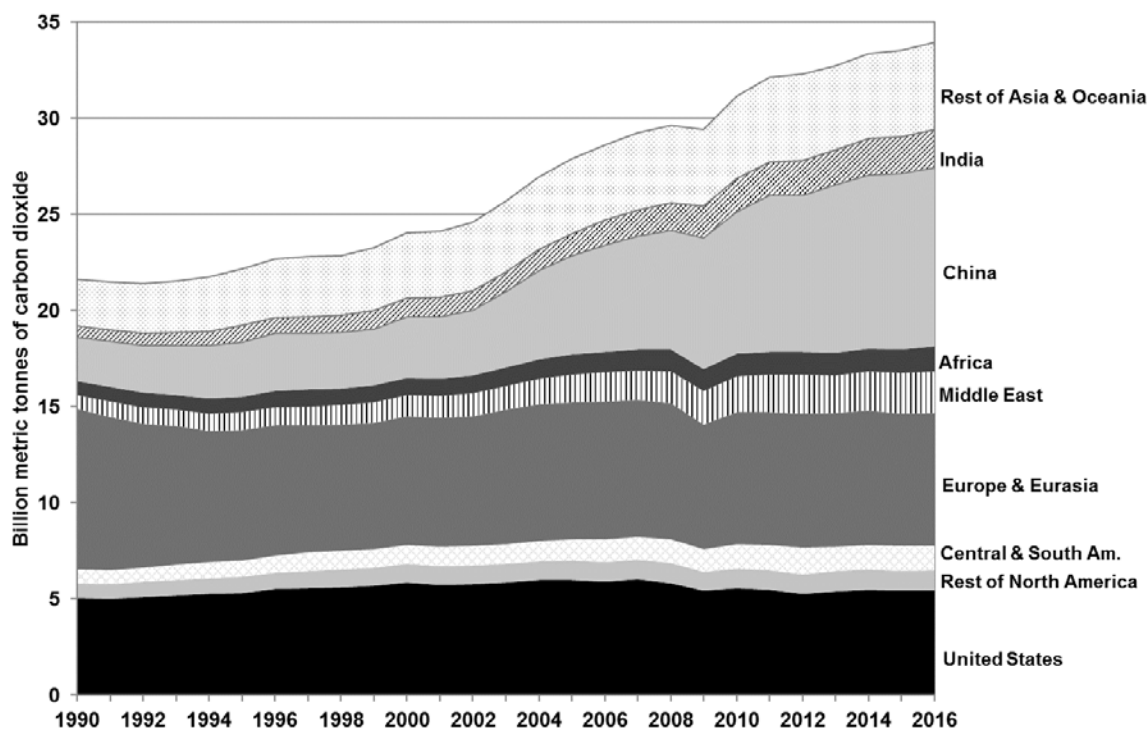
U.S. Department of Energy, Energy Information Administration, *International Energy Statistics Databases*, and *International Energy Outlook*, Washington, DC, May 2016. (Additional resources: www.eia.doe.gov)

^a OECD is the Organization for Economic Cooperation and Development. See Glossary for included countries.



Since 1990, China shows the greatest increase of carbon dioxide (CO₂) emissions. The Americas have about the same CO₂ emissions in 2014 as in 1990. Europe and Eurasia have fewer CO₂ emissions in 2016 than 1990.

Figure 11.1. World Carbon Dioxide Emissions, 1990–2016



Source:

1990–2012: U.S. Department of Energy, Energy Information Administration, *International Energy Statistics*, Total Carbon Dioxide Emissions from the Consumption of Energy, www.eia.doe.gov/cfapps/ipdbproject/IEDIndex3.cfm, September 2016.

2013–2016: U.S. Department of Energy, Energy Information Administration, *International Energy Outlook 2016*, www.eia.gov/forecasts/aeo/index.cfm, accessed August 2017. (Additional resources: www.eia.doe.gov)



Global Warming Potentials (GWP) were developed to allow comparison of the ability of each greenhouse gas to trap heat in the atmosphere relative to carbon dioxide. Extensive research has been performed and it has been discovered that the effects of various gases on global warming are too complex to be precisely summarized by a single number. Further understanding of the subject also causes frequent changes to estimates. Despite that, the scientific community has developed approximations, the latest of which are shown below. Most analysts use the 100-year time horizon.

Table 11.2
Numerical Estimates of Global Warming Potentials Compared with Carbon Dioxide
(kilogram of gas per kilogram of carbon dioxide)

Gas	Lifetime (years)	Global warming potential direct effect for time horizons of	
		20 years	100 years
Carbon Dioxide (CO ₂)	5-200 ^a	1	1
Methane (CH ₄) ^b	12.4	86	34
Tetrafluoroethane (HFC-134a)	13.4	3,790	1,550
Trichlorofluoromethane (CFC-11)	45	7,020	5,350
Nitrous Oxide (N ₂ O)	121	268	298
Perfluoromethane (CF ₄)	50,000	4,950	7,350

Note: Includes climate-carbon feedbacks.

Source:

Myhre, G., D. Shindell, F.-M. Breon, W. Collins, J. Fuglestedt, J. Huang, D. Koch, J.-F. Lamarque, D. Lee, B. Mendoza, T. Nakajima, A. Robock, G. Stephens, T. Takemura and H. Zhang, 2013: Anthropogenic and Natural Radiative Forcing. In: *Climate Change 2013: The Physical Science Basis*. Contribution of Working Group 1 to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Stocker, R.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Zia, V. Bex and P.M. Midgley (eds)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

^a No single lifetime can be defined for carbon dioxide due to different rates of uptake by different removal processes.

^b These values do not include carbon dioxide from methane oxidation. Perturbation lifetime is used in the calculation of metrics.



Carbon dioxide emissions in 2015 were 5% higher than in 1990, but down from the highest annual emissions of this data series in 2007. Carbon dioxide accounts for the majority (82%) of greenhouse gases.

Table 11.3
U.S. Emissions of Greenhouse Gases, Based on Global Warming Potential, 1990–2015
(million metric tons of carbon dioxide equivalent^a)

Year	Carbon dioxide	Methane	Nitrous oxide	High GWP gases ^b	Total
1990	5,089.8	780.7	359.4	99.6	6,329.5
1991	5,034.7	785.1	358.6	90.6	6,269.0
1992	5,141.3	784.2	361.7	95.2	6,382.4
1993	5,253.8	769.0	373.9	94.9	6,491.6
1994	5,344.6	772.8	364.9	97.9	6,580.2
1995	5,410.0	765.1	377.0	116.6	6,668.7
1996	5,596.2	756.4	383.3	127.0	6,862.9
1997	5,671.6	740.3	374.1	133.8	6,919.8
1998	5,711.7	725.6	388.7	149.2	6,975.2
1999	5,784.4	713.8	362.8	145.6	7,006.6
2000	5,955.8	704.0	361.8	146.3	7,167.9
2001	5,849.8	695.6	363.7	132.8	7,041.9
2002	5,892.4	684.1	362.0	140.6	7,079.1
2003	5,932.9	684.3	365.8	130.4	7,113.4
2004	6,046.0	675.8	385.8	137.4	7,245.0
2005	6,074.0	680.9	361.5	138.8	7,255.2
2006	5,992.8	682.1	371.2	141.7	7,187.8
2007	6,078.7	685.9	378.7	153.5	7,296.8
2008	5,883.5	695.0	361.4	155.6	7,095.5
2009	5,448.6	690.4	362.1	151.8	6,652.9
2010	5,653.4	692.0	370.3	163.0	6,878.7
2011	5,523.6	672.1	363.9	170.9	6,730.5
2012	5,313.7	666.0	340.5	169.3	6,489.5
2013	5,466.1	658.8	335.5	171.7	6,632.1
2014	5,519.1	659.1	335.4	179.5	6,693.1
2015	5,364.9	655.7	334.6	184.6	6,539.8

Note: This greenhouse gas emissions inventory includes fossil fuel combustion, use of fluorinated gases and other transportation categories.

Source:

U.S. Environmental Protection Agency, *Inventory of U. S. Greenhouse Gas Emissions and Sinks: 1990-2015*, April 13, 2017, EPA 430-P-17-001. (Additional resources: www.epa.gov/ghgemissions/inventory-us-greenhouse-gas-emissions-and-sinks-1990-2015)

^a Carbon dioxide equivalents are computed by multiplying the weight of the gas being measured by its estimated Global Warming Potential (See Table 11.2).

^b GWP = Global warming potential. Includes HFC-hydrofluorocarbons; PFC-perfluorocarbons; and SF₆-sulfur hexafluoride.



The transportation sector accounts for 32.6% of carbon dioxide emissions. The industrial sector is the only sector that accounts for more greenhouse gas emissions than the transportation sector.

Table 11.4
Total U.S. Greenhouse Gas Emissions by End-Use Sector, 2015
(million metric tons of carbon dioxide equivalent^a)

	Carbon dioxide	Methane	Nitrous oxide	Hydrofluorocarbons, perfluorocarbons, sulfur hexafluoride	Total greenhouse gas emissions
Residential	1,009.7	4.1	7.9	49.9	1,071.6
Commercial	915.0	133.9	14.1	51.6	1,114.6
Agricultural	97.5	244.5	269.9	0.1	612.0
Industrial	1,592.6	271.6	29.1	37.9	1,931.2
Transportation	1,750.1	1.6	13.6	45.1	1,810.4
Transportation share of total	32.6%	0.2%	4.1%	24.4%	27.7%
Total greenhouse gas emissions	5,364.9	655.7	334.6	184.6	6,539.8

Note: Totals may not sum due to rounding.

Source:

U.S. Environmental Protection Agency, *Inventory of U. S. Greenhouse Gas Emissions and Sinks: 1990-2015*, April 13, 2017, EPA 430-P-17-001. (Additional resources: www.epa.gov/ghgemissions/inventory-us-greenhouse-gas-emissions-and-sinks-1990-2015)

^a Carbon dioxide equivalents are computed by multiplying the weight of the gas being measured by its estimated Global Warming Potential (See Table 11.2).



Gases which contain carbon can be measured in terms of the full molecular weight of the gas or just in terms of their carbon content. This table presents carbon dioxide gas. The ratio of the weight of carbon to carbon dioxide is 0.2727. The transportation sector accounts for approximately one-third of carbon emissions.

Table 11.5
U.S. Carbon Emissions from Fossil Fuel Consumption
by End-Use Sector, 1990–2015^a
(million metric tons of carbon dioxide)

	End use sector				Transportation percentage	CO ₂ from all sectors
	Residential	Commercial	Industrial	Transportation		
1990	931.4	755.4	1529.2	1496.8	31.8%	4,712.8
1991	949.1	762.1	1497.0	1450.6	31.1%	4,658.8
1992	945.2	758.0	1557.0	1499.8	31.5%	4,760.0
1993	998.0	782.3	1565.1	1535.4	31.5%	4,880.8
1994	989.0	794.8	1588.4	1580.1	31.9%	4,952.3
1995	994.7	812.4	1586.7	1612.9	32.2%	5,006.7
1996	1055.4	843.2	1644.2	1657.4	31.9%	5,200.2
1997	1045.2	883.0	1662.3	1673.2	31.8%	5,263.7
1998	1049.7	901.2	1639.6	1709.8	32.3%	5,300.3
1999	1070.5	912.8	1619.2	1764.3	32.9%	5,366.8
2000	1133.2	972.2	1643.8	1808.9	32.5%	5,558.1
2001	1124.9	980.7	1578.8	1793.1	32.7%	5,477.5
2002	1151.7	978.8	1553.5	1834.1	33.2%	5,518.1
2003	1181.7	989.4	1572.5	1826.5	32.8%	5,570.1
2004	1179.6	1007.7	1598.1	1871.7	33.1%	5,657.1
2005	1214.1	1026.8	1564.6	1891.8	33.2%	5,697.3
2006	1151.8	1007.2	1564.2	1887.2	33.6%	5,610.4
2007	1204.5	1047.3	1563.1	1891.1	33.1%	5,706.0
2008	1190.4	1039.3	1499.8	1796.5	32.5%	5,526.0
2009	1122.7	976.5	1329.5	1721.4	33.4%	5,150.1
2010	1174.6	993.0	1416.5	1732.7	32.6%	5,316.8
2011	1116.2	958.4	1399.6	1711.9	33.0%	5,186.1
2012	1007.8	897.0	1375.7	1700.6	34.1%	4,981.1
2013	1064.6	925.5	1407.0	1717.0	33.6%	5,114.1
2014	1080.1	934.7	1399.3	1746.9	33.8%	5,161.0
2015	1003.9	909.4	1355.0	1740.1	34.7%	5,008.4
<i>Average annual percentage change</i>						
1990–2015	0.3%	0.7%	-0.5%	0.6%		0.2%
2005–2015	-1.9%	-1.2%	-1.4%	-0.8%		-1.3%

Note: The CO₂ from all sectors does not match Table 11.3 since it is only from fossil fuel consumption and does not include the use of fluorinated gases and other transportation categories.

Source:

U.S. Environmental Protection Agency, *Inventory of U. S. Greenhouse Gas Emissions and Sinks: 1990-2015*, April 13, 2017, EPA 430-P-17-001. (Additional resources: www.epa.gov/ghgemissions/inventory-us-greenhouse-gas-emissions-and-sinks-1990-2015)

^a Includes energy from petroleum, coal, and natural gas. Electric utility emissions are distributed across consumption sectors.



This report has typically displayed carbon and carbon dioxide data from the Environmental Protection Agency (EPA). However, the Energy Information Administration's (EIA's) Monthly Energy Review also includes carbon dioxide emission data. The differences in the two-data series have been about 3-4%, but as high as 6.8% in 1991. Reasons for the differences include the treatment of international bunker fuel, nonfuel use of fossil fuels, and the agencies' use of different fuel consumption control totals.

Table 11.6
Transportation Sector Carbon Dioxide Emissions from
Energy Consumption, 1973-2016
(million metric tons of carbon dioxide)

Year	Energy Information Administration's <i>Monthly</i> <i>Energy Review</i>	Environmental Protection Agency's Greenhouse Gas Inventory Report	Percentage difference
1973	1,315.2	^a	^a
1975	1,291.6	^a	^a
1980	1,400.2	^a	^a
1985	1,421.2	^a	^a
1990	1,587.7	1,508.7	5.0%
1991	1,567.9	1,461.2	6.8%
1992	1,591.6	1,510.6	5.1%
1993	1,607.2	1,546.5	3.8%
1994	1,647.4	1,591.7	3.4%
1995	1,681.3	1,624.3	3.4%
1996	1,725.2	1,668.4	3.3%
1997	1,744.2	1,684.8	3.4%
1998	1,782.0	1,722.0	3.4%
1999	1,828.0	1,776.5	2.8%
2000	1,872.5	1,821.0	2.8%
2001	1,852.0	1,804.2	2.6%
2002	1,892.5	1,845.1	2.5%
2003	1,892.1	1,836.7	2.9%
2004	1,958.6	1,882.0	3.9%
2005	1,985.6	1,902.0	4.2%
2006	2,013.7	1,897.1	5.8%
2007	2,021.0	1,901.5	5.9%
2008	1,897.9	1,806.0	4.8%
2009	1,831.6	1,730.0	5.5%
2010	1,849.0	1,742.3	5.8%
2011	1,817.5	1,720.9	5.3%
2012	1,780.2	1,708.9	4.0%
2013	1,807.0	1,725.8	4.5%
2014	1,825.1	1,756.1	3.8%
2015	1,882.8	^a	5.3%
2016	1,882.8	^a	^a

Sources:

U.S. Department of Energy, Energy Information Administration, *Monthly Energy Review*, July 2017, Washington, DC, Table 12.5.

U.S. Environmental Protection Agency, *Inventory of U. S. Greenhouse Gas Emissions and Sinks: 1990-2015*, April 13, 2017, EPA 430-P-17-001. (Additional resources: www.epa.gov/ghgemissions/inventory-us-greenhouse-gas-emissions-and-sinks-1990-2015)

^a Data are not available.



Most U.S. transportation sector carbon dioxide emissions come from petroleum fuels. Motor gasoline has been responsible for 60%-67% of U.S. carbon dioxide emissions over the last twenty-five years.

Table 11.7
U.S. Carbon Emissions from Fossil Fuel Combustion in the Transportation
End-Use Sector, 1990–2015
(million metric tons of carbon dioxide equivalent)

Year	Motor gasoline	LPG ^a	Jet fuel	Distillate fuel	Residual fuel	Aviation gas	Natural gas	Electricity ^b	Total
1990	983.5	1.4	184.2	262.9	22.6	3.1	36.0	3.0	1,496.7
1991	969.7	1.3	168.8	255.2	16.9	2.9	32.9	3.0	1,450.6
1992	992.8	1.2	166.6	271.2	30.0	2.8	32.2	3.0	1,499.7
1993	1,010.9	1.2	168.2	287.6	27.6	2.7	34.2	3.0	1,535.4
1994	1,022.9	2.1	175.5	309.4	26.9	2.6	37.6	3.1	1,580.1
1995	1,042.4	1.1	172.2	323.8	29.1	2.7	38.4	3.1	1,612.9
1996	1,063.6	1.0	184.5	339.9	23.6	2.6	39.1	3.1	1,657.4
1997	1,075.6	0.9	184.5	354.8	10.3	2.7	41.4	3.1	1,673.2
1998	1,107.5	1.1	188.4	366.0	5.9	2.5	35.3	3.2	1,710.0
1999	1,128.0	0.9	192.4	387.9	13.2	2.7	35.8	3.2	1,764.3
2000	1,136.2	0.7	194.9	402.1	33.3	2.5	35.6	3.4	1,808.8
2001	1,149.4	0.8	189.6	400.3	12.0	2.4	34.9	3.6	1,793.0
2002	1,174.6	0.9	185.3	413.4	17.1	2.3	37.0	3.5	1,834.1
2003	1,177.2	1.1	179.3	421.9	7.4	2.1	33.2	4.3	1,826.5
2004	1,194.1	1.2	186.6	437.1	14.0	2.2	31.9	4.5	1,871.7
2005	1,183.7	1.7	189.4	457.5	19.3	2.4	33.1	4.7	1,891.7
2006	1,171.8	1.7	182.3	468.5	23.0	2.3	33.1	4.5	1,887.2
2007	1,166.0	1.4	179.5	472.9	29.0	2.2	35.2	5.1	1,891.3
2008	1,109.2	2.5	173.0	448.1	20.4	2.0	36.7	4.7	1,796.6
2009	1,101.5	1.7	154.1	405.9	13.9	1.8	37.9	4.5	1,721.3
2010	1,092.5	1.8	151.5	422.0	20.4	1.9	38.1	4.5	1,732.7
2011	1,068.8	2.1	146.6	430.0	19.4	1.9	38.9	4.3	1,712.0
2012	1,064.7	2.3	143.4	427.5	15.8	1.7	41.3	3.9	1,700.6
2013	1,065.6	2.7	147.1	433.9	15.1	1.5	47.0	4.0	1,716.9
2014	1,096.1	2.9	148.6	447.7	5.8	1.5	40.3	4.1	1,747.0
2015	1,070.5	3.0	157.7	460.7	4.2	1.5	38.8	3.7	1,740.1
<i>Average annual percentage change</i>									
1990-2015	0.3%	3.1%	-0.6%	2.3%	-6.5%	-2.9%	0.3%	0.8%	0.6%
2005-2015	-1.0%	5.8%	-1.8%	0.1%	-14.2%	-4.6%	1.6%	-2.4%	-0.8%

Note: Emissions from U.S. Territories are not included. Emissions from International Bunker Fuels are not included.

Source:

U.S. Environmental Protection Agency, *Inventory of U. S. Greenhouse Gas Emissions and Sinks: 1990-2015*, April 13, 2017, EPA 430-P-17-001. (Additional resources: www.epa.gov/ghgemissions/inventory-us-greenhouse-gas-emissions-and-sinks-1990-2015)

^a Liquefied petroleum gas.

^b Share of total electric utility carbon dioxide emissions weighted by sales to the transportation sector.



Highway vehicles are responsible for the majority of greenhouse gas emissions in the transportation sector.

Table 11.8
Transportation Carbon Dioxide Emissions by Mode, 1990–2015
 (Million metric tons of carbon dioxide equivalent)

Year	Passenger Vehicles	Heavy Trucks	Highway Total	Water	Air	Rail	Pipeline	Total
1990	951.8	238.7	1,190.5	44.3	187.4	38.5	36.0	1,496.7
1991	936.9	233.3	1,170.2	39.5	171.7	36.4	32.9	1,450.7
1992	968.5	243.8	1,212.3	48.5	169.4	37.4	32.2	1,499.8
1993	988.1	256.9	1,245.0	47.1	170.9	38.3	34.2	1,535.5
1994	1,001.6	273.9	1,275.5	47.7	178.1	41.2	37.6	1,580.1
1995	1,015.1	284.2	1,299.3	57.7	174.9	42.7	38.4	1,613.0
1996	1,037.7	296.5	1,334.2	53.7	187.1	43.4	39.1	1,657.5
1997	1,051.4	310.5	1,361.9	39.4	187.2	43.5	41.4	1,673.4
1998	1,082.5	323.9	1,406.4	33.4	190.9	43.9	35.2	1,709.8
1999	1,116.1	342.6	1,458.7	29.3	195.1	45.4	35.7	1,764.2
2000	1,113.4	356.6	1,470.0	60.3	197.4	45.5	35.4	1,808.6
2001	1,124.3	354.6	1,478.9	41.8	192.0	45.8	34.6	1,793.1
2002	1,150.1	367.7	1,517.8	46.5	187.6	45.4	36.6	1,833.9
2003	1,163.8	365.0	1,528.8	36.5	181.4	47.1	32.7	1,826.5
2004	1,182.2	380.3	1,562.5	39.3	188.8	49.6	31.3	1,871.5
2005	1,165.0	408.0	1,573.0	44.4	191.8	50.2	32.4	1,891.8
2006	1,153.6	417.0	1,570.6	47.4	184.6	52.2	32.4	1,887.2
2007	1,123.7	446.0	1,569.7	53.9	181.7	51.3	34.4	1,891.0
2008	1,065.3	428.0	1,493.3	44.7	175.1	47.6	35.9	1,796.6
2009	1,061.3	388.5	1,449.8	38.0	155.9	40.4	37.1	1,721.2
2010	1,053.4	401.4	1,454.8	44.0	153.4	43.1	37.3	1,732.6
2011	1,034.3	400.8	1,435.1	45.5	148.5	44.7	38.1	1,711.9
2012	1,030.1	402.2	1,432.3	39.3	145.1	43.4	40.5	1,700.6
2013	1,030.3	409.1	1,439.4	38.6	148.6	44.1	46.2	1,716.9
2014	1,071.9	422.8	1,494.7	16.9	150.1	45.7	39.4	1,746.8
2015	1,037.4	429.7	1,467.1	32.3	159.2	43.6	38.0	1,740.2
<i>Average annual percentage change</i>								
1990-2015	0.3%	2.4%	0.8%	-1.3%	-0.7%	0.5%	0.2%	0.6%
2005-2015	-1.2%	0.5%	-0.7%	-3.1%	-1.8%	-1.4%	1.6%	-0.8%

Note: Emissions from U.S. Territories are not included. Emissions from International Bunker Fuels are not included. Passenger vehicles include cars, light trucks and motorcycles. Heavy trucks include medium and heavy trucks and buses.

Source:

U.S. Environmental Protection Agency, *Inventory of U. S. Greenhouse Gas Emissions and Sinks: 1990-2015*, April 13, 2017, EPA 430-P-17-001. (Additional resources: www.epa.gov/ghgemissions/inventory-us-greenhouse-gas-emissions-and-sinks-1990-2015)

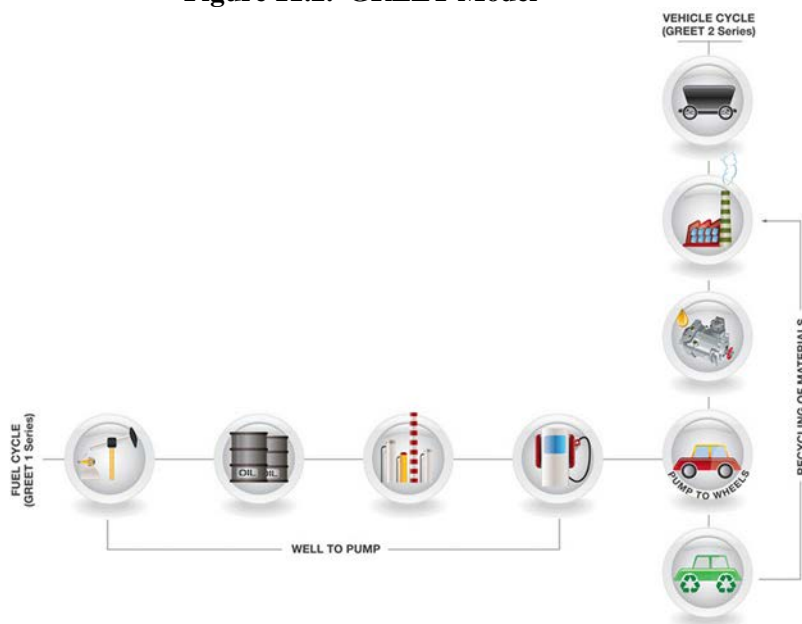


The Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation (GREET) Model

greet.es.anl.gov

Sponsored by the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy (EERE), Argonne has developed a full life-cycle model called GREET® (Greenhouse gases, Regulated Emissions, and Energy use in Transportation). It allows researchers and analysts to evaluate energy and environmental impacts of various vehicle and fuel combinations on a life-cycle basis. The first version of GREET was released in 1996. Since then, Argonne has continued to update and expand the model. The most recent GREET versions are GREET 1 2015 version for fuel-cycle analysis and GREET 2 2015 version for vehicle-cycle analysis.

Figure 11.2. GREET Model



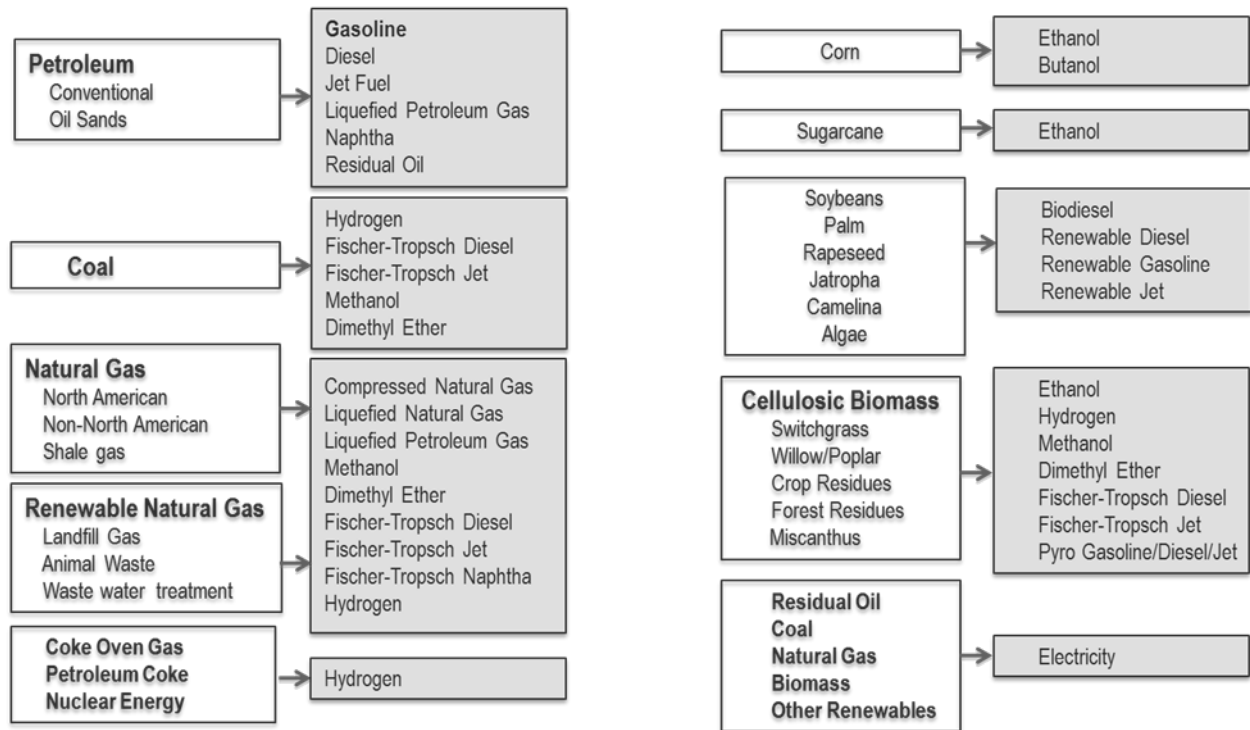
For a given vehicle and fuel system, GREET separately calculates the following:

- Consumption of total energy (energy in non-renewable and renewable sources), fossil fuels (petroleum, natural gas, and coal together), petroleum, coal and natural gas.
- Emissions of CO₂-equivalent greenhouse gases - primarily carbon dioxide (CO₂), methane (CH₄), and nitrous oxide (N₂O).
- Emissions of six criteria pollutants: volatile organic compounds (VOCs), carbon monoxide (CO), nitrogen oxide (NO_x), particulate matter with size smaller than 10 micron (PM₁₀), particulate matter with size smaller than 2.5 micron (PM_{2.5}), and sulfur oxides (SO_x).



REET includes more than 100 fuel production pathways and more than 80 vehicle/fuel systems. These vehicle/fuel systems cover current and advanced vehicle technologies such as conventional spark-ignition engine vehicles, compression-ignition engine vehicles, hybrid electric vehicles, plug-in hybrid electric vehicles, battery-powered electric vehicles and fuel-cell electric vehicles. REET also evaluates transportation modes other than light-duty vehicles, such as heavy-duty vehicles, aviation, rail and marine.

Figure 11.3. REET Model Feedstocks and Fuels



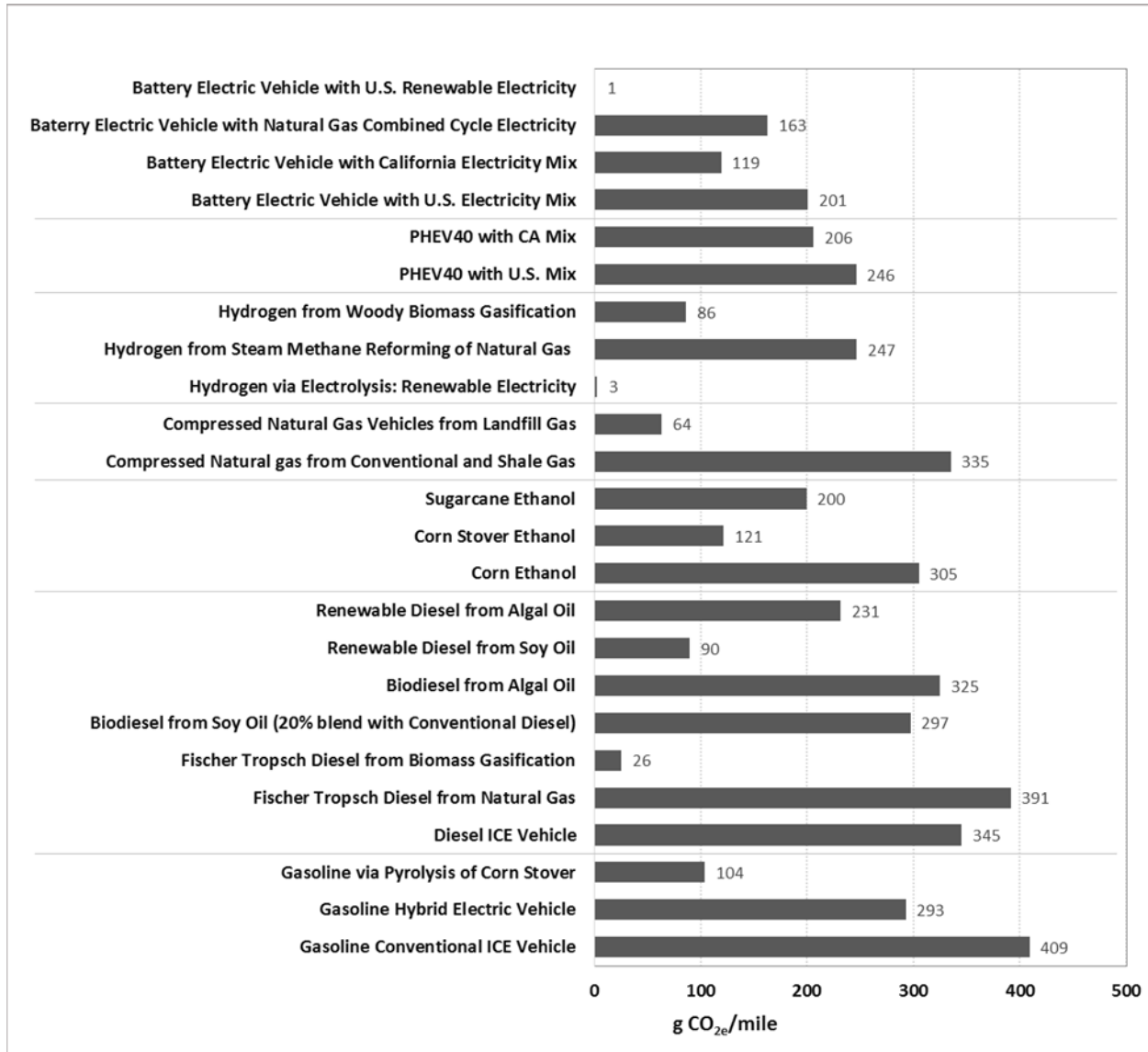
To address technology improvements over time, REET 2015 simulates current and future vehicle/fuel systems up to year 2040.

For additional information about the REET model and associated documentation, please visit the REET website www.reet.es.anl.gov, or contact reet@anl.gov.



Results from the GREET 2015 model on emissions of carbon dioxide per mile are shown below for various fuels and vehicle technologies. A full description of the model is on the preceding pages.

Figure 11.4. Well-to-Wheel Emissions for Various Fuels and Vehicle Technologies



Note: PHEV40 = Plug-in hybrid electric vehicle with 40-mile electric range.

Source: Argonne National Laboratory, GREET 1 2015 Model.



Carbon Footprint

The carbon footprint measures a vehicle's impact on climate change in tons of carbon dioxide (CO₂) emitted annually. The following three tables show the carbon footprint for various vehicle classes. The sales-weighted average fuel economy rating for each vehicle class, based on 45% highway and 55% city driving, is used to determine the average annual carbon footprint for vehicles in the class. An estimate of 15,000 annual miles is used for each vehicle class and for each year in the series.

$$\text{CarbonFootprint} = \left(CO_2 \times LHV \times \frac{\text{AnnualMiles}}{\text{CombinedMPG}} \right) + (CH_4 + N_2O) \times \text{AnnualMiles}$$

where:

CO₂ = (Tailpipe CO₂ + Upstream Greenhouse Gases) in grams per million Btu

LHV = Lower (or net) Heating Value in million Btu per gallon

CH₄ = Tailpipe CO₂ equivalent methane in grams per mile

N₂O = Tailpipe CO₂ equivalent nitrous oxide in grams per mile

Note: The Environmental Protection Agency publishes tailpipe emissions in terms of grams of CO₂ per mile in the *Light-Duty Automotive Technology, Carbon Dioxide Emissions, and Fuel Economy Trends: 1975 through 2016*, www.epa.gov/fueleconomy/trends-report.



The production-weighted average annual carbon footprint for cars and car SUVs declined by an average of 1.9% annually between 1975 and 2016.

Table 11.9
Production-Weighted Annual Carbon Footprint of New Domestic and Import Cars
Model Years 1975–2016^a
(metric tons of CO₂)

Model Year	Car	Car SUV ^b
1975	12.6	15.2
1980	8.5	11.6
1985	7.4	8.4
1986	7.1	8.9
1987	7.1	8.7
1988	7.0	8.8
1989	7.2	8.9
1990	7.3	9.0
1991	7.2	9.3
1992	7.3	9.5
1993	7.2	9.9
1994	7.3	9.4
1995	7.2	9.5
1996	7.3	9.2
1997	7.3	8.8
1998	7.3	9.3
1999	7.4	9.1
2000	7.4	9.5
2001	7.4	9.0
2002	7.3	8.8
2003	7.3	8.5
2004	7.3	8.5
2005	7.2	8.4
2006	7.3	8.3
2007	7.0	8.2
2008	7.0	8.0
2009	6.7	7.7
2010	6.5	7.4
2011	6.5	7.2
2012	6.1	7.2
2013	5.9	6.9
2014	5.9	6.9
2015	5.8	6.7
2016	5.7	6.6
<i>Average annual percentage change</i>		
1975–2016	-1.9%	-2.0%
2006–2016	-2.4%	-2.3%

Source:

Calculated using fuel economy from the U.S. Environmental Protection Agency, *Light-Duty Automotive Technology, Carbon Dioxide Emissions, and Fuel Economy Trends: 1975 Through 2016*, December 2016. See page 11-14 for details. (Additional resources: www.epa.gov/otaq/fetrends.htm)

^a Annual carbon footprint is based on 15,000 miles of annual driving. Includes tailpipe plus upstream emissions.

^b Car SUV category is defined in Table 4.9.



The production-weighted average annual footprint of pickups, vans, and truck SUVs decreased from 1975 to 2016. Truck SUVs and vans experienced the greatest decline from 2005 to 2016.

Table 11.10
Production-Weighted Annual Carbon Footprint of New Domestic and Import Trucks
Model Years 1975–2016^a
(metric tons of CO₂)

Model Year	Pickup	Van	Truck SUV ^b
1975	14.2	15.2	15.3
1980	10.2	12.0	12.8
1985	9.3	10.2	10.2
1990	9.7	9.5	10.3
1991	9.3	9.4	10.1
1992	9.7	9.4	10.4
1993	9.6	9.3	10.4
1994	9.7	9.5	10.6
1995	10.0	9.4	10.6
1996	9.9	9.2	10.4
1997	10.0	9.3	10.5
1998	10.0	9.1	10.5
1999	10.4	9.3	10.5
2000	10.2	9.1	10.6
2001	10.6	9.4	10.3
2002	10.7	9.1	10.4
2003	10.5	8.9	10.3
2004	10.7	8.8	10.3
2005	10.7	8.8	10.1
2006	10.5	8.7	9.9
2007	10.5	8.7	9.6
2008	10.3	8.5	9.3
2009	10.0	8.4	8.8
2010	10.0	8.4	8.6
2011	9.8	8.1	8.5
2012	9.9	7.9	8.5
2013	9.7	8.0	8.1
2014	9.4	7.9	7.8
2015	9.0	7.8	7.7
2016	8.9	7.7	7.5
<i>Average annual percentage change</i>			
1975–2016	-1.1%	-1.6%	-1.7%
2006–2016	-1.6%	-1.2%	-2.7%

Note: Includes light trucks of 8,500 lbs. or less.

Source:

Calculated using fuel economy from the U.S. Environmental Protection Agency, *Light-Duty Automotive Technology, Carbon Dioxide Emissions, and Fuel Economy Trends: 1975 Through 2016*, December 2016. See page 11-14 for details. (Additional resources: www.epa.gov/otaq/fetrends.htm)

^a Annual carbon footprint is based on 15,000 miles of annual driving. Includes tailpipe plus upstream emissions.

^b Truck SUV category includes all SUV not in the Car SUV category. Car SUV category is defined in Table 4.9.



Between 1975 and 2016, the production-weighted average annual carbon footprint for new light vehicles dropped dramatically. Total new cars experienced a decrease of 53.4% while the carbon footprint for light trucks decreased by 45.4%.

Table 11.11
Average Annual Carbon Footprint of New Vehicles by Vehicle Classification,
Model Years 1975 and 2016^a
(metric tons of CO₂)

Vehicle class	Production share		Carbon footprint		Percent change 1975 - 2016
	Model year 1975	Model year 2016	Model year 1975	Model year 2016	
Cars					
Car	80.6%	51.4%	12.6	5.7	-54.6%
Car SUV ^b	0.1%	10.7%	15.2	6.6	-56.3%
Total cars	80.7%	62.1%	12.6	5.9	-53.4%
Light trucks					
Van	4.5%	3.7%	15.2	7.7	-49.1%
Truck SUV ^b	1.7%	23.4%	15.3	7.5	-51.1%
Pickup	13.1%	10.8%	14.2	8.9	-37.1%
Total light trucks	19.3%	37.9%	14.5	7.9	-45.4%

Source:

Calculated using fuel economy from the U.S. Environmental Protection Agency, *Light-Duty Automotive Technology, Carbon Dioxide Emissions, and Fuel Economy Trends: 1975 Through 2016*, December 2016. See page 11-14 for details. (Additional resources: www.epa.gov/otaq/fetrends.htm)

^a Annual carbon footprint is based on 15,000 miles of annual driving. Includes tailpipe and upstream emissions.

^b Car SUV category is defined in Table 4.9. Truck SUV category includes all SUVs not in the Car SUV category.



The amount of carbon dioxide released into the atmosphere by a vehicle is primarily determined by the carbon content of the fuel. However, there is a small portion of the fuel that is not oxidized into carbon dioxide when the fuel is burned. The Environmental Protection Agency (EPA) has published information on carbon dioxide emissions from gasoline and diesel which takes the oxidation factor into account and is based on the carbon content used in EPA's fuel economy analyses. The other fuels listed come from the Energy Information Administration.

Table 11.12
Direct Carbon Dioxide Emissions from a Gallon of Fuel^a

	Grams per gallon	Kilograms per gallon	Pounds per gallon
Gasoline	8,887	8.9	19.6
Diesel	10,180	10.2	22.4
E85	1,340	1.3	3.0
B20	8,120	8.1	17.9
LPG	5,805	5.8	12.8
Propane	5,740	5.8	12.7
Aviation gasoline	8,320	8.3	18.3
Jet fuel	9,751	9.6	21.5
Kerosene	9,751	9.8	21.5
Residual fuel	11,791	11.8	26.0

Sources:

Gasoline and Diesel: U.S. Environmental Protection Agency, "Greenhouse Gas Emissions from a Typical Passenger Vehicle," May 2014. (Additional resources: www.epa.gov/otaq)

All others: Energy Information Administration, Voluntary Reporting of Greenhouse Gases Program, Fuel and Energy Source Codes and Emission Coefficients.

^a Direct emissions are from the "tank-to-wheels" process. No upstream emissions are included.



The average carbon content of 11 different transportation fuels comes from the GREET Model. Residual oil (used in ships) has the highest carbon content of those listed. Ethanol has the lowest carbon content per gallon.

Table 11.13
Carbon Content of Transportation Fuels

Fuel Type	Density (grams/gallon)	Carbon ratio (grams of carbon per grams of fuel)	Carbon content (grams/gallon)	Carbon content ^a (grams per Btu)
Gasoline blendstock	2,819	0.863	2,433	0.0196
Ethanol	2,988	0.522	1,560	0.0185
Gasoline (E10)	2,836	0.828	2,347	0.0195
U.S. conventional diesel	3,167	0.865	2,739	0.0199
Low-sulfur diesel	3,206	0.871	2,792	0.0202
Conventional jet fuel	3,036	0.862	2,617	0.0197
Ultra low-sulfur jet fuel	2,998	0.860	2,578	0.0196
Residual oil	3,752	0.868	3,257	0.0217
Liquefied petroleum gas (LPG)	1,923	0.820	1,577	0.0173
Methyl ester (biodiesel, BD)	3,361	0.776	2,608	0.0204

Source:

Argonne National Laboratory, GREET 1 2015 Model.

^a Based on higher heating values.





Chapter 12

Criteria Air Pollutants

Summary Statistics from Tables in this Chapter

Source		
Table 12.1	Transportation's share of U.S. emissions, 2016	
	<i>CO</i>	52.3%
	<i>NO_x</i>	57.4%
	<i>VOC</i>	21.1%
	<i>PM-2.5</i>	4.6%
	<i>PM-10</i>	1.8%
	<i>SO₂</i>	1.8%



Transportation accounts for the majority of carbon monoxide and nitrogen oxide emissions. Highway vehicles are responsible for the largest share of transportation emission.

Table 12.1
Total National Emissions of the Criteria Air Pollutants by Sector, 2016
(millions of short tons/percentage)

Sector	CO	NO _x	VOC	PM-10	PM-2.5	SO ₂
Highway vehicles	17.87	3.61	1.77	0.29	0.13	0.02
	30.3%	34.4%	11.1%	1.2%	2.2%	0.7%
Other off-highway	12.99	2.42	1.58	0.16	0.15	0.03
	22.0%	23.0%	9.9%	0.7%	2.5%	1.1%
Transportation total	30.86	6.02	3.34	0.45	0.28	0.05
	52.3%	57.4%	21.1%	1.8%	4.6%	1.8%
Stationary source fuel combustion	4.13	2.78	0.53	0.92	0.78	1.97
	7.0%	26.5%	3.4%	3.8%	12.7%	72.8%
Industrial processes	2.22	1.29	7.30	0.96	0.42	0.50
	3.8%	12.3%	46.0%	3.9%	6.8%	18.5%
Waste disposal and recycling total	2.16	0.11	0.20	0.31	0.25	0.04
	3.7%	1.1%	1.2%	1.2%	4.1%	1.4%
Miscellaneous	19.62	0.29	4.49	21.80	4.43	0.15
	33.3%	2.8%	28.3%	89.2%	71.8%	5.5%
Total of all sources	58.98	10.49	15.86	24.44	6.16	2.71
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Note: CO = Carbon monoxide. NO_x = Nitrogen oxides. VOC = Volatile organic compounds. PM-10 = Particulate matter less than 10 microns. PM-2.5 = Particulate matter less than 2.5 microns. SO₂ = Sulfur dioxide.

Source:

U. S. Environmental Protection Agency, National Emission Inventory Air Pollutant Emission Trends website www.epa.gov/air-emissions-inventories/air-pollutant-emissions-trends-data. (Additional resources: www.epa.gov/air-emissions-inventories/national-emissions-inventory)



The transportation sector accounted for almost 53% of the nation's carbon monoxide (CO) emissions in 2016. Highway vehicles are by far the source of the greatest amount of CO. For details on the highway emissions of CO, see Table 12.3.

Table 12.2
Total National Emissions of Carbon Monoxide, 1970–2016^a
(million short tons)

Source category	1970	1980	1990	2000	2010	2016	Percent of total, 2016
Highway vehicles	163.23	143.83	110.26	68.06	28.24	17.87	30.3%
Other off-highway	11.37	16.69	21.45	24.18	15.35	12.99	22.0%
Transportation total	174.60	160.52	131.71	92.24	43.59	30.86	52.3%
Stationary fuel combustion total	4.63	7.30	5.51	4.78	4.52	4.13	7.0%
Industrial processes total	9.84	6.95	4.77	2.63	1.90	2.22	3.8%
Waste disposal and recycling total	7.06	2.30	1.08	1.85	1.20	2.16	3.7%
Miscellaneous total	7.91	8.34	11.12	12.96	22.56	19.62	33.3%
Total of all sources	204.04	185.41	154.19	114.46	73.77	58.98	100.0%

Source:

U. S. Environmental Protection Agency, National Emission Inventory Air Pollutant Emission Trends website www.epa.gov/air-emissions-inventories/air-pollutant-emissions-trends-data. (Additional resources: www.epa.gov/air-emissions-inventories/national-emissions-inventory)

^a The sums of subcategories may not equal total due to rounding.



Though gasoline-powered light vehicles continue to be responsible for the majority of carbon monoxide emissions from highway vehicles, the total pollution from light vehicles in 2005 is less than a fifth of what it was in 1970. This is despite the fact that there were many more light vehicles on the road in 2005. Between 2005 and 2011 the Environmental Protection Agency updated their source from the MOBILE 6.2 emissions model to the MOVES emission model. MOVES results typically show higher emissions, especially for heavy trucks. The 2014 data are the latest available.

Table 12.3
Emissions of Carbon Monoxide from Highway Vehicles, 1970–2014^a
(million short tons)

Source category	1970	1980	1990	2000	2005	2011 ^b	2014 ^b	Percent of total, 2014
Gasoline powered								
Light vehicles & motorcycles	119.14	98.21	67.24	36.40	24.19	c	c	c
Light trucks ^d	22.27	28.83	32.23	27.04	21.19	c	c	c
<i>Subtotal light vehicles</i>	<i>141.41</i>	<i>127.04</i>	<i>99.47</i>	<i>63.44</i>	<i>45.38</i>	<i>25.34</i>	<i>20.03</i>	<i>91.7%</i>
Heavy vehicles	21.27	15.35	8.92	3.42	1.97	0.86	0.90	4.1%
<i>Subtotal gasoline vehicles</i>	<i>162.68</i>	<i>142.39</i>	<i>108.39</i>	<i>66.86</i>	<i>47.35</i>	<i>26.20</i>	<i>20.93</i>	<i>95.8%</i>
Diesel powered								
Light vehicles	0.01	0.03	0.04	0.01	0.01	c	c	c
Light trucks ^d	0.06	0.05	0.03	0.01	0.01	c	c	c
<i>Subtotal light vehicles</i>	<i>0.07</i>	<i>0.08</i>	<i>0.07</i>	<i>0.02</i>	<i>0.02</i>	<i>0.38</i>	<i>0.24</i>	<i>1.1%</i>
Heavy vehicles	0.49	1.36	1.81	1.19	0.85	0.77	0.67	3.1%
<i>Subtotal diesel vehicles</i>	<i>0.56</i>	<i>1.43</i>	<i>1.87</i>	<i>1.20</i>	<i>0.87</i>	<i>1.15</i>	<i>0.91</i>	<i>4.2%</i>
Total								
Highway vehicle total	163.23	143.83	110.26	68.06	48.22	27.36	21.84	100.0%
Percent diesel	0.3%	1.0%	1.7%	1.8%	1.8%	4.2%	4.2%	

Source:

U. S. Environmental Protection Agency, National Emission Inventory Air Pollutant Emission Trends website www.epa.gov/air-emissions-inventories/national-emissions-inventory-nei. (Additional resources: www.epa.gov/air-emissions-inventories/national-emissions-inventory)

^a The sums of subcategories may not equal total due to rounding.

^b These data are not directly comparable to the older data due to the change in source from the MOBILE emissions model to the MOVES emissions model.

^c Data are not available.

^d Less than 8,500 pounds.



The transportation sector accounted for almost 60% of the nation's nitrogen oxide (NO_x) emissions in 2016, with the majority coming from highway vehicles. For details on the highway emissions of NO_x, see Table 12.5.

Table 12.4
Total National Emissions of Nitrogen Oxides, 1970–2016^a
(million short tons)

Source category	1970	1980	1990	2000	2010	2016	Percent of total, 2016
Highway vehicles	12.62	11.49	9.59	8.39	5.70	3.61	34.4%
Other off-highway	2.65	3.35	3.78	4.17	3.32	2.42	23.0%
Transportation total	15.27	14.84	13.37	12.56	9.02	6.02	57.4%
Stationary fuel combustion total	10.06	11.32	10.89	8.82	4.33	2.78	26.5%
Industrial processes total	0.78	0.56	0.80	0.81	1.12	1.29	12.3%
Waste disposal and recycling total	0.44	0.11	0.09	0.13	0.09	0.11	1.1%
Miscellaneous total	0.33	0.25	0.37	0.28	0.30	0.29	2.8%
Total of all sources	26.88	27.08	25.52	22.60	14.86	10.49	100.0%

Source:

U. S. Environmental Protection Agency, National Emission Inventory Air Pollutant Emission Trends website www.epa.gov/air-emissions-inventories/air-pollutant-emissions-trends-data. (Additional resources: www.epa.gov/air-emissions-inventories/national-emissions-inventory)

^a The sums of subcategories may not equal total due to rounding.



Diesel-powered vehicles were responsible for nearly one-half (49%) of highway vehicle nitrogen oxide emissions in 2014, while light gasoline vehicles were responsible for the rest. Between 2005 and 2011 the Environmental Protection Agency updated their source from the MOBILE 6.2 emissions model to the MOVES emission model. MOVES results typically show higher emissions, especially for heavy trucks. The 2014 data are the latest available.

Table 12.5
Emissions of Nitrogen Oxides from Highway Vehicles, 1970–2014^a
(million short tons)

Source category	1970	1980	1990	2000	2005	2011 ^b	2014 ^b	Percent of total, 2014
Gasoline powered								
Light vehicles & motorcycles	8.54	6.63	4.26	2.31	1.63	c	c	c
Light trucks ^d	1.54	1.58	1.50	1.44	1.56	c	c	c
<i>Subtotal light vehicles</i>	10.08	8.21	5.76	3.75	3.19	3.09	2.29	49.1%
Heavy vehicles	0.72	0.62	0.57	0.45	0.38	0.09	0.09	1.9%
<i>Subtotal gasoline vehicles</i>	10.81	8.83	6.33	4.20	3.57	3.18	2.38	51.0%
Diesel powered								
Light vehicles	0.00	0.03	0.04	0.01	0.00	c	c	c
Light trucks ^d	0.07	0.05	0.02	0.01	0.01	c	c	c
<i>Subtotal light vehicles</i>	0.07	0.08	0.06	0.02	0.01	0.13	0.11	2.4%
Heavy vehicles	1.76	2.59	3.19	4.18	2.81	2.56	2.17	46.6%
<i>Subtotal diesel vehicles</i>	1.83	2.66	3.26	4.19	2.82	2.69	2.28	49.0%
Total								
Highway vehicle total	12.64	11.49	9.59	8.39	6.39	5.87	4.67	100.0%
Percent diesel	14.5%	23.1%	34.0%	49.9%	44.1%	45.8%	49.0%	

Source:

U. S. Environmental Protection Agency, National Emission Inventory Air Pollutant Emission Trends website www.epa.gov/air-emissions-inventories/national-emissions-inventory-nei. (Additional resources: www.epa.gov/air-emissions-inventories/national-emissions-inventory)

^a The sums of subcategories may not equal total due to rounding.

^b These data are not directly comparable to the older data due to the change in source from the MOBILE emissions model to the MOVES emissions model.

^c Data are not available.

^d Less than 8,500 pounds.



The transportation sector accounted for about 21% of the nation's volatile organic compound (VOC) emissions in 2016, with the majority coming from highway vehicles. For details on the highway emissions of VOC, see Table 12.7.

Table 12.6
Total National Emissions of Volatile Organic Compounds, 1970–2016^a
(million short tons)

Source category	1970	1980	1990	2000	2010	2016	Percent of total, 2016
Highway vehicles	16.91	13.87	9.39	5.33	2.77	1.77	11.1%
Off-highway	1.62	2.19	2.66	2.64	2.30	1.58	9.9%
Transportation total	18.53	16.06	12.05	7.97	5.07	3.34	21.1%
Stationary fuel combustion total	0.72	1.05	1.01	1.18	0.61	0.53	3.4%
Industrial processes total	12.33	12.10	9.01	7.21	6.96	7.30	46.0%
Waste disposal and recycling total	1.98	0.76	0.99	0.42	0.15	0.20	1.2%
Miscellaneous total	1.10	1.13	1.06	0.73	5.06	4.49	28.3%
Total of all sources	34.66	31.10	24.12	17.51	17.85	15.86	100.0%

Source:

U. S. Environmental Protection Agency, National Emission Inventory Air Pollutant Emission Trends website www.epa.gov/air-emissions-inventories/air-pollutant-emissions-trends-data. (Additional resources: www.epa.gov/air-emissions-inventories/national-emissions-inventory)

^a The sum of subcategories may not equal total due to rounding. The EPA's definition of volatile organic compounds excludes methane, ethane, and certain other nonphotochemically reactive organic compounds.



Gasoline-powered vehicles are responsible for over 90% of highway vehicle emissions of volatile organic compounds. VOC emissions from highway vehicles in 2014 were less than one-quarter of the 1990 level. Between 2005 and 2011 the Environmental Protection Agency updated their source from the MOBILE 6.2 emissions model to the MOVES emission model. MOVES results typically show higher emissions, especially for heavy trucks. The 2014 data are the latest available.

Table 12.7
Emissions of Volatile Organic Compounds from Highway Vehicles, 1970–2014^a
(thousand short tons)

Source category	1970	1980	1990	2000	2005	2011 ^b	2014 ^b	Percent of total, 2014
Gasoline powered								
Light vehicles & motorcycles	11,996	9,304	5,690	2,903	2,111	c	c	c
Light trucks ^d	2,776	2,864	2,617	1,929	1,629	c	c	c
<i>Subtotal light vehicles</i>	14,772	12,168	8,307	4,832	3,740	2,345	1,811	88.2%
Heavy vehicles	1,679	1,198	633	256	171	40	41	2.0%
<i>Subtotal gasoline vehicles</i>	16,451	13,366	8,940	5,088	3,911	2,386	1,853	90.3%
Diesel powered								
Light vehicles	8	16	18	3	2	c	c	c
Light trucks ^d	41	28	15	4	6	c	c	c
<i>Subtotal light vehicles</i>	49	44	33	7	8	43	26	1.3%
Heavy vehicles	411	459	415	230	159	213	174	8.4%
<i>Subtotal diesel vehicles</i>	460	503	448	238	167	256	200	9.7%
Total								
Highway vehicle total	16,911	13,869	9,388	5,326	4,078	2,642	2,053	100.0%
Percent diesel	2.7%	3.6%	4.8%	4.5%	4.1%	9.7%	9.7%	

Source:

U. S. Environmental Protection Agency, National Emission Inventory Air Pollutant Emission Trends website www.epa.gov/air-emissions-inventories/national-emissions-inventory-nei. (Additional resources: www.epa.gov/air-emissions-inventories/national-emissions-inventory)

^a The sums of subcategories may not equal total due to rounding.

^b These data are not directly comparable to the older data due to the change in source from the MOBILE emissions model to the MOVES emissions model.

^c Data are not available.

^d Less than 8,500 pounds.



The transportation sector accounted for less than 2% of the nation's particulate matter (PM-10) emissions in 2016. For details on the highway emissions of PM-10, see Table 12.9.

Table 12.8
Total National Emissions of Particulate Matter (PM-10), 1970–2016^a
(million short tons)

Source category	1970	1980	1990	2000	2010	2016	Percent of total, 2016
Highway vehicles	0.48	0.43	0.39	0.23	0.28	0.29	1.2%
Off-highway	0.16	0.26	0.33	0.32	0.23	0.16	0.7%
Transportation total	0.64	0.69	0.72	0.55	0.51	0.45	1.8%
Stationary fuel combustion total	2.87	2.45	1.20	1.47	0.98	0.92	3.8%
Industrial processes total	7.67	2.75	1.04	0.71	1.05	0.96	3.9%
Waste disposal and recycling total	1.00	0.27	0.27	0.36	0.21	0.31	1.2%
Miscellaneous total	0.84	0.85	24.54	20.65	18.08	21.80	89.2%
Total of all sources	13.02	7.01	27.77	23.74	20.83	24.44	100.0%

Note: Because PM-10 is fine particle matter less than 10 microns, it also includes PM-2.5. Specific data for PM-2.5 are shown on Tables 12.10 and 12.11.

Source:

U. S. Environmental Protection Agency, National Emission Inventory Air Pollutant Emission Trends website www.epa.gov/air-emissions-inventories/air-pollutant-emissions-trends-data. (Additional resources: www.epa.gov/air-emissions-inventories/national-emissions-inventory)

^a Fine particle matter less than 10 microns. The sums of subcategories may not equal total due to rounding.



In 2014, diesel-powered vehicles were responsible for 45% of highway vehicle emissions of particulate matter (PM-10); in 1990 diesels were responsible for 73.4%. Between 2005 and 2011 the Environmental Protection Agency updated their source from the MOBILE 6.2 emissions model to the MOVES emission model. MOVES results typically show higher emissions, especially for heavy trucks. The 2014 data are the latest available.

Table 12.9
Emissions of Particulate Matter (PM-10) from Highway Vehicles, 1970–2014^a
(thousand short tons)

Source category	1970	1980	1990	2000	2005	2011 ^b	2014 ^b	Percent of total, 2014
Gasoline powered								
Light vehicles & motorcycles	249	141	56	51	46	c	c	c
Light trucks ^d	74	49	31	31	35	c	c	c
<i>Subtotal light vehicles</i>	323	190	87	82	81	199	166	53.5%
Heavy vehicles	44	30	17	10	8	3	5	1.5%
<i>Subtotal gasoline vehicles</i>	367	220	104	92	89	203	171	55.0%
Diesel powered								
Light vehicles	2	9	11	1	1	c	c	c
Light trucks ^d	19	12	5	1	1	c	c	c
<i>Subtotal light vehicles</i>	21	21	16	2	2	10	7	2.2%
Heavy vehicles	92	191	268	135	92	159	133	42.8%
<i>Subtotal diesel vehicles</i>	113	212	284	137	94	168	140	45.0%
Total								
Highway vehicle total	480	432	387	230	183	371	311	100.0%
Percent diesel	23.5%	49.1%	73.4%	59.6%	51.4%	45.3%	45.0%	

Note: Because PM-10 is fine particle matter less than 10 microns, it also includes PM-2.5. Specific data for PM-2.5 are shown on Tables 12.10 and 12.11.

Source:

U. S. Environmental Protection Agency, National Emission Inventory Air Pollutant Emission Trends website www.epa.gov/air-emissions-inventories/national-emissions-inventory-nei. (Additional resources: www.epa.gov/air-emissions-inventories/national-emissions-inventory)

^a The sums of subcategories may not equal total due to rounding.

^b These data are not directly comparable to the older data due to the change in source from the MOBILE emissions model to the MOVES emissions model.

^c Data are not available.

^d Less than 8,500 pounds.



The transportation sector accounted for almost 5% of the nation's particulate matter (PM-2.5) emissions in 2016. For details on the highway emissions of PM-2.5, see Table 12.11.

Table 12.10
Total National Emissions of Particulate Matter (PM-2.5), 1990–2016^a
(million short tons)

Source category	1990	1995	2000	2005	2010	2016	Percent of total, 2016
Highway vehicles	0.32	0.25	0.17	0.31	0.20	0.13	2.2%
Off-highway	0.30	0.31	0.30	0.29	0.21	0.15	2.5%
Transportation total	0.62	0.56	0.47	0.60	0.41	0.28	4.6%
Stationary fuel combustion total	0.91	0.90	1.29	1.13	0.84	0.78	12.7%
Industrial processes total	0.56	0.50	0.50	0.53	0.42	0.42	6.8%
Waste disposal and recycling total	0.23	0.25	0.33	0.27	0.18	0.25	4.1%
Miscellaneous total	5.23	4.73	4.69	3.07	4.15	4.43	71.8%
Total of all sources	7.55	6.94	7.28	5.60	6.00	6.16	100.0%

Source:

U. S. Environmental Protection Agency, National Emission Inventory Air Pollutant Emission Trends website www.epa.gov/air-emissions-inventories/air-pollutant-emissions-trends-data. (Additional resources: www.epa.gov/air-emissions-inventories/national-emissions-inventory)

^a The sums of subcategories may not equal total due to rounding.



Diesel vehicles are responsible for the majority of highway vehicle PM-2.5 emissions. Nearly two-thirds of the highway vehicles' PM-2.5 emissions are from heavy diesel trucks. Between 2005 and 2011 the Environmental Protection Agency updated their source from the MOBILE 6.2 emissions model to the MOVES emission model. MOVES results typically show higher emissions, especially for heavy trucks. The 2014 data are the latest available.

Table 12.11
Emissions of Particulate Matter (PM-2.5) from Highway Vehicles, 1990–2014^a
(thousand short tons)

Source category	1990	1995	2000	2005	2011 ^b	2014 ^b	Percent of total, 2014
Gasoline powered							
Light vehicles & motorcycles	35	30	27	23	c	c	c
Light trucks ^d	21	20	18	18	c	c	c
<i>Subtotal light vehicles</i>	<i>56</i>	<i>50</i>	<i>45</i>	<i>41</i>	<i>68</i>	<i>59</i>	<i>37.2%</i>
Heavy vehicles	11	9	7	6	2	2	1.1%
<i>Subtotal gasoline vehicles</i>	<i>67</i>	<i>59</i>	<i>52</i>	<i>47</i>	<i>70</i>	<i>61</i>	<i>38.3%</i>
Diesel powered							
Light vehicles	9	4	1	1	c	c	c
Light trucks ^d	4	2	1	1	c	c	c
<i>Subtotal light vehicles</i>	<i>13</i>	<i>6</i>	<i>2</i>	<i>2</i>	<i>6</i>	<i>4</i>	<i>2.8%</i>
Heavy vehicles	243	179	119	79	120	93	58.9%
<i>Subtotal diesel vehicles</i>	<i>256</i>	<i>185</i>	<i>121</i>	<i>81</i>	<i>126</i>	<i>97</i>	<i>61.7%</i>
Total							
Highway vehicle total	323	244	173	128	196	159	100.0%
Percent diesel	79.3%	75.8%	69.9%	63.3%	64.6%	61.7%	

Source:

U. S. Environmental Protection Agency, National Emission Inventory Air Pollutant Emission Trends website www.epa.gov/air-emissions-inventories/national-emissions-inventory-nei. (Additional resources: www.epa.gov/air-emissions-inventories/national-emissions-inventory)

^a The sums of subcategories may not equal total due to rounding.

^b These data are not directly comparable to the older data due to the change in source from the MOBILE emissions model to the MOVES emissions model. The 2011 data include condensable plus filterable PM-2.5.

^c Data are not available.

^d Less than 8,500 pounds.



The transportation sector accounted for only 2% of the nation's sulfur dioxide (SO₂) emissions in 2016, with off-highway vehicles responsible for most of the emissions. Stationary fuel combustion (e.g., factories) was responsible for nearly 73% of all SO₂ emissions in 2016.

Table 12.12
Total National Emissions of Sulfur Dioxide, 1970–2016^a
(million short tons)

Source category	1970	1980	1990	2000	2010	2016	Percent of total, 2016
Highway vehicles	0.27	0.39	0.50	0.26	0.04	0.02	0.7%
Other off-highway	0.28	0.32	0.37	0.44	0.12	0.03	1.1%
Transportation total	0.55	0.72	0.87	0.70	0.16	0.05	1.8%
Stationary fuel combustion total	23.46	21.39	20.21	14.16	6.75	1.97	72.8%
Industrial processes total	7.10	3.81	1.90	1.42	0.68	0.50	18.5%
Waste disposal and recycling total	0.01	0.03	0.04	0.03	0.02	0.04	1.4%
Miscellaneous total	0.11	0.01	0.01	0.07	0.16	0.15	5.5%
Total of all sources	31.22	25.93	23.08	16.35	7.73	2.71	100.0%

Source:

U. S. Environmental Protection Agency, National Emission Inventory Air Pollutant Emission Trends website
www.epa.gov/air-emissions-inventories/air-pollutant-emissions-trends-data.
 (Additional resources: www.epa.gov/air-emissions-inventories/national-emissions-inventory)

^a The sums of subcategories may not equal total due to rounding.



EMISSION STANDARDS

The U.S. Environmental Protection Agency (EPA) regulates emissions from mobile sources including vehicles, engines, and motorized equipment that produce exhaust and evaporative emissions. Mobile sources contribute to four main air pollutants: carbon monoxide, hydrocarbons, nitrogen oxides, and particulate matter. The EPA not only sets standards for the vehicles, engines, and equipment, but also the fuels that they use. Tables 12.13 through Table 12.30 contain summaries of the current standards.

Acronyms Used on Tables 12.13 through Table 12.30

ABT	Averaging, banking, and credit trading program	LLDT	Light light-duty truck
ATV	All-terrain vehicle	LPG	Liquefied petroleum gas
bhp	Brake horsepower-hour	LVW	Loaded vehicle weight
CFR	Code of Federal Regulations	MDPV	Medium-duty passenger vehicle (8,500-10,000 lbs. GVWR)
CI	Compression-ignition	MDV	Medium-duty vehicle
CO	Carbon Monoxide	MY	Model year
DE	Diesel engine	NMHC	Non-methane hydrocarbon
EPA	Environmental Protection Agency	NMOG	Non-methane organic gases
FEL	Family emission limit	NR	Nonroad
FTP	Federal test procedure	NRLM	Nonroad, locomotive and marine
g	Gram	NOx	Nitrogen oxides
g/kN	Grams per kilonewton	NTE	Not-to-exceed
g/kW-hr	Grams per kilowatt-hour	OEM	Original equipment manufacturer
g/mi	Grams per mile	PM	Particulate matter
GPA	Geographic Phase-in Area	ppm	Parts per million
GVW	Gross vehicle weight	PWC	Personal watercraft
HC	Hydrocarbons	rO	Rated output
HCHO	Formaldehyde	rPR	Rated pressure ratio
HLDT	Heavy light-duty truck	SI	Spark-ignition
Hp-hr	Horsepower-hour	SULEV	Super-ultra-low-emission vehicle
ICAO	International Civil Aviation Organization	THC	Total hydrocarbons
kN	Kilonewton	THCE	Total hydrocarbon equivalent
kW	Kilowatt	ULEV	Ultra-low-emission vehicle
kW-hr	Kilowatt-hour	ULSD	Ultra-low sulfur diesel
LDT	Light-duty truck	ZEV	Zero-emission vehicle
LDV	Light-duty vehicle		
LEV	Low-emission vehicle		



The Environmental Protection Agency issued final Tier 3 emission standards in 2014. The combined emissions of non-methane organic gases (NMOG) and nitrogen oxides (NOx) that new gasoline engines are allowed to produce from model years 2017 to 2025 are regulated in these new standards. These standards apply to a corporate average, meaning that some vehicles produced in those model years will emit more than the standard, while others will emit less, so long as the average for each Original Equipment Manufacturer (OEM) product offerings meets the standard.

Table 12.13
Tier 3 Non-Methane Organic Gases and Nitrogen Oxide Standards
(milligrams per mile)

Model Year	Light-duty vehicles and LDT1	LDT2, 3, 4, and medium-duty passenger vehicles	Class 2b trucks	Class 3 trucks
2016	^a	^a	333 ^b	548 ^b
2017	86	101	310 ^b	508 ^b
2018	79	92	278	451
2019	72	83	253	400
2020	65	74	228	349
2021	58	65	203	298
2022	51	56	178	247
2023	44	47	178	247
2024	37	38	178	247
2025 and later	30	30	178	247

Notes: Standards are for the Federal Test Procedure. Different standards apply for the Supplemental Federal Test Procedure. For vehicles over 6,000 lbs. gross vehicle weight rating (GVWR), the standards apply beginning in MY 2018.

LDT1 = Light trucks less than 6,000 lbs. GVWR and less than 3,750 lbs. loaded vehicle weight (LVW).

LDT2, 3, 4 = Light trucks less than 8,500 lbs. GVWR and more than 3,750 lbs. LVW.

Class 2b trucks = trucks 8,501-10,000 lbs. GVWR.

Class 3 trucks = trucks 10,001-14,000 lbs. GVWR.

Source:

Federal Register Vol. 79, No. 81, Monday, April 28, 2014.

^a Not applicable.

^b Voluntary standard.



Table 12.14
Tier 3 Particulate Matter Emission Standards for Light Gasoline Vehicles, MY 2017 and Beyond
(milligrams per mile)

Model Year	Certification standard (milligrams per mile)	In-use standard (milligrams per mile)	Phase-in (percent of U.S. sales)
2017	3	6	20 ^a
2018	3	6	20
2019	3	6	40
2020	3	6	70
2021	3	6	100
2022-on	3	3	100

Note: Standards are for the Federal Test Procedure. The standards apply to all light-duty vehicles, light-duty trucks, and medium-duty passenger vehicles. For vehicles over 6,000 lbs. gross vehicle weight rating, the standards apply beginning in MY 2018.

Source:

Federal Register Vol. 79, No. 81, Monday, April 28, 2014.

Table 12.15
Tier 3 Evaporative Emission Standards
(grams per test)

Vehicle class	Highest hot soak + diurnal level (over both 2-day and 3-day diurnal tests)
Light-duty vehicles and LDT1	0.3
LDT2	0.4
LDT3, LT4, and medium-duty passenger vehicles	0.5
Heavy-duty gasoline vehicles	0.6

Note: LDT1 = Light trucks less than 6,000 lbs. gross vehicle weight rating (GVWR) and less than 3,750 lbs. loaded vehicle weight (LVW).

LDT2 = Light trucks less than 6,000 lbs. GVWR and less than 3,750 lbs. LVW.

LDT3, 4 = Light trucks less than 8,500 lbs. GVWR and more than 3,750 lbs. LVW.

Heavy-duty gasoline vehicles = trucks over 10,000 lbs. GVWR.

Source:

Federal Register Vol. 79, No. 81, Monday, April 28, 2014.

^a Manufacturers comply with 20% of their light-duty truck fleet under 6,000 lbs. gross vehicle weight, alternatively with 10% of their total light-duty vehicle, light-duty trucks and medium-duty passenger vehicle fleet.



These exhaust emission standards were phased-in from 2004 to 2010.

Table 12.16
Light-Duty Vehicle, Light-Duty Truck, and Medium-Duty Passenger Vehicle – Tier 2 Exhaust Emission Standards

	Standard	Emission limits at 50,000 miles					Emission limits at full useful life (120,000 miles) ^a				
		NO _x (g/mi)	NMOG (g/mi)	CO (g/mi)	PM (g/mi)	HCHO (g/mi)	NO _x (g/mi)	NMOG (g/mi)	CO (g/mi)	PM (g/mi)	HCHO (g/mi)
Federal	Bin 1	-	-	-	-	-	0	0	0	0	0
	Bin 2	-	-	-	-	-	0.02	0.01	2.1	0.01	0.004
	Bin 3	-	-	-	-	-	0.03	0.055	2.1	0.01	0.011
	Bin 4	-	-	-	-	-	0.04	0.07	2.1	0.01	0.011
	Bin 5	0.05	0.075	3.4	-	0.015	0.07	0.09	4.2	0.01	0.018
	Bin 6	0.08	0.075	3.4	-	0.015	0.1	0.09	4.2	0.01	0.018
	Bin 7	0.11	0.075	3.4	-	0.015	0.15	0.09	4.2	0.02	0.018
	Bin 8	0.14	0.100 / 0.125 ^c	3.4	-	0.015	0.2	0.125 / 0.156	4.2	0.02	0.018
	Bin 9 ^b	0.2	0.075 / 0.140	3.4	-	0.015	0.3	0.090 / 0.180	4.2	0.06	0.018
	Bin 10 ^b	0.4	0.125 / 0.160	3.4 / 4.4	-	0.015 / 0.018	0.6	0.156 / 0.230	4.2 / 6.4	0.08	0.018 / 0.027
	Bin 11 ^b	0.6	0.195	5	-	0.022	0.9	0.28	7.3	0.12	0.032

Note: Tests Covered: Federal Test Procedure (FTP), cold carbon monoxide, highway, and idle. Definitions of acronyms are on page 12-14.

Source:

40 CR 86 Subpart S. (Additional resources: www.epa.gov/emission-standards-reference-guide/light-duty-vehicles-and-trucks-emission-standards)

^a In lieu of intermediate useful life standards (50,000 miles) or to gain additional nitrogen oxides credit, manufacturers may optionally certify to the Tier 2 exhaust emission standards with a useful life of 150,000 miles.

^b Bins 9-11 expired in 2006 for light-duty vehicles and light light-duty trucks and 2008 for heavy light-duty trucks and medium-duty passenger vehicles.

^c Pollutants with two numbers have a separate certification standard (1st number) and in-use standard (2nd number).



Table 12.17
Light-Duty Vehicle, Light-Duty Truck, and Medium-Duty Passenger Vehicle – Tier 2 Evaporative Emission Standards

	Vehicle type	Model year	3 Day diurnal + hot soak (g/test)	Supplemental 2 day diurnal + hot soak (g/test)	Running loss (g/mi)
Federal	LDV/LLDTs ^a	2004	0.95	1.20	0.05
	HLDTs ^b	2004	1.20	1.50	0.05
	MDPVs ^{a, b}	2004	1.40	1.75	0.05
	LDV ^a	2009	0.50	0.65	0.05
	LLDT ^a	2009	0.65	0.85	0.05
	HLDT ^b	2010	0.90	1.15	0.05
	MDPV ^{a, b}	2010	1.00	1.25	0.05

Note: Multi-fuel vehicle phase-in applies. Definitions of acronyms are on page 12-14.

Source:

40 CR 86 Subpart S. (Additional resources: www.epa.gov/emission-standards-reference-guide/light-duty-vehicles-and-trucks-emission-standards)

^a For liquefied petroleum gas-fueled light-duty vehicles (LDV), light-duty trucks (LDT), and medium-duty passenger vehicles (MDPV): 0.15 grams hydrocarbon per gallon (0.04 grams per liter) of fuel dispensed.

^b Refueling standards for heavy light-duty trucks (HLDT) are subject to phase-in requirements. MDPVs must also comply with the phase-in requirement and must be grouped with HLDTs to determine phase-in compliance.



Table 12.18
Heavy-Duty Highway Compression-Ignition Engines and Urban Buses – Exhaust
Emission Standards

	Year	HC (g/bhp-hr)	NMHC (g/bhp-hr)	NMHC + NOx (g/bhp-hr)	NOx (g/bhp-hr)	PM (g/bhp-hr)	CO (g/bhp-hr)	Idle CO (percent Exhaust gas flow)	Smoke ^a (percentage)	Useful life (hours/years/miles)
Federal ^b	1974-78	-	-	16	-	-	40	-	20 / 15 / 50	-
	1979-84	1.5	-	10	-	-	25	-	20 / 15 / 50	-
	1985-87	1.3	-	-	10.7	-	15.5	-	20 / 15 / 50	LHDDE: - / 8 / 110,000 MHDDE: - / 8 / 185,000 HHDDE: - / 8 / 290,000
	1988-89	1.3 ^d	-	-	10.7	0.6	15.5	0.5 ^c	20 / 15 / 50	1990-97 and 1998+ for HC, CO, and PM: LHDDE: - / 8 / 110,000 MHDDE: - / 8 / 185,000 HHDDE: - / 8 / 290,000
	1990	1.3 ^d	-	-	6.0	0.6	15.5	0.5 ^c	20 / 15 / 50	
	1991-93	1.3	-	-	5.0 [ABT]	0.25 [ABT] 0.10 ^e	15.5	0.5 ^c	20 / 15 / 50	
	1994-97	1.3	-	-	5.0 [ABT]	0.1 [ABT] 0.07 ^f , 0.05 ^g	15.5	0.5 ^c	20 / 15 / 50	1994+ urban buses for PM only: LHDDE: - / 10 / 110,000 1998+ for NOx: LHDDE: - / 10 / 110,000 MHDDE: - / 10 / 185,000 HHDDE: - / 10 / 290,000
	1998-2003	1.3	-	-	4.0 [ABT]	0.1 [ABT] 0.05 ^g	15.5	0.5 ^c	20 / 15 / 50	
	2004-2006 ^h	-	-	2.4 (or 2.5 with a limit of 0.5 on NMHC) ^o [ABT] ^{i,j}	-	0.1 0.05 ^k	15.5	0.5	20 / 15 / 50	For all pollutants: ^p LHDDE: - / 10 / 110,000 MHDDE: - / 10 / 185,000 HHDDE: 22,000 / 10 / 435,000
	2007+ ^{h,k,l,m,n}	-	0.14 ^o	2.4 (or 2.5 with a limit of 0.5 on NMHC) [ABT]	0.2 ^o	0.01	15.5	0.5	20 / 15 / 50	

Note: The test procedures are the EPA Transient Test Procedure and the EPA Smoke Test Procedure. Definitions of acronyms are on page 12-14.

Sources:

40 CFR 86.099-11 Emission standards for 1999 and later model year diesel heavy-duty engines and vehicles.
 40 CFR 86.004-11 Emission standards for 2004 and later model year diesel heavy-duty engines and vehicles.
 40 CFR 86.007-11 Emission standards and supplemental requirements for 2007 and later model year diesel heavy-duty engines and vehicles. (Additional resources: www.epa.gov/emission-standards-reference-guide/light-duty-vehicles-and-trucks-emission-standards)

^a Percentages apply to smoke opacity at acceleration/lug/peak modes.

^b Standards for 1990 apply only to diesel-fueled heavy-duty engines (HDE). Standards for 1991+ apply to both diesel- and methanol-fueled HDEs. Standards that apply to urban buses specifically are footnoted.

^c This standard applies to the following fueled engines for the following model years: methanol - 1990+, natural gas and liquefied petroleum gas (LPG) - 1994+.

^d For petroleum-fueled engines, the standard is for hydrocarbons (HC). For methanol-fueled engines, the standard is for total hydrocarbon equivalent (THCE).

^e Certification standard for urban buses for 1993.

^f Certification standard for urban buses from 1994-95.

^g Certification standard for urban buses from 1996 and later. The in-use standard is 0.07.

^h Load Response Test certification data submittal requirements take effect for heavy-duty diesel engines beginning in model year 2004. The following requirements take effect with the 2007 model year: steady-state test requirement and Not-to-Exceed (NTE) test procedures for testing of in-use engines. On-board diagnostic requirements applicable to heavy-duty diesel vehicles and engines up to 14,000 pounds gross vehicle weight rating (GVWR) phase in from the 2005 through 2007 model years.



Table 12.18 (continued)
Heavy-Duty Highway Compression-Ignition Engines and Urban Buses – Exhaust
Emission Standards

ⁱ The modified averaging, banking, and trading program for 1998 and later model year engines applies only to diesel cycle engines. Credits generated under the modified program may be used only in 2004 and later model years.

^j For heavy-duty diesel engines, there are three options to the measurement procedures currently in place for alternative fueled engines: (1) use a THC measurement in place of a non-methane hydrocarbon (NMHC) measurement; (2) use a measurement procedure specified by the manufacturer with prior approval of the Administrator; or (3) subtract two percent from the measured THC value to obtain an NMHC value. The methodology must be specified at time of certification and will remain the same for the engine family throughout the engines' useful life. For natural gas vehicles, EPA allows the option of measuring NMHC through direct quantification of individual species by gas chromatography.

^k Starting in 2006, refiners must begin producing highway diesel fuel that meets a maximum sulfur standard of 15 parts per million (ppm).

^l Subject to a Supplemental Emission Test (1.0 x Federal Test Procedure [FTP] standard (or Family Emission Limit [FEL]) for nitrogen oxides [NO_x], NMHC, and particulate matter [PM]) and a NTE test (1.5 x FTP standard [or FEL] for NO_x, NMHC, and PM).

^m EPA adopted the lab-testing and field-testing specifications in 40 CFR Part 1065 for heavy-duty highway engines, including both diesel and Otto-cycle engines. These procedures replace those previously published in 40 Code of Federal Regulations (CFR) Part 86, Subpart N. Any new testing for 2010 and later model years must be done using the 40 CFR Part 1065 procedures.

ⁿ Two-phase in-use NTE testing program for heavy-duty diesel vehicles. The program begins with the 2007 model year for gaseous pollutants and 2008 for PM. The requirements apply to diesel engines certified for use in heavy-duty vehicles (including buses) with GVWRs greater than 8,500 pounds. However, the requirements do not apply to any heavy-duty diesel vehicle that was certified using a chassis dynamometer, including medium-duty passenger vehicles with GVWRs of between 8,500 and 10,000 pounds.

^o NO_x and NMHC standards will be phased in together between 2007 and 2010. The phase-in will be on a percent-of-sales basis: 50 percent from 2007 to 2009 and 100 percent in 2010.

^p Note that for an individual engine, if the useful life hours interval is reached before the engine reaches 10 years or 100,000 miles, the useful life shall become 10 years or 100,000 miles, whichever occurs first, as required under Clean Air Act section 202(d).



Table 12.19
Heavy-Duty Highway Spark-Ignition Engines – Exhaust Emission Standards

	Engine or vehicle	Year	Gross vehicle weight (lbs)	HC ^a (g/bhp-hr)	NMHC ^b (g/bhp-hr)	NOx (g/bhp-hr)	NOx + NMHC ^c (g/bhp-hr)	PM (g/bhp-hr)	CO (g/bhp-hr)	Idle CO (% exhaust gas flow)	Formaldehyde (g/mile)	Useful life (years / miles)
Federal	Heavy duty engines ^d	Prior to Control	-	12.7	-	-	6.86	-	155	-	-	5 / 50,000
		1970-73	-	275 ppm	-	-	-	-	1.50%	-	-	
		1974-78	-	-	-	16	-	-	40	-	-	
		1979-84	-	1.5	-	10	-	-	25	-	-	
		1985-86	-	1.9	-	-	10.6	-	37.1	-	-	
		1987	≤ 14,000	1.1	-	-	10.6	-	14.4	0.5	-	
			> 14,000	1.9	-	-	10.6	-	37.1		-	
		1988-90	≤ 14,000	1.1	-	-	6.0	-	14.4	-	-	
			> 14,000	1.9	-	-	6.0	-	37.1	-	-	
		1990 ^e	≤ 14,000	1.1	-	-	6.0	-	14.4	0.5 ⁱ	-	8 / 110,000 ^k
			> 14,000	1.9	-	-	6.0	-	37.1		-	
		1991-97 ^f	≤ 14,000	1.1 ^g	-	-	5.0	-	14.4		-	
			> 14,000	1.9 ^h	-	-	5.0	-	37.1		-	
		1998-2004 ^f	≤ 14,000	1.1 ^g	-	-	4.0 ^j	-	14.4		-	
			> 14,000	1.9 ^h	-	-		-	37.1		-	
		2005-2007 ^f	≤ 14,000	1.1 ^g	-	1.0 ^j	-	-	14.4		-	10 / 110,000
			> 14,000	1.9 ^h	-		-	-	37.1		-	
		2008+	All	-	0.14	0.2	-	0.01	14.4		-	11 / 110,000
	Complete heavy-duty vehicles ^{h, q}	2005-2007	8,500 - 10,000	-	0.280 ^m	-	0.9	-	7.3		-	
			10,000 - 14,000	-	0.330 ^m	-	1.0	-	8.1		-	
		2008+ ^p	8,500 - 10,000	-	0.195 ^o	-	0.2	0.02	7.3		0.032	
			10,000 - 14,000	-	0.230 ^o	-	0.4	0.02	8.1		0.04	

Note: Definitions of acronyms are on page 12-14.

Sources:

40 CFR 86.1816-05, 86.1816-08 Emission standards for complete heavy-duty vehicles

40 CFR 86.1806-01, 86.1806-04, 86.1806-05 Onboard diagnostics requirements

40 CFR 86.1817-05, 86.1817-08 Complete heavy-duty vehicle averaging, banking, and trading program

40 CFR 86.091-10 Heavy-duty engine averaging, banking, and trading program for 1991 and later - Not available in the e-CFR

40 CFR Part 86 Subpart B Vehicle test procedures (Additional resources: www.epa.gov/emission-standards-reference-guide/light-duty-vehicles-and-trucks-emission-standards)

^a For methanol-fueled engines, the standard is for total hydrocarbon equivalent (THCE).

^b For methanol and alcohol fueled vehicles the standard is for non-methane hydrocarbon equivalent (NMHCE).

^c For methanol fueled engines the standard is for nitrogen oxides (NOx) plus NMHCE.

^d Standards for heavy-duty engines are expressed in grams per brake horsepower-hour (g/bhp-hr). Starting with the 1998 model year, crankcase emissions are not allowed.

^e Standards for 1990 apply to gasoline and methanol-fueled engines.

^f Standards for 1991 and later apply to gasoline and methanol engines and are optional for natural gas and Liquefied Petroleum Gas-fueled engines through the 1996 model year.

^g For natural gas fueled engines the standard is 0.9 g/bhp-hr non-methane hydrocarbon (NMHC).



Table 12.19 (continued)
Heavy-Duty Highway Spark-Ignition Engines – Exhaust Emission Standards

^h For natural gas fueled engines the standard is 1.7 g/bhp-hr NMHC.

ⁱ The NO_x standard is 5.0 for all natural gas-fueled engines.

^j This standard applies to the following engines utilizing aftertreatment technology (except for methanol) for the following model years: gasoline/1990+; natural gas and LPG/1991+; methanol/1990+. Starting in 2005, engines certified to on-board diagnostics requirements are not required to meet the idle carbon monoxide (CO) standard.

^k Useful life is expressed in years or miles, whichever comes first. Useful life for the 1998 and later NO_x standard and for all 2004 standards is 10 years or 110,000 miles, whichever comes first.

^l Manufacturers can choose this standard or one of the following options: (1) a standard of 1.5 g/bhp-hr NMHC+NO_x that applies to the 2004 through 2007 model years, with complete heavy-duty vehicle standards taking effect in 2005; or (2) a standard of 1.5 g/bhp-hr NMHC + NO_x that would apply to the 2003 through 2007 heavy-duty engines and optionally to 2003 through 2006 complete heavy-duty vehicles.

^m Standard is expressed as non-methane organic gas, but compliance can optionally be shown using measurement of NMHC or total hydrocarbon (THC).

ⁿ Complete heavy-duty vehicles have the primary load-carrying container or device attached. Incomplete heavy-duty vehicles are certified to heavy-duty engine standards. Standards for complete heavy-duty vehicles are expressed in grams per mile (g/mi). Starting in 2005 (or 2003 or 2004 depending on the selected phase in option; see footnote l), complete heavy-duty vehicles under 14,000 lbs gross vehicle weight are tested on chassis-based rather than engine-based procedures and must meet these complete heavy-duty vehicle standards.

^o Although expressed as NMHC, compliance can optionally be shown using measurement of NMOG or THC.

^p At least 50 percent of a manufacturer's sales must meet these standards in 2008, with 100 percent required in 2009.

^q Gross vehicle weight ranges are more accurately specified as follows: $8,500 \leq \text{GVW} \leq 10,000$ and $10,000 < \text{GVW} < 14,000$.



Table 12.20
Heavy-Duty Highway Compression-Ignition and Spark-Ignition Engines – Evaporative
Emission Standards

	Engine type	Year	Gross vehicle weight (lbs)	Conventional diurnal + hot soak (g/test) ^a	Three-diurnal test sequence (g/test) ^b	Supplemental two-diurnal test sequence (g/test) ^c	Running loss (g/mi) ^c	Spitback (g/test) ^c	Useful life ^d
Federal	SI	1991-95	≤ 14,000	3.0	-	-	-	-	8 / 110,000
			> 14,000 ^e	4.0	-	-	-	-	
		1996-2007 (Enhanced) ^f	≤ 14,000	-	3.0	3.5	0.05	1.0	10 / 120,000
			> 14,000 ^e	-	4.0	4.5		-	
		2008+ (Enhanced)	8500-14,000	-	1.4	1.75		1.0	11 / 110,000
			> 14,000 ^e	-	1.9	2.3		-	
	CI	1996-97	≤ 14,000	-	3.0	-	-	-	MHDDE: 8 / 185,000 HHDE: 8 / 290,000 MHDDE: 8 / 185,000 HHDE: 8 / 290,000
			> 14,000 ^e	-	4.0	-	-	-	
		1998+ (Enhanced) ^g	≤ 14,000	-	3.0	3.5	0.05	1.0	
			> 14,000 ^e	-	4.0	4.5		-	

Note: Definitions of acronyms are on page 12-14.

Sources:

40 CFR 86.099-11 Emission standards for 1999 and later model year diesel heavy-duty engines and vehicles.

40 CFR 86.004-11 Emission standards for 2004 and later model year diesel heavy-duty engines and vehicles.

CFR 86.007-11 Emission standards and supplemental requirements for 2007 and later model year diesel heavy-duty engines and vehicles. (Additional resources: www.epa.gov/emission-standards-reference-guide/light-duty-vehicles-and-trucks-emission-standards)

^a Applies to gasoline and methanol engines. Standard is hydrocarbon (HC) for gasoline engines, total hydrocarbon equivalent (THCE) for methanol engines.

^b For spark-ignition (SI) engines, standard applies to gasoline, methanol, natural gas, and liquefied petroleum gas engines. For compression-ignition (CI) engines, standard applies to methanol, natural gas, and liquefied petroleum gas engines. Standard is THCE for methanol engines, HC for others.

^c For SI engines, standard applies to gasoline and methanol engines. For CI engines, standard applies to methanol engines. Standard is THCE for methanol engines, HC for others.

^d Useful life is expressed in years or miles, whichever comes first.

^e Vehicles over 26,000 pounds gross vehicle weight may demonstrate compliance with an engineering design evaluation in lieu of testing.

^f A new enhanced evaporative test procedure applies, which is considerably more stringent than the previous test procedure despite the fact that the standard values do not change from prior years. Gasoline and methanol engines are phased in at the following rates of a manufacturer's sales for the specified model year: 1996: 20 percent; 1997: 40 percent; 1998: 90 percent; 1999: 100 percent.

^g A new enhanced evaporative test procedure applies, which is considerably more stringent than the previous test procedure despite the fact that the standard values do not change from prior years. Methanol-fueled vehicles are phased in at a rate of 90 percent of a manufacturer's production in 1998 and 100 percent in 1999.



The LEV III exhaust standards apply to new cars, light trucks, and medium vehicles, including fuel-flexible, bi-fuel, and dual-fuel vehicles from model year 2015-on.

Table 12.21
California New Car, Light Truck and Medium Truck Emission Certification Standards,
Model Year 2015-On

Vehicle type	Vehicle emission category	Non-methane organic gases + nitrogen oxides (g/mi)	Carbon monoxide (g/mi)	Formaldehyde (mg/mi)	Particulates (g/mi)
All passenger cars; LDTs 8,500 lbs. GVW or less	LEV160	0.16	4.2	4	0.01
	ULEV125	0.125	2.1	4	0.01
	ULEV70	0.07	1.7	4	0.01
All MDPVs	ULEV50	0.05	1.7	4	0.01
	SULEV30	0.03	1.0	4	0.01
	SULEV20	0.02	1.0	4	0.01
Vehicles in this category are tested at their loaded vehicle weight					
MDVs 8,501-10,000 lbs. GVW	LEV395	0.395	6.4	6	0.12
	ULEV340	0.34	6.4	6	0.06
	ULEV250	0.25	6.4	6	0.06
	ULEV200	0.2	4.2	6	0.06
	SULEV170	0.17	4.2	6	0.06
	SULEV150	0.15	3.2	6	0.06
Vehicles in this category are tested at their adjusted loaded vehicle weight					
MDVs 10,000-14,000 lbs. GVW	LEV630	0.63	7.3	6	0.12
	ULEV570	0.57	7.3	6	0.06
	ULEV400	0.4	7.3	6	0.06
	ULEV270	0.27	4.2	6	0.06
	SULEV230	0.23	4.2	6	0.06
	SULEV200	0.2	3.7	6	0.06

Note: Definitions of acronyms are on page 12-14.

Source:

California LEV III Regulations with amendments effective January 1, 2016,
www.arb.ca.gov/msprog/levprog/cleandoc/cleancomplete%20ev-ghg%20regs%201-16.pdf. (Additional resources: www.arb.ca.gov)



These exhaust emission standards apply to commercial aircraft engines.

Table 12.22
Aircraft – Exhaust Emission Standards

	Year	Pressure ratio (PR)	Applicability ^a	HC (g/kN)	NO _x	CO (g/kN)	Smoke
Federal ^b	1974+	-	T8	-	-	-	30
	1976+	-	TF with rO ^c ≥ 129 kN	-	-	-	83.6(rO) ^{-0.274}
	1978+	-	T3 ^d	-	-	-	25
	1983+	-	TF with rO < 26.7 kN	-	-	-	83.6(rO) ^{-0.274} NTE max of SN=50
	1984+	-	T3, T8, TF with rO ≥ 26.7 kN	19.6	-	-	83.6(rO) ^{-0.274} NTE max of SN=50
		-	TSS	140(.92) ^{rPR}	-	-	83.6(rO) ^{-0.274} NTE max of SN=50
		-	TSS with rO ≥ 26.7 kN	140(.92) ^{rPR}	-	-	83.6(rO) ^{-0.274} NTE max of SN=50
		-	TP with rO ≥ 1,000 kW	-	-	-	187(rO) ^{-0.168}
	1997+	-	T3, T8, TF with rO > 26.7 kN	19.6	40+2(rPR)	118	83.6(rO) ^{-0.274} NTE max of SN=50
		-	T3, T8, TF newly certified with rO > 26.7 kN	19.6	32+1.6(rPR)	118	83.6(rO) ^{-0.274} NTE max of SN=50
	2000+	-	T3, T8, TF newly manufactured with rO > 26.7 kN	19.6	32+1.6(rPR)	118	83.6(rO) ^{-0.274} NTE max of SN=50
	2005+	PR ≤ 30	T3, T8, TF newly certified with rO > 89 kN	-	19+1.6(rPR)	-	-
			T3, T8, TF newly certified with 26.7 kN < rO ≤ 89 kN	-	37.572+1.6(rPR)-0.2087(rO)	-	-
		30 < PR < 62.5	T3, T8, TF newly certified with rO > 89 kN	-	7+2.0(rPR)	-	-
			T3, T8, TF newly certified with 26.7kN < rO ≤ 89kN	-	42.71+1.4286(rPR)-0.4013(rO)+0.00642(rPR)(rO)	-	-
		PR ≤ 62.5	T3, T8, TF	-	32+1.6(rPR)	-	-

Note: The test procedures are the International Civil Aviation Organization (ICAO) Smoke Emission Test Procedure and the ICAO Gaseous Emissions Test Procedure. There is no useful life or warranty period for purposes of compliance with aircraft emissions standards. Definitions of acronyms are on page 12-14.

Source:

40 CFR Part 87, Aircraft emission standards, test procedures, certification requirements (Additional resources: www.epa.gov/emission-standards-reference-guide/nonroad-engines-and-vehicles-emission-standards)

^a T8=all aircraft gas turbine engines of the JT8D model family

TF=all turbofan and turbojet aircraft engines except engines of Class T3, T8, and TSS

T3=all aircraft gas turbine engines of the JT3D model family

TSS=all aircraft gas turbine engines for aircraft operations at supersonic flight speeds

TP=all aircraft turboprop engines

^b Federal standards apply to planes operating in the United States, regardless of where they were manufactured.

^c Rated output (rO) is the maximum power/thrust available for takeoff.

^d T3 engines are no longer manufactured but are in the existing fleet.



These standards apply to construction and agricultural equipment, such as excavators, paving equipment, tractors, combines, bulldozers, and skidders.

Table 12.23
Nonroad Compression-Ignition Engines – Exhaust Emission Standards

	Rated power (kW)	Tier	Model year	NMHC (g/kW-hr)	NMHC + NOx (g/kW-hr)	NOx (g/kW-hr)	PM (g/kW-hr)	CO (g/kW-hr)	Smoke ^a percentage	Useful life (hours/years) ^b
Federal	kW < 8	1	2000-2004	--	10.5	--	1.0	8.0	20 / 15 / 50	3,000 / 5
		2	2005-2007	--	7.5	--	0.80	8.0		
		4	2008+	--	7.5	--	0.40 ^c	8.0		
	8 ≤ kW < 19	1	2000-2004	--	9.5	--	0.80	6.6		3,000 / 5
		2	2005-2007	--	7.5	--	0.80	6.6		
		4	2008+	--	7.5	--	0.40	6.6		
	19 ≤ kW < 37	1	1999-2003	--	9.5	--	0.80	5.5		5,000 / 7 ^d
		2	2004-2007	--	7.5	--	0.60	5.5		
		4	2008-2012	--	7.5	--	0.30	5.5		
			2013+	--	4.7	--	0.03	5.5		
	37 ≤ kW < 56	1	1998-2003	--	--	9.2	--	--		8,000 / 10
		2	2004-2007	--	7.5	--	0.40	5.0		
		3 ^e	2008-2011	--	4.7	--	0.40	5.0		
		4 (Option 1) ^f	2008-2012	--	4.7	--	0.30	5.0		
		4 (Option 2) ^f	2012	--	4.7	--	0.03	5.0		
		4	2013+	--	4.7	--	0.03	5.0		
	56 ≤ kW < 75	1	1998-2003	--	--	9.2	--	--		
		2	2004-2007	--	7.5	--	0.40	5.0		
		3	2008-2011	--	4.7	--	0.40	5.0		
		4	2012-2103 ^g	--	4.7	--	0.02	5.0		
			2014+ ^h	0.19	--	0.4	0.02	5.0		
	75 ≤ kW < 130	1	1997-2002	--	--	9.2	--	--		
		2	2003-2006	--	6.6	--	0.3	5.0		
		3	2007-2011	--	4.0	--	0.3	5.0		
		4	2012-2013 ^g	--	4.0	--	0.02	5.0		
			2014+	0.19	--	0.4	0.02	5.0		
	130 ≤ kW < 225	1	1996-2002	1.3 ⁱ	--	9.2	0.54	11.4		
		2	2003-2005	--	6.6	--	0.20	3.5		
		3	2006-2010	--	4.0	--	0.20	3.5		
		4	2011-2013 ^g	--	4.0	--	0.02	3.5		
			2014+ ^h	0.19	--	0.4	0.02	3.5		
	225 ≤ kW < 450	1	1996-2000	1.3 ⁱ	--	9.2	0.54	11.4		
		2	2001-2005	--	6.4	--	0.20	3.5		
		3	2006-2010	--	4.0	--	0.20	3.5		
		4	2011-2013 ^g	--	4.0	--	0.02	3.5		
			2014+ ^h	0.19	--	0.4	0.02	3.5		
	450 ≤ kW < 560	1	1996-2001	1.3 ⁱ	--	9.2	0.54	11.4		
		2	2002-2005	--	6.4	--	0.20	3.5		
		3	2006-2010	--	4.0	--	0.20	3.5		
		4	2011-2013 ^g	--	4.0	--	0.02	3.5		
			2014+ ^h	0.19	--	0.4	0.02	3.5		
	560 ≤ kW < 900	1	2000-2005	1.3 ⁱ	--	9.2	0.54	11.4		
		2	2006-2010	--	6.4	--	0.20	3.5		
		4	2011-2014	0.4	--	3.5	0.10	3.5		
			2015+ ^h	0.19	--	3.5 ^j	0.04 ^k	3.5		



Table 12.23 (continued)
Nonroad Compression-Ignition Engines – Exhaust Emission Standards

	Rated power (kW)	Tier	Model year	NMHC (g/kW-hr)	NMHC + NOx (g/kW-hr)	NOx (g/kW-hr)	PM (g/kW-hr)	CO (g/kW-hr)	Smoke ^a percentage	Useful life (hours/years) ^b
Federal	kW > 900	1	2000-2005	1.3 ⁱ	--	9.2	0.54	11.4	20 / 15 / 50	8,000 / 10
		2	2006-2010	--	6.4	--	0.20	3.5		
		4	2011-2014	0.4	--	3.5 ^j	0.10	3.5		
			2015+ ^h	0.19	--	3.5 ^j	0.04 ^k	3.5		

Note: Definitions of acronyms are on page 12-14.

Sources:

40 CFR 98.112 = Exhaust emission standards

40 CFR 1039.101 = Exhaust emission standards for after 2014 model year

40 CFR 1039.102 = Exhaust emission standards for model year 2014 and earlier

40 CFR 1039 Subpart F = Exhaust emissions transient and steady state test procedures

40 CFR 86 Subpart I = Smoke emission test procedures

40 CFR 1065 = Test equipment and emissions measurement procedures (Additional resources:

www.epa.gov/emission-standards-reference-guide/nonroad-engines-and-vehicles-emission-standards)

^a Smoke emissions may not exceed 20 percent during the acceleration mode, 15 percent during the lugging mode, and 50 percent during the peaks in either mode. Smoke emission standards do not apply to single-cylinder engines, constant-speed engines, or engines certified to a PM emission standard of 0.07 grams per kilowatt-hour (g/kW-hr) or lower. Smoke emissions are measured using procedures in 40 CFR Part 86 Subpart I.

^b Useful life and warranty period are expressed hours and years, whichever comes first.

^c Hand-startable air-cooled direct injection engines may optionally meet a PM standard of 0.60 g/kW-hr. These engines may optionally meet Tier 2 standards through the 2009 model years. In 2010 these engines are required to meet a PM standard of 0.60 g/kW-hr.

^d Useful life for constant speed engines with rated speed 3,000 revolutions per minute (rpm) or higher is 5 years or 3,000 hours, whichever comes first.

^e These Tier 3 standards apply only to manufacturers selecting Tier 4 Option 2. Manufacturers selecting Tier 4 Option 1 will be meeting those standards in lieu of Tier 3 standards.

^f A manufacturer may certify all their engines to either Option 1 or Option 2 sets of standards starting in the indicated model year. Manufacturers selecting Option 2 must meet Tier 3 standards in the 2008-2011 model years.

^g These standards are phase-out standards. Not more than 50 percent of a manufacturer's engine production is allowed to meet these standards in each model year of the phase out period. Engines not meeting these standards must meet the final Tier 4 standards.

^h These standards are phased in during the indicated years. At least 50 percent of a manufacturer's engine production must meet these standards during each year of the phase in. Engines not meeting these standards must meet the applicable phase-out standards.

ⁱ For Tier 1 engines the standard is for total hydrocarbons.

^j The NOx standard for generator sets is 0.67 g/kW-hr.

^k The PM standard for generator sets is 0.03 g/kW-hr.



These standards apply to gasoline and propane industrial equipment such as forklifts, generators, airport service equipment, compressors and ice-grooming machines.

Table 12.24
Nonroad Large Spark-Ignition Engines – Exhaust and Evaporative Emission Standards

	Tier	Year	General duty-cycle standards		Alternative standards for severe-duty engines		Field testing standards		Useful life (years/hours)	
			HC+NOx ^a (g/kW-hr)	CO (g/kW-hr)	HC+NOx ^a (g/kW-hr)	CO (g/kW-hr)	HC+NOx ^a (g/kW-hr)	CO (g/kW-hr)		
Federal ^b	1 ^c	2004-2006	4.0 ^d	50.0	4.0 ^d	130.0	-	-	7 / 5,000 ^e	
	2 ^f	2007+	2.7 ^f	4.4 ^f	2.7	130.0	3.8 ^f	6.5 ^f	7 / 5,000 ^e	
			Evaporative emission standards (for engines fueled by a volatile liquid fuel)							
			Fuel line permeation	Nonmetallic fuel lines must meet the permeation specifications of SAE J2260 (November 1996)						5 / -
			Diurnal emissions	Evaporative HC emissions may not exceed 0.2 grams per gallon of fuel tank capacity						
			Running loss	Liquid fuel in the fuel tank may not reach boiling during continuous engine operation in the final installation at an ambient temperature of 30°C						

Sources:

40 CFR 1048.101 = Exhaust emission standards

40 CFR 1048.105 = Evaporative emission standards

40 CFR 1048.110 = Engine diagnostic requirements (Additional resources: www.epa.gov/emission-standards-reference-guide/nonroad-engines-and-vehicles-emission-standards)

^a The numerical emission standards for hydrocarbons (HC) must be met based on the following types of hydrocarbon emissions for engines powered by the following fuels: (1) non-methane hydrocarbons (NMHC) for natural gas; (2) total hydrocarbon equivalent (THCE) for alcohol; and (3) total hydrocarbons (THC) for other fuels.

^b Voluntary Blue Sky standards for large spark-ignition (SI) engines are available. Engines with displacement at or below 1,000 cubic centimeters (cc) and maximum power at or below 30 kilowatts (kW) may be certified under the program for small SI engines.

^c Emission standards are based on testing over a steady-state duty-cycle.

^d The Tier 1 HC plus nitrogen oxides (NO_x) emission standard for in-use testing is 5.4 grams per kW-hour (g/kW-hr).

^e Useful life is expressed in years and hours, whichever comes first. These are the minimum useful life requirements. For severe-duty engines, the minimum useful life is seven years or 1,500 hours of operation, whichever comes first. A longer useful life in hours is required if: (a) the engine is designed to operate longer than the minimum useful life based on the recommended rebuild interval; or (b) the basic mechanical warranty is longer than the minimum useful life.

^f Optional engine certification is allowed according to the following formula: $(\text{HC} + \text{NO}_x) \times \text{CO}^{0.784} \leq 8.57$. The HC+NO_x and carbon monoxide (CO) emission levels selected to satisfy this formula, rounded to the nearest 0.1 g/kW-hr, become the emission standards that apply for those engines. One may not select an HC+NO_x emission standard higher than 2.7 g/kW-hr or a CO emission standard higher than 20.6 g/kW-hr.



Table 12.25
Locomotives – Exhaust Emission Standards

	Duty-cycle ^b	Tier	Year ^c	HC ⁱ (g/hp-hr)	NOx (g/bhp-hr)	PM (g/bhp-hr)	CO (g/bhp-hr)	Smoke (percentage) ^m	Minimum useful life (hours / years / miles) ⁿ
Federal ^a	Line-haul	Tier 0	1973-1992 ^{d,e}	1.0	9.5 [ABT]	0.22 [ABT]	5.0	30 / 40 / 50	(7.5 x hp) / 10 / 750,000 ^o
		Tier 1	1993-2004 ^{d,e}	0.55	7.4 [ABT]	0.22 [ABT]	2.2	25 / 40 / 50	(7.5 x hp) / 10 / 750,000 ^o
		Tier 2	2005-2011 ^d	0.30	5.5 [ABT]	0.10 ^k [ABT]	1.5	20 / 40 / 50	(7.5 x hp) / 10 / -
		Tier 3	2012-2014 ^f	0.30	5.5 [ABT]	0.10 [ABT]	1.5	20 / 40 / 50	(7.5 x hp) / 10 / -
		Tier 4	2015+ ^g	0.14	1.3 [ABT]	0.03 [ABT]	1.5	-	(7.5 x hp) / 10 / -
	Switch	Tier 0	1973-2001	2.10	11.8 [ABT]	0.26 [ABT]	8.0	30 / 40 / 50	(7.5 x hp) / 10 / 750,000 ^o
		Tier 1	2002-2004 ^h	1.20	11.0 [ABT]	0.26 [ABT]	2.5	25 / 40 / 50	(7.5 x hp) / 10 / -
		Tier 2	2005-2010 ^h	0.60	8.1 [ABT]	0.13 ⁱ [ABT]	2.4	20 / 40 / 50	(7.5 x hp) / 10 / -
		Tier 3	2011-2014	0.60	5.0 [ABT]	0.10 [ABT]	2.4	20 / 40 / 50	(7.5 x hp) / 10 / -
		Tier 4	2015+	0.14 ^j	1.3 [ABT]	0.03 [ABT]	2.4	-	(7.5 x hp) / 10 / -

Source:

40 CFR 1033.101 = Emission Standards and Useful Life. (Additional resources: www.epa.gov/emission-standards-reference-guide/nonroad-engines-and-vehicles-emission-standards)

^a These standards apply to locomotives that are propelled by engines with total rated horsepower (hp) of 750 kilowatts (kW) (1006 hp) or more, unless the owner chooses to have the equipment certified to meet the requirements of locomotives. This does not include vehicles propelled by engines with total rated horsepower of less than 750 kW (1006 hp); see the requirements in 40 Code of Federal Regulations (CFR) Parts 86, 89 and 1039. The test procedures specify chassis-based testing of locomotives. These test procedures include certification testing, production line testing, and in-use testing using the Federal Test Procedure (FTP) when the locomotive has reached between 50-70 percent of its useful life.

^b Line-haul locomotives are powered by an engine with a maximum rated power (or a combination of engines having a total rated power) greater than 2300 hp. Switch locomotives are powered by an engine with a maximum rated power (or a combination of engines having a total rated power) of 2300 hp or less.

^c The Tier 0 standards apply to locomotives manufactured after 1972 when they are manufactured or remanufactured. Note that interim standards may apply for Tier 0 or Tier 1 locomotives remanufactured in 2008 or 2009, or for Tier 2 locomotives manufactured or remanufactured in 2008-2012.

^d Line-haul locomotives subject to the Tier 0 through Tier 2 emission standards must also meet switch standards of the same tier.

^e The Tier 0 standards apply for 1993-2001 locomotives not originally manufactured with a separate loop intake air cooling system.

^f Tier 3 line-haul locomotives must also meet Tier 2 switch standards.

^g Manufacturers using credits may elect to meet a combined nitrogen oxides (NOx) plus hydrocarbon (HC) standard of 1.4 grams per brakehorsepower-hour (g/bhp-hr) instead of the otherwise applicable Tier 4 NOx and HC standards.

^h Tier 1 and Tier 2 switch locomotives must also meet line-haul standards of the same tier.

ⁱ The numerical emission standards for HC must be met based on the following types of hydrocarbon emissions for locomotives powered by the following fuels: (1) alcohol: total hydrocarbon equivalent (THCE) emissions for Tier 3 and earlier locomotives, and non-methane hydrocarbon equivalent (NMHCE) for Tier 4; (2) natural gas and liquefied petroleum gas: non-methane hydrocarbon (NMHC) emissions; and (3) diesel: total hydrocarbon (THC) emissions for Tier 3 and earlier locomotives, and NMHC for Tier 4.



Table 12.25 (continued)
Locomotives – Exhaust Emission Standards

^j Manufacturers may elect to meet a combined NO_x+HC standard of 1.4 g/bhp-hr instead of the otherwise applicable Tier 4 NO_x and HC standards.

^k The line-haul particulate matter (PM) standard for newly remanufactured Tier 2 locomotives is 0.20 g/bhp-hr until January 1, 2013, except as specified in 40 CFR Part 1033.150(a).

^l The switch PM standard for new Tier 2 locomotives is 0.24 g/bhp-hr until January 1, 2013, except as specified in 40 CFR Part 1033.150(a).

^m The smoke opacity standards apply only for locomotives certified to one or more PM standards or Family Emission Limits (FEL) greater than 0.05 g/bhp-hr. Percentages apply to smoke opacity at steady state/30-second peak/3-second peak, as measured continuously during testing.

ⁿ Useful life and warranty period are expressed in megawatt-hours (MW-hr), years, or miles, whichever comes first. Manufacturers are required to certify to longer useful lives if their locomotives are designed to last longer between overhauls than the minimum useful life value.

^o For locomotives originally manufactured before January 1, 2000, and not equipped with MW-hr meters.



These standards apply to auxiliary and propulsion engines used by all types of recreational and commercial vessels, from small fishing boats to ocean-going ships.

Table 12.26
Marine Compression-Ignition (CI) Engines – Exhaust Emission Standards

	Category ^{a, b}	Tier	Displacement (L/cylinder)	Power ^c (kW)	Speed (rpm)	Model Year	NOx (g/kW- hr)	HC (g/kW- hr)	HC+NOx ^d (g/kW-hr)	PM (g/kW- hr)	CO (g/kW- hr)	Useful Life ^e (years/hours)	
Federal ^f	C1 Commercial	1	≥ 2.5	≥ 37	rpm < 130	2004 ^h	17.0	-	-	-	-	10 / 10,000	
					130 ≤ rpm < 2000		45.0 x N ^{0.201}	-	-	-	-		
					rpm ≥ 2000		9.8	-	-	-	-		
					-		-	-	7.5 (ABT)	0.40 (ABT)	5.0		
		2	disp. < 0.9	all	-	2005 ^h	-	-	7.2 (ABT)	0.30 (ABT)	5.0	10 / 10,000	
			0.9 ≤ disp < 1.2		-	2004 ^h	-	-	7.2 (ABT)	0.20 (ABT)	5.0		
			1.2 ≤ disp < 2.5		-	2004 ^h	-	-	7.2 (ABT)	0.20 (ABT)	5.0		
			2.5 ≤ disp < 5.0		-	2007 ^h	-	-	7.2 (ABT)	0.20 (ABT)	5.0		
	C1 Commercial & Recreational	1	≥ 2.5	≥ 37	rpm < 130	2004	17.0	-	-	-	-	10 / 1,000	
					130 ≤ rpm < 2000		45.0 x N ^{0.201}	-	-	-	-		
					rpm ≥ 2000		9.8	-	-	-	-		
					-		-	-	7.5 (ABT)	0.40 (ABT)	5.0		
		2	disp < 0.9	all	-	2007	-	-	7.2 (ABT)	0.30 (ABT)	5.0	10 / 1,000	
			0.9 ≤ disp < 1.2		-	2006	-	-	7.2 (ABT)	0.20 (ABT)	5.0		
			1.2 ≤ disp < 2.5		-	2006	-	-	7.2 (ABT)	0.20 (ABT)	5.0		
			2.5 ≤ disp < 5.0		-	2009	-	-	7.2 (ABT)	0.20 (ABT)	5.0		
	C1 Commercial & Recreational < 75 kW	3	< 0.9	< 8	-	2009+	-	-	7.5 (ABT)	0.40 (ABT)	8.0	5 / 3,000 10 / 1,000 for CI Recreational	
				8 ≤ kW < 19	-	2009+	-	-	7.5 (ABT)	0.40 (ABT)	6.6		
				19 ≤ kW < 37	-	2009-2013	-	-	7.5 ⁱ (ABT)	0.30 ^j (ABT)	5.5		
				-	-	2014+	-	-	4.7 ⁱ (ABT)	0.20 (ABT)	5.0		
				37 ≤ kW < 75	-	2009-2013	-	-	7.5 ⁱ (ABT)	0.30 ^j (ABT)	5.0		
				-	-	2014+	-	-	4.7 ⁱ (ABT)	0.30 ^j (ABT)	5.0		
				-	-	-	-	-	-	-	-		
				-	-	-	-	-	-	-	-		
	C1 Commercial Engines with ≤ 35 kW/L power density ^k	3 ⁱ	< 0.9	-	-	2012+	-	-	5.4 (ABT)	0.14 (ABT)	8.0 for < 8 kW	5 / 3,000 for commercial engines < 19 kW	
			0.9 ≤ disp < 1.2	All	-	2013+	-	-	5.4 (ABT)	0.12 (ABT)	6.6 for 8 ≤ kW < 19	7 / 5,000 for commercial engines 19 ≤ kW < 37	
			1.2 ≤ disp < 2.5	< 600	-	2014-2017	-	-	5.6 (ABT)	0.11 (ABT)	5.5 for 19 ≤ kW < 37	10 / 10,000 for C1 Commercial ≤ 37 kW	
				≥ 600	-	2018+	-	-	5.6 (ABT)	0.10 (ABT)	5.0 for ≤ 37 kW		
			2.5 ≤ disp < 3.5	< 600	-	2013-2017	-	-	5.6 (ABT)	0.11 (ABT)			
				≥ 600	-	2018+	-	-	5.6 (ABT)	0.10 (ABT)			
			3.5 ≤ disp < 7.0	< 600	-	2012-2017	-	-	5.8 (ABT)	0.11 (ABT)			
				≥ 600	-	2018+	-	-	5.8 (ABT)	0.10 (ABT)			
			3 ⁱ	< 0.9	-	2012+	-	-	5.8 (ABT)	0.15 (ABT)	8.0 for < 8 kW	5 / 3,000 for commercial engines < 19 kW	
				0.9 ≤ disp < 1.2	-	2013+	-	-	5.8 (ABT)	0.14 (ABT)	6.6 for 8 ≤ kW < 19	7 / 5,000 for commercial engines 19 ≤ kW < 37	
				1.2 ≤ disp < 2.5	-	2014+	-	-	5.8 (ABT)	0.14 (ABT)	5.5 for 19 ≤ kW < 37	10 / 10,000 for C1 Commercial ≥ 37 kW	
				2.5 ≤ disp < 3.5	-	2013+	-	-	5.8 (ABT)	0.12 (ABT)	5.0 for ≥ 37 kW	10 / 1,000 for CI Recreational	
				3.5 ≤ disp < 7.0	-	2012+	-	-	5.8 (ABT)	0.11 (ABT)			

(Continued on next page)



Table 12.26 (continued)
Marine Compression-Ignition (CI) Engines – Exhaust Emission Standards

	Category ^{a, b}	Tier	Displacement (L/cylinder)	Power ^c (kW)	Speed (rpm)	Model Year	NOx (g/kW- hr)	HC (g/kW- hr)	HC+NOx ^d (g/kW-hr)	PM (g/kW- hr)	CO (g/kW- hr)	Useful Life ^e (years/hours)
Federal ^g	C1 Commercial > 600 kW	4 ^m	All	600 ≤ kW < 1,400	-	2017+	1.8 (ABT)	-	0.19 HC ⁿ	0.04 (ABT)	5.0	10 / 10,000
			All	1,400 ≤ kW < 2,000	-	2016+	1.8 (ABT)	-	0.19 HC ⁿ	0.04 (ABT)		
			All	2,000 ≤ kW < 3,700	-	2014+	1.8 (ABT)	-	0.19 HC ⁿ	0.04 (ABT)		
			< 7.0	≥ 3,700	-	2014-2015	1.8 (ABT)	-	0.19 HC ⁿ	0.12 (ABT)		
					-	2016+	1.8 (ABT)	-	0.19 HC ⁿ	0.06 (ABT)		
	C2	1	≥ 2.5	≥ 37	rpm < 130	2004	17.0	-	-	-	-	10 / 20,000
					130 ≤ rpm < 2,000		45.0 x N ^{0.20 i}	-	-	-	-	
					rpm ≥ 2,000		9.8	-	-	-	-	
		2	5.0 ≤ disp < 15.0	all	-	2007	-	-	7.8 (ABT)	0.27 (ABT)	5.0	10 / 20,000
			15.0 ≤ disp < 20.0	< 3,300	-		-	-	8.7 (ABT)	0.50 (ABT)	5.0	
			15.0 ≤ disp < 20.0	≥ 3,300	-		-	-	9.8 (ABT)	0.50 (ABT)	5.0	
			20.0 ≤ disp < 25.0	all	-		-	-	9.8 (ABT)	0.50 (ABT)	5.0	
			25.0 ≤ disp < 30.0	all	-		-	-	11.0 (ABT)	0.50 (ABT)	5.0	
		3 ^{n,p}	7.0 ≤ disp < 15.0	< 2,000	-	2013+	-	-	6.2 (ABT)	0.14 (ABT)	5.0	10 / 20,000
			2,000 ≤ kW < 3,700	-	-		-	7.8 (ABT)	0.14 (ABT)	5.0		
			15.0 ≤ disp < 20.0	< 2,000	-	2014+	-	-	7.0 (ABT)	0.34 (ABT)	5.0	
			20.0 ≤ disp < 25.0	< 2,000	-		-	-	9.8 (ABT)	0.27 (ABT)	5.0	
			25.0 ≤ disp < 30.0	< 2,000	-		-	-	11.0 (ABT)	0.27 (ABT)	5.0	
		4 ^{m,p}	All	600 ≤ kW < 1,400	-	2017+	1.8 (ABT)	-	0.19 HC ⁿ	0.04 (ABT)	5.0	10 / 20,000
			All	1400 ≤ kW < 2,000	-	2016+	1.8 (ABT)	-	0.19 HC ⁿ	0.04 (ABT)		
			All	2,000 ≤ kW < 3,700 ^q	-	2014+	1.8 (ABT)	-	0.19 HC ⁿ	0.04 (ABT)		
			< 15.0	≥ 3,700	-	2014-2015	1.8 (ABT)	-	0.19 HC ⁿ	0.12 (ABT)		
			15.0 ≤ disp < 30.0		-	2014-2015	1.8 (ABT)	-	0.19 HC ⁿ	0.25 (ABT)		
			All		-	2016+	1.8 (ABT)	-	0.19 HC ⁿ	0.06 (ABT)		
		C3	1	≥30.0	All	rpm < 130	2004	17.0	-	-	-	-
	130 ≤ rpm < 2,000					45.0 x N ^{0.20 i}		-	-	-	-	
	rpm ≥ 2,000					9.8		-	-	-	-	
	2		≥30.0	All	rpm < 130	2011	14.4	2.0	-	-	5.0	3 / 10,000
					130 ≤ rpm < 2,000		44.0 x N ^{0.23 i}		-	-		
					rpm ≥ 2,000		7.7		-	-		
	3		≥ 30.0	All	rpm < 130	2016	3.4	2.0	-	-	5.0	3 / 10,000
					130 ≤ rpm < 2,000		9.0 x N ^{0.20 i}		-	-		
					rpm ≥ 2,000		2.0		-	-		

Sources:

40 CFR 89.104 = Tiers 1 and 2 useful life & warranty period for marine CI engines less than 37 kW

40 CFR 89.112 = Tiers 1 and 2 emission standards for marine CI engines less than 37 kW

40 CFR 89 Subpart E = Tiers 1 and 2 test procedures for marine CI engines less than 37 kW

40 CFR 94.8 = Tiers 1 and 2 emission standards for C1 (both commercial & recreational), C2 and C3 engines

40 CFR 94.9 = Tiers 1 and 2 useful life for C1 (both commercial & recreational), C2 and C3 engines

40 CFR 94 Subpart B = Tiers 1 and 2 test procedures for C1 (both commercial & recreational), C2 and C3 engines

40 CFR 1042.101 = Tiers 3 and 4 exhaust emission standards and useful life



Table 12.26 (continued)
Marine Compression-Ignition (CI) Engines – Exhaust Emission Standards

Sources (continued):

40 CFR 1042.107 = Tiers 3 and 4 evaporative emission standards engines using a volatile liquid fuel (e.g., methanol)

40 CFR 1042.120 = Tiers 3 and 4 warranty period

40 CFR 1042 Subpart F = Tiers 3 and 4 test procedures (Additional resources: www.epa.gov/emission-standards-reference-guide/nonroad-engines-and-vehicles-emission-standards)

^a For Tiers 1 and 2, Category 1 marine engines are greater than or equal to 37 kilowatts (kW) and have a displacement less than 5.0 liters per cylinder (L/cylinder); Category 2 marine engines have a displacement greater than or equal to 5.0 L/cylinder and less than 30 L/cylinder; and Category 3 marine engines have a displacement greater than or equal to 30.0 L/cylinder. For Tiers 3 and 4, Category 1 represents engines up to 7 L/cylinder displacement; and Category 2 includes engines from 7 to 30 L/cylinder. The definition of Category 3 marine engines remains the same.

^b Tiers 1 and 2 for marine engines less than 37 kW are subject to the same emission standards as for land-based engines. See Table 1 in 40 Code of Federal Regulations (CFR) Part 89.112 and 40 CFR Part 89.104.

^c For Tiers 1 and 2, this refers to the rated power; for Tiers 3 and 4, this refers to the maximum engine power.

^d Total hydrocarbon (THC) plus nitrogen oxides (NOx) for Tier 2 standards.

^e Useful life is expressed in hours or years, whichever comes first. For Tiers 3 and 4, a longer useful life in hours for an engine family must be specified if either: 1) the engine is designed, advertised, or marketed to operate longer than the minimum useful life; or 2) the basic mechanical warranty is longer than the minimum useful life.

^f Warranty period is expressed in years and hours, whichever comes first.

^g For Tiers 3 and 4, there are no evaporative emission standards for diesel-fueled engines, or engines using other nonvolatile or nonliquid fuels (e.g., natural gas). If an engine uses a volatile liquid fuel, such as methanol, the engine's fuel system and the vessel in which the engine is installed must meet the evaporative emission requirements of 40 Code of Federal Regulations (CFR) Part 1045 that apply with respect to spark-ignition engines. Manufacturers subject to evaporative emission standards must meet the requirements of 40 CFR 1045.112 as described in 40 CFR 1060.1(a)(2).

^h Indicates the model years for which the specified standards start.

ⁱ N is the maximum test speed of the engine in revolutions per minute (rpm).

^j Manufacturers of Tier 3 engines greater than or equal to 19 kW and less than 75 kW with displacement below 0.9 L/cylinder may alternatively certify some or all of their engine families to a particulate matter (PM) emission standard of 0.20 grams per kilowatt-hour (g/kW-hr) and a NOx+HC emission standard of 5.8 g/kW-hr for 2014 and later model years.

^k The applicable Tier 2 NOx+HC standards continue to apply instead of the Tier 3 values for engines at or above 2000 kW.

^l These Tier 3 standards apply to Category 1 engines below 3700 kW except for recreational marine engines at or above 3700 kW (with any displacement), which must meet the Tier 3 standards specified for recreational marine engines with a displacement of 3.5 to 7.0 L/cylinder.

^m The following provisions are optional: 1) Manufacturers may use NOx credits to certify Tier 4 engines to a NOx+HC emission standard of 1.9 g/kW-hr instead of the NOx and HC standards. See 40 CFR 1042.101(a)(8)(i) for more details. 2) For engines below 1000 kW, manufacturers may delay complying with the Tier 4 standards until October 1, 2017. 3) For engines at or above 3700 kW, manufacturers may delay complying with the Tier 4 standards until December 31, 2016.

ⁿ The Tier 4 standard is for HC (not HC+NOx) in g/kW-hr.

^o These Tier 3 standards apply to Category 2 engines below 3700 kW; no Tier 3 standards apply for Category 2 engines at or above 3700 kW, although there are Tier 4 standards that apply.



Table 12.26 (continued)
Marine Compression-Ignition (CI) Engines – Exhaust Emission Standards

^p An alternative set of Tier 3 and Tier 4 standards for PM, NO_x, and HC are available for Category 2 engines at or above 1400 kW, but must be applied to all of a manufacturer's engines in a given displacement category in model years 2012 through 2015.

Tier	Maximum engine power	Model year	PM (g/kW-hr)	NO _x (g/kW-hr)	HC (g/kW-hr)
3	kW ≥ 1400	2012-2014	0.14	7.8 NO _x +HC	
4	1400 ≤ kW < 3700	2015	0.04	1.8	0.19
	kW ≥ 3700	2015	0.06	1.8	0.19

^q Interim Tier 4 PM standards apply for 2014 and 2015 model year Category 2 engines with per-cylinder displacement at or above 15.0 liters: 0.34 g/kW-hr for engines 2000 = kW < 3000, and 0.27 g/kW-hr for engines 3300 = kW < 3700.



These standards apply to gasoline boats and personal watercraft, such as pleasure boats, jet-skis, outboard engines and sterndrive/inboard engines.

Table 12.27
Marine Spark-Ignition Engines and Vessels – Exhaust Emission Standards

	Engine type	Model year	HC + NO _x ^a (g/KW-hr)		CO ^c (g/KW-hr)		Useful life (hours/years) ^d
			P ≤ 4.3 kW ^b	P > 4.3 kW ^b	P ≤ 4.3 kW ^b	P > 4.3 kW ^b	
Federal ^e	Personal watercraft & outboard marine engines	1998	278 ABT	$(0.917 \times (151 + 557/P^{0.9}) + 2.44)$ [ABT]	--	--	350 / 5
		1999	253 ABT	$(0.833 \times (151 + 557/P^{0.9}) + 2.89)$ [ABT]	--	--	
		2000	228 ABT	$(0.750 \times (151 + 557/P^{0.9}) + 3.33)$ [ABT]	--	--	
		2001	204 ABT	$(0.667 \times (151 + 557/P^{0.9}) + 3.78)$ [ABT]	--	--	
		2002	179 ABT	$(0.583 \times (151 + 557/P^{0.9}) + 4.22)$ [ABT]	--	--	
		2003	155 ABT	$(0.500 \times (151 + 557/P^{0.9}) + 4.67)$ [ABT]	--	--	
		2004	130 ABT	$(0.417 \times (151 + 557/P^{0.9}) + 5.11)$ [ABT]	--	--	
		2005	105 ABT	$(0.333 \times (151 + 557/P^{0.9}) + 5.56)$ [ABT]	--	--	
		2006-2009	81 ABT	$(0.250 \times (151 + 557/P^{0.9}) + 6.00)$ [ABT]	--	--	
		2010 + ^g	30 ABT	$2.1 + 0.09 \times (151 + 557/P^{0.9})$ [ABT]	500 - 5.0 x P	300	Personal Watercraft: 350 / 5 ^h Outboard: 350 / 10 ^h
	Sterndrive/ inboard engines	Conventional engines ^g	2010 +	5.0 [ABT]		75 [ABT]	480 / 10 ⁱ
				P ≤ kW ^b	P > 485 kW ^b	350	P ≤ 485 kW: 150 / 3
		High-performance engines	2010	20.0	25.0		P > 485 kW: 50 / 1
			2011+	16.0	22.0		

Sources:

40 CFR 91.104 = Outboard and personal watercraft (PWC) exhaust emission standards (1998-2009)

40 CFR 91.105 = Outboard and PWC useful life (1998-2009)

40 CFR 1045.103 = Outboard and PWC exhaust emission standards (2010+)

40 CFR 1045.105 = Sterndrive/Inboard exhaust emission standards

40 CFR 1045.107 = Not-to-exceed exhaust emission standards (Additional resources: www.epa.gov/emission-standards-reference-guide/nonroad-engines-and-vehicles-emission-standards)

^a The numerical emission standards for hydrocarbons (HC) must be met based on the following types of HC emissions for engines powered by the following fuels: (1) total hydrocarbon equivalent for alcohol; (2) non-methane hydrocarbon for natural gas; and (3) total hydrocarbons for other fuels.



Table 12.27 (continued)
Marine Spark-Ignition Engines and Vessels – Exhaust Emission Standards

^b P stands for the maximum engine power in kilowatts.

^c Manufacturers may generate or use emission credits for averaging, but not for banking or trading.

^d Useful life and warranty period are expressed hours or years of operation (unless otherwise indicated), whichever comes first.

^e The test procedure for federal standards uses the International Organization for Standardization (ISO) 8178 E4 5-Mode Steady-State Test Cycle.

^f Also applies to model year (MY) 1997 engine families certified pursuant to 40 Code of Federal Regulations (CFR) 91.205.

^g Not-to-exceed emission standards specified in 40 CFR 1045.107 also apply.

^h A longer useful life in terms of hours must be specified for the engine family if the average service life is longer than the minimum value as described in 40 CFR 1045.103(e)(3).

ⁱ The useful life may not be shorter than: (1) 150 hours of operation; (2) the recommended overhaul interval; or (3) the engine's mechanical warranty. A longer useful life must be specified in terms of hours if the average service life is longer than the minimum value as described in 40 CFR 1045.105(e)(3).



These standards apply to land-based recreational vehicles, such as snowmobiles, dirt bikes, all-terrain vehicles and go-karts.

Table 12.28
Nonroad Recreational Engines and Vehicles – Exhaust Emission Standards

	Vehicle	Phase	Year	HC ^a g/kW-hr	HC + NO _x g/km	CO		Minimum useful life (hours/years/km) ^b
						g/kW-hr	g/km	
Federal	Snowmobiles ^c	1 ^d	2006+	100 [ABT]	-	275 [ABT]	-	400 / 5 / 8,000
		2	2010- 2011	75 [ABT]	-	275 [ABT]	-	
		3 ^e	2012+	150 ^f [ABT]	-	400 ^f [ABT]	-	
	Off-highway motorcycles ^g	1 ^d	2006+	-	2.0 ^{h,i} [ABT]	-	25 ^{h,i} [ABT]	> 70 cc Displacement: - / 5 / 10,000
								≤ 70 cc Displacement: - / 5 / 5,000
	ATVs ^g	1 ^d	2006+	-	1.5 ^{i,k} [ABT]	-	35 ^k [ABT]	≥ 100 cc Displacement: 1000 / 5 / 10,000 < 100 cc Displacement: 500 / 5 / 5,000

Source:

40 CFR 1051.101-115 = Emission standards (Additional resources: www.epa.gov/emission-standards-reference-guide/nonroad-engines-and-vehicles-emission-standards)

^a The numerical emission standards for hydrocarbons (HC) must be met based on the following types of hydrocarbon emissions for recreational engines and vehicles powered by the following fuels: (1) non-methane hydrocarbons for natural gas; (2) total hydrocarbon equivalent for alcohol; and (3) total hydrocarbons for other fuels.

^b Useful life is expressed in hours, years, or kilometers, whichever comes first; warranty period is expressed in hours, months, or kilometers (km), whichever comes first. Nonroad recreational engines and vehicles must meet emission standards over their full useful life. A longer useful life in terms of km and hours must be specified for the engine family if the average service life is longer than the minimum value as described in 40 Code of Federal Regulations (CFR) 1051 Subpart B.

^c Test procedures for snowmobiles use the equipment and procedures for spark-ignition engines in 40 CFR Part 1065.

^d Phase 1 standards will be phased in: 50 percent by 2006, 100 percent by 2007.

^e Litigation on the November 2002 final rule resulted in a court decision that requires EPA to clarify the evidence and analysis upon which the Phase 3 carbon monoxide (CO) and HC standards were based. EPA will address this in a future rulemaking.

^f These are the maximum allowable family emission limits (FEL). The HC and CO standards are defined by a functional relationship as described in 40 CFR 1051.103(a)(2).

^g For off-highway motorcycles and ATVs, chassis dynamometer emissions test procedures are specified in 40 CFR Part 86, Subpart F and engine dynamometer emissions test procedures are specified in 40 CFR Part 1065.

^h Maximum allowable FEL: 20.0 grams per kilometer (g/km) for HC plus nitrogen oxides (NO_x) and 50 g/km for CO.



Table 12.28 (continued)
Nonroad Recreational Engines and Vehicles – Exhaust Emission Standards

ⁱ Manufacturers may certify off-highway motorcycles with engines that have total displacement of 70 cubic centimeters (cc) or less to an HC+NO_x standard of 16.1 grams per kilowatt-hour (g/kW-hr) (with an FEL cap of 32.2 g/kW-hr) and a CO standard of 519 g/kW-hr.

^j Maximum allowable FEL for HC+NO_x is 20.0 g/km.

^k Manufacturers may certify all-terrain vehicles with engines that have total displacement of less than 100 cc to an HC+NO_x standard of 25.0 g/kW-hr (with an FEL cap of 40.0 g/kW-hr) and a CO standard of 500 g/kW-hr.



The latest standards were established by the Environmental Protection Agency in conjunction with the Tier 3 emission standards.

Table 12.29
Gasoline Sulfur Standards

	Regulated entity	Refinery average and per-gallon cap by year (ppm)						
		2004	2005	2006	2007	2008-2016	2017-2019	2020
Federal	Large refiners / importers ^a	120 ^b / 300 ^c	30 / 90 ^b / 300	30 / 80	30 / 80	30 / 80	10 / 80	10 / 80
	GPA refiners ^{d, e}	150 / 300 ^c	150 / 300	150 / 300	30 / 80	30 / 80	30 / 80	10 / 80
	Small refiners ^{f, g, h}	k	k	k	k	30 / 80	30 / 80	10 / 80
	Downstream standards ^{i, j}	378	326	95	95	95	95	95

Source:

40 CFR 80 Subpart H (Additional resources: www.epa.gov/emission-standards-reference-guide/fuel-sulfur-standards)

^a Standards effective January 1 at the refinery gate.

^b No Refinery Average Standard applies in 2004; Corporate Average Standard applies in 2004 (120 ppm) and 2005 (90 ppm).

^c Cap exceedances up to 50 ppm in 2004 must be made up in 2005.

^d Geographic Phase-in Area (GPA) refiners must also comply with the corporate average standards in 2004 and 2005 if less than 50% of the refiner's gasoline is designated as GPA gasoline in a given compliance period.

^e GPA refiners may receive an additional two years (i.e., through 2008) to comply with the 30 / 80 ppm gasoline sulfur standards in exchange for producing 95% of their highway diesel fuel at the 15 ppm sulfur standard by June 1, 2006.

^f Small refiners may receive an additional two years (i.e., through 2009) to comply with the 30 / 80 ppm gasoline sulfur standards via a hardship demonstration.

^g Small refiners may receive an additional three years (i.e., through 2010) to comply with the 30 / 80 ppm gasoline sulfur standards in exchange for producing 95% of their highway diesel fuel at the 15 ppm sulfur standard by June 1, 2006.

^h Small refiners may receive a 20% increase in their annual average and per-gallon cap standards in exchange for producing 95% of their highway, nonroad, locomotive, and marine diesel fuel at the 15 ppm sulfur standard by June 1, 2006.

ⁱ Downstream standards are effective February 1 at any downstream location other than at a retail outlet or wholesale purchaser-consumer (e.g., pipelines and terminals) and March 1 at any downstream location.

^j Downstream standards for gasoline that is not blended with small refiner gasoline are shown. Refer to the Code of Federal Regulations (CFR) for the downstream standards that apply when a gasoline blend includes small refiner gasoline.

^k

1997-98 Refinery baseline sulfur level (ppm)	Small refiner interim gasoline sulfur standards (ppm) 2004 - 2007	
	Average	Cap
0 to 30	30	300
31 to 200	baseline level	300
201 to 400	200	300
401 to 600	50% of baseline	1.5 x avg. standard
601 and above	300	450



Ultra-low sulfur diesel (ULSD) fuel is necessary for new advanced emission control technologies. It also reduces particulate matter in the existing fleet of nonroad engines and equipment.

Table 12.30
Highway, Nonroad, Locomotive, and Marine (NRLM) Diesel Fuel Sulfur Standards

	Regulated entity	Covered fuel	Per-gallon maximum sulfur level by year (ppm)								
			2006 ^a	2007 ^b	2008	2009	2010 ^{c,d}	2011	2012	2013	2014
Federal	Large refiners & importers	Highway	80% 15				15				
		20% 500									
	Small refiners	Highway	500								
	Large refiners & importers	NR	-	500	500	500	15	15	15	15	15
		LM	-	500	500	500	500	500	15	15	15
		NRLM with credits ^e	-	HS	HS	HS	500	500	500	500	15
	Small refiners	NRLM ^f	-	HS	HS	HS	500	500	500	500	15
	Transmix processor & in-use	NR ^e	-	HS	HS	HS	500	500	500	500	15
		LM ^e	-	HS	HS	HS	500	500	500	500	500

Source:

40 CFR 80 Subpart I (Additional resources: www.epa.gov/emission-standards-reference-guide/fuel-sulfur-standards)

^a For highway diesel fuel, standards are effective June 1 for refiners/importers, September 1 for pipelines and terminals, and October 15 for retailers and wholesale purchaser-consumers. Anti-downgrading provisions effective October 16, 2006.

^b For Nonroad, Locomotive, and Marine (NRLM) diesel fuel, standards are effective June 1 for refiners; downstream requirements apply for Northeast/Mid-Atlantic area only (August 1 for terminals, October 1 for retailers and wholesale purchaser-consumers, and December 1 for in-use).

^c For highway diesel fuel, standards are effective June 1 for refiners/importers, October 1 for pipelines and terminals, and December 1 for retailers and wholesale purchaser-consumers.

^d For NRLM diesel fuel, standards are effective June 1 for refiners, August 1 for terminals, October 1 for retailers and wholesale purchaser-consumers, and December 1 for in-use.

^e Excluding the Northeast and Alaska.

^f Excluding the Northeast, with approval in Alaska.



APPENDIX A

SOURCES & METHODOLOGIES

SOURCES & METHODOLOGIES

This appendix 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 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. Since abbreviations are used throughout the appendix, a list of abbreviations is also included.

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1. LIST OF ABBREVIATIONS USED IN APPENDIX A

AAR	Association of American Railroads
APTA	American Public Transportation Association
Amtrak	National Railroad Passenger Corporation
BTS	Bureau of Transportation Statistics
Btu	British thermal unit
CD	Compact Disc
CNG	Compressed Natural Gas
CO ₂	Carbon Dioxide
CPI	Consumer Price Index
CY	Calendar Year
DOE	Department of Energy
DOT	Department of Transportation
EIA	Energy Information Administration
EPA	Environmental Protection Agency
FAA	Federal Aviation Administration
FHWA	Federal Highway Administration
IRS	Internal Revenue Service
gal	Gallons
kWhr	Kilowatt hour
L	Liter
lb	Pound
lng	Liquefied Natural Gas
lpg	Liquefied Petroleum Gas
mpg	Miles per Gallon
NHTS	National Household Travel Survey
NPTS	Nationwide Personal Transportation Survey
NVPP	National Vehicle Population Profile
ORNL	Oak Ridge National Laboratory
RTECS	Residential Transportation Energy Consumption Survey
SCF	Standard Cubic Feet
TIUS	Truck Inventory and Use Survey
VIUS	Vehicle Inventory and Use Survey
vmt	vehicle-miles traveled

2. ENERGY USE SOURCES

2.1 HIGHWAY ENERGY USE

2.1.1 Cars

Fuel use in gallons (1970-2008) – DOT, FHWA, *Highway Statistics 2008*, Table VM-1 and annual editions back to 1996; DOT, FHWA, *Highway Statistics Summary* to 1995.

Fuel use in gallons (2009 – 2015) – See Section 7. Appendix A Car and Light Truck Shares.

Fuel type distribution for gallons – Fuel use was distributed among fuel types using the percentages shown in Table A.1. The FHWA discontinued gasohol data in 2005. Therefore, data from EIA, *Alternatives to Traditional Transportation Fuels*, 2006-2011, Table C1 were used.

Electricity use (2014) – U.S. Department of Energy, Energy Information Administration, *Annual Energy Outlook 2016*, July 2016, Table 37. Total light vehicle electricity usage was split between cars and light trucks using cumulative vehicle sales as a proxy.

Electricity use (2015) – Estimates derived using cumulative electric vehicle (EV) and plug-in hybrid vehicle (PHEV) sales as a proxy for vehicle population; sales-weighted vehicle efficiencies from the U.S. Department of Energy and U.S. Environmental Protection Agency's vehicle database on www.fueleconomy.gov; and annual miles traveled from varying PHEV utility factors and EV usage assumptions. A report documenting this methodology is forthcoming.

Table A.1
Car Fuel Use and Fuel Type Shares for Calculation of Energy Use

Year	Fuel use (million gallons)	Source for gasohol shares	Source for gasoline/diesel shares	Shares by fuel type ^b		
				Gasoline	Gasohol	Diesel
1970	67,820		1984 NVPP	99.8%	0.0%	0.2%
1971	71,346		interpolated	99.2%	0.0%	0.8%
1972	75,937		interpolated	98.7%	0.0%	1.3%
1973	78,233		interpolated	98.1%	0.0%	1.9%
1974	74,229		interpolated	97.5%	0.0%	2.5%
1975	74,140		interpolated	97.0%	0.0%	3.0%
1976	78,297		interpolated	96.4%	0.0%	3.6%
1977	79,060		interpolated	95.8%	0.0%	4.2%
1978	80,652		interpolated	95.3%	0.0%	4.7%
1979	76,588		1979 RTECS	94.7%	0.0%	5.3%
1980	69,981	FHWA, MF-33e	interpolated	93.9%	0.5%	5.6%
1981	69,112	FHWA, MF-33e	1981 RTECS	93.4%	0.7%	5.9%
1982	69,116	FHWA, MF-33e	interpolated	93.5%	2.3%	4.2%
1983	70,322	FHWA, MF-33e	1983 RTECS	93.2%	4.3%	2.5%
1984	70,663	FHWA, MF-33e	interpolated	92.7%	5.3%	2.0%
1985	71,518	FHWA, MF-33e	1985 RTECS	90.8%	7.7%	1.5%
1986	73,174	FHWA, MF-33e	interpolated	91.0%	7.6%	1.4%
1987	73,308	FHWA, MF-33e	interpolated	92.4%	6.3%	1.3%
1988	73,345	FHWA, MF-33e	1988 RTECS	91.4%	7.4%	1.2%
1989	73,913	FHWA, MF-33e	interpolated	92.6%	6.2%	1.2%
1990	69,568	FHWA, MF-33e	interpolated	92.0%	6.8%	1.2%
1991	64,318	FHWA, MF-33e	1991 RTECS	90.8%	8.0%	1.2%
1992	65,436	FHWA, MF-33e	interpolated	90.8%	7.9%	1.2%
1993	67,047	FHWA, MF-33e	interpolated	89.7%	9.1%	1.3%
1994	67,874	FHWA, MF-33e	1994 RTECS	89.1%	9.6%	1.3%
1995	68,072	FHWA, MF-33e	interpolated	87.6%	11.2%	1.2%
1996	69,221	FHWA, MF-33e	interpolated	88.8%	10.1%	1.0%
1997	69,892	FHWA, MF-33e	interpolated	86.9%	12.2%	0.9%
1998	71,695	FHWA, MF-33e	interpolated	88.0%	11.2%	0.8%
1999	73,283	FHWA, MF-33e	interpolated	88.3%	11.0%	0.6%
2000	73,065	FHWA, MF-33e	2000 NVPP	86.9%	12.6%	0.5%
2001	73,559	FHWA, MF-33e	2001 NVPP	86.5%	13.0%	0.5%
2002	75,471	FHWA, MF-33e	2001 NVPP	83.9%	15.6%	0.5%
2003	74,590	FHWA, MF-33e	2001 NVPP	75.3%	24.2%	0.5%
2004	75,402	FHWA, MF-33e	2001 NVPP	67.2%	32.3%	0.5%
2005	77,418	FHWA, MF-33e	2001 NVPP	66.9%	32.6%	0.5%
2006	75,009	EIA, C1	2001 NVPP	78.2%	21.3%	0.5%
2007	74,377	EIA, C1	2001 NVPP	72.9%	26.6%	0.5%
2008	71,497 ^a	EIA, C1	2001 NVPP	61.8%	37.7%	0.5%
2009	66,587	EIA, C1	2001 NVPP	55.8%	43.7%	0.5%
2010	62,245	EIA, C1	2001 NVPP	49.5%	50.0%	0.5%
2011	59,646	EIA, C1	2001 NVPP	48.7%	50.8%	0.5%
2012	57,899	EIA, C1	2001 NVPP	48.7%	50.8%	0.5%
2013	57,290	EIA, C1	2001 NVPP	49.0%	50.5%	0.5%
2014	56,420	EIA, C1	2001 NVPP	50.1%	49.4%	0.5%
2015	55,212	EIA, C1	2001 NVPP	50.0%	49.5%	0.5%
Heat content used for conversion to btu:				125,000	120,900	138,700
				btu/gallon	btu/gallon	btu/gallon

^a Data are not continuous between 2008 and 2009 due to changes in source.

^b Percentages may not sum due to rounding.

2.1.2 Motorcycles

DOT, FHWA, *Highway Statistics 2015*, Table VM-1, and annual editions. The FHWA made methodology changes for *Highway Statistics 2009-10*. At that time, they published historical data back to 2007 which do not match the previous data.

Table A.2
Motorcycle Fuel Use

Year	Fuel use (thousand gallons)	Year	Fuel use (thousand gallons)
1970	59,580	1993	198,120
1971	72,140	1994	204,800
1972	86,620	1995	198,262
1973	103,880	1996	195,940
1974	108,900	1997	201,620
1975	112,580	1998	205,660
1976	120,060	1999	211,680
1977	126,980	2000	209,380
1978	143,160	2001	192,780
1979	172,740	2002	191,040
1980	204,280	2003	190,780
1981	213,800	2004	202,447
1982	198,200	2005	189,495
1983	175,200	2006	221,030 ^a
1984	175,680	2007	474,923
1985	181,720	2008	489,417
1986	187,940	2009	482,290
1987	190,120	2010	426,732
1988	200,480	2011	426,378
1989	207,420	2012	491,130
1990	191,140	2013	467,716
1991	183,560	2014	458,628
1992	191,140	2015	447,879
Heat content used for conversion to btu:		125,000 btu/gallon	

^a Data are not continuous between 2006 and 2007 due to changes in estimation methodology. See source document for details.

2.1.3 Buses

Transit

APTA, *2016 Public Transportation Fact Book*, Washington, DC, 2016. Includes motorbus and trolley bus data. Data for 2015 were generated from the National Transit Database.

Table A.3
Transit Bus Fuel Use

Year	LNG (million gallons)	LPG (million gallons)	CNG (million gallons)	Gasoline (million gallons)	Diesel fuel (million gallons)	Electricity (thousand kilowatt hours)	Biodiesel (million gallons)	Methanol (million gallons)
1994	1.1	0.2	3.1	2.1	565.1	102.9	^a	12.5
1995	1.7	0.3	10.0	2.3	563.8	100.0	^a	12.0
1996	2.3	0.6	11.5	1.8	577.7	69.0	^a	11.6
1997	3.3	1.0	20.0	2.7	597.6	78.0	^a	8.7
1998	3.1	0.9	32.6	2.0	606.6	74.0	^a	5.0
1999	5.3	0.8	39.9	1.4	618.0	75.0	^a	2.7
2000	10.5	0.7	50.4	1.3	635.2	77.0	^a	0.8
2001	11.7	1.2	60.9	1.5	587.2	74.0	^a	0.8
2002	16.8	1.8	77.8	1.3	559.0	73.0	^a	1.8
2003	14.2	1.8	94.9	1.1	536.0	69.0	^a	1.9
2004	16.5	1.7	106.7	1.8	550.5	68.0	^a	4.7
2005	18.3	2.0	117.2	1.0	533.8	67.0	^a	8.1
2006	19.6	1.6	138.8	2.3	536.7	62.0	20.5	0.9
2007	18.3	^a	129.1	2.5	494.1	61.0	25.8	1.3
2008	17.9	^a	135.5	3.8	493.3	62.2	41.8	0.9
2009	25.5	^a	141.6	6.7	455.5	69.5	40.6	0.0
2010	23.0	^a	126.2	8.1	435.4	66.0	43.5	0.0
2011	21.6	^a	131.1	8.9	455.1	61.0	51.1	0.0
2012	19.6	^a	127.3	12.5	439.0	61.0	56.6	0.0
2013	17.6	6.3	134.9	12.9	427.5	63.0	66.2	0.0
2014	15.4	6.2	146.0	11.7	413.6	64.0	38.1	1.2
2015	10.3	7.6	151.3	8.6	377.8	74.8	39.9	1.2
Heat content used for conversion to btu:	84,800 btu/gallon	91,300 btu/gallon	138,700 btu/gallon	125,000 btu/gallon	138,700 btu/gallon	3,412 btu/kWhr	126,200 btu/gallon	64,600 btu/gallon

Note: CNG is reported in diesel-gallon equivalents.

^a Data are not available.

Intercity and School

Eno Transportation Foundation, *Transportation in America, 2001, Nineteenth Edition*, 2003, Washington, DC, pp. 20–23. School bus fuel was assumed to be 90% diesel fuel and 10% gasoline based on estimates from the National Association of State Directors of Pupil Transportation Services. Intercity bus fuel was assumed to be 100% diesel.

Table A.4
Intercity and School Bus Fuel Use

Year	Intercity (million gallons)	School (million gallons)
1970	305.34	299.88
1975	181.02	341.88
1980	213.78	379.68
1981	205.38	386.82
1982	227.22	398.58
1983	237.30	400.68
1984	169.26	375.06
1985	165.48	425.04
1986	148.68	462.42
1987	155.82	487.20
1988	160.44	511.14
1989	166.74	498.12
1990	159.60	472.08
1991	160.44	533.40
1992	157.08	546.00
1993	171.36	533.40
1994	195.30	546.00
1995	195.30	545.16
1996	199.92	545.16
1997	212.52	544.74
1998	220.08	550.20
1999	241.08	555.66
2000	233.10	577.08
2001	217.35*	538.08*
2002	210.22*	520.44*
2003	208.32*	515.72*
2004	208.87*	517.09*
2005	214.37*	530.70*
2006	208.32*	515.72*
2007	214.37*	530.70*
2008	218.48*	540.89*
2009	224.58*	556.00*
2010	214.95*	532.15*
2011	215.53*	533.58*
2012	230.42	570.45*
2013	236.76	586.14*
2014	249.75	618.29*
2015	253.35	627.22
Fuel type shares	100% diesel	90% diesel 10% gasoline
Heat content used for conversion to btu:	138,700 btu/gallon	138,700 btu/gallon 125,000 btu/gallon

*Estimated using the rate of change of bus vehicle-miles traveled from FHWA Highway Statistics, Table VM-1 (recently revised).

2.1.4 Trucks

Light Trucks

Fuel use in gallons (1970-2007) – DOT, FHWA, *Highway Statistics 2008*, Table VM-1 and annual editions back to 1996 and DOT, FHWA, *Highway Statistics Summary to 1995*.

Fuel use in gallons (2008 – 2014) – See Section 7. Appendix A Car and Light Truck Shares.

Fuel type distribution – Fuel use was distributed among fuel types using the percentages shown in Table A.1. The FHWA discontinued gasohol data in 2005. Therefore, data from EIA, *Alternatives to Traditional Transportation Fuels*, 2006-2011, Table C.1 were used.

Electricity (2015) – U.S. Department of Energy, Energy Information Administration, *Annual Energy Outlook 2017*, January 2017, Table 3.7. Total light vehicle electricity usage was split between cars and light trucks using cumulative vehicle sales as a proxy.

Table A.5
Light Truck Fuel Use and Fuel Type Shares for Calculation of Energy Use

Year	Fuel use (million gallons)	Source for gasohol shares	Source for gasoline/diesel /lpg shares	Shares by fuel type			
				Gasoline	Gasohol	Diesel	Lpg
1970	12,313		1977 TIUS	97.6%	0.0%	1.6%	0.8%
1975	19,081		1977 TIUS	97.6%	0.0%	1.6%	0.8%
1976	20,828		1977 TIUS	97.6%	0.0%	1.6%	0.8%
1977	22,383		1977 TIUS	97.6%	0.0%	1.6%	0.8%
1978	24,162		Interpolated	97.1%	0.0%	2.0%	0.9%
1979	24,445		Interpolated	96.7%	0.0%	2.4%	1.0%
1980	23,796	FHWA, MF-33e	Interpolated	95.7%	0.5%	2.7%	1.0%
1981	23,697	FHWA, MF-33e	Interpolated	95.1%	0.7%	3.1%	1.1%
1982	22,702	FHWA, MF-33e	1982 TIUS	93.0%	2.3%	3.5%	1.2%
1983	23,945	FHWA, MF-33e	Interpolated	91.0%	4.3%	3.5%	1.2%
1984	25,604	FHWA, MF-33e	Interpolated	90.0%	5.3%	3.5%	1.2%
1985	27,363	FHWA, MF-33e	Interpolated	87.6%	7.7%	3.5%	1.2%
1986	29,074	FHWA, MF-33e	Interpolated	87.7%	7.6%	3.5%	1.2%
1987	30,598	FHWA, MF-33e	1987 TIUS	89.0%	6.3%	3.5%	1.2%
1988	32,653	FHWA, MF-33e	Interpolated	88.2%	7.4%	3.5%	1.0%
1989	33,271	FHWA, MF-33e	Interpolated	89.5%	6.2%	3.4%	0.8%
1990	35,611	FHWA, MF-33e	Interpolated	89.2%	6.8%	3.4%	0.7%
1991	38,217	FHWA, MF-33e	Interpolated	88.1%	8.0%	3.3%	0.5%
1992	40,929	FHWA, MF-33e	1992 TIUS	88.5%	7.9%	3.3%	0.3%
1993	42,851	FHWA, MF-33e	Interpolated	87.3%	9.1%	3.3%	0.3%
1994	44,112	FHWA, MF-33e	Interpolated	86.8%	9.6%	3.3%	0.3%
1995	45,605	FHWA, MF-33e	Interpolated	85.1%	11.2%	3.4%	0.3%
1996	47,354	FHWA, MF-33e	Interpolated	86.2%	10.1%	3.4%	0.3%
1997	49,388	FHWA, MF-33e	1997 VIUS	84.2%	12.2%	3.4%	0.2%
1998	50,462	FHWA, MF-33e	Interpolated	85.0%	11.2%	3.5%	0.3%
1999	52,859	FHWA, MF-33e	Interpolated	84.9%	11.0%	3.6%	0.4%
2000	52,939	FHWA, MF-33e	Interpolated	83.1%	12.6%	3.8%	0.6%
2001	53,522	FHWA, MF-33e	Interpolated	82.4%	13.0%	3.9%	0.7%
2002	55,220	FHWA, MF-33e	2002 VIUS	79.6%	15.6%	4.0%	0.8%
2003	60,758	FHWA, MF-33e	2002 VIUS	71.0%	24.2%	4.0%	0.8%
2004	63,417	FHWA, MF-33e	2002 VIUS	62.9%	32.3%	4.0%	0.8%
2005	58,869	FHWA, MF-33e	2002 VIUS	62.6%	32.6%	4.0%	0.8%
2006	60,685	EIA, C1	2002 VIUS	73.9%	21.3%	4.0%	0.8%
2007	61,836	EIA, C1	2002 VIUS	68.6%	26.6%	4.0%	0.8%
2008	61,199 ^a	EIA, C1	2002 VIUS	57.5%	37.7%	4.0%	0.8%
2009	61,824	EIA, C1	2002 VIUS	51.5%	43.7%	4.0%	0.8%
2010	64,687	EIA, C1	2002 VIUS	45.2%	50.0%	4.0%	0.8%
2011	65,786	EIA, C1	2002 VIUS	44.4%	50.8%	4.0%	0.8%
2012	66,395	EIA, C1	2002 VIUS	44.4%	50.8%	4.0%	0.8%
2013	65,555	EIA, C1	2002 VIUS	44.7%	50.5%	4.0%	0.8%
2014	69,012	EIA, C1	2002 VIUS	45.8%	49.4%	4.0%	0.8%
2015	67,730	EIA, C1	2002 VIUS	45.7%	49.5%	4.0%	0.8%
Heat content used for conversion to btu:				125,000 btu/gallon	120,900 btu/gallon	138,700 btu/gallon	90,800 btu/gallon

^a Data are not continuous between 2008 and 2009 due to changes in source.

Medium/Heavy Trucks

DOT, FHWA, *Highway Statistics 2015*, Table VM-1 and annual editions back to 1996 and DOT, FHWA, *Highway Statistics Summary to 1995*. The FHWA made methodology changes for *Highway Statistics 2009*. At that time, they published historical data back to 2007 which do not match the previous data. Total gallons for medium/heavy trucks are the sum of single-unit trucks and combination trucks.

Table A.6
Medium/Heavy Truck Fuel Use and Fuel Type Shares for Calculation of Energy Use

Year	Fuel use (million gallons)	Source for fuel type shares	Shares by fuel type		
			Gasoline	Diesel	Lpg
1970	11,316	1977 TIUS	10.4%	89.5%	0.1%
1975	14,598	1977 TIUS	10.4%	89.5%	0.1%
1980	19,960	Interpolated	27.9%	71.4%	0.6%
1981	20,376	Interpolated	33.8%	65.4%	0.8%
1982	20,386	1982 TIUS	39.6%	59.4%	1.0%
1983	20,761	Interpolated	35.6%	63.6%	0.8%
1984	21,428	Interpolated	31.5%	67.8%	0.7%
1985	21,405	Interpolated	27.5%	72.0%	0.5%
1986	21,861	Interpolated	23.4%	76.2%	0.4%
1987	22,513	1987 TIUS	19.4%	80.4%	0.2%
1988	22,925	Interpolated	18.8%	81.0%	0.3%
1989	23,512	Interpolated	18.1%	81.6%	0.3%
1990	24,490	Interpolated	17.5%	82.1%	0.4%
1991	24,981	Interpolated	16.8%	82.7%	0.4%
1992	25,453	1992 TIUS	16.2%	83.3%	0.5%
1993	26,236	Interpolated	15.4%	84.1%	0.5%
1994	27,685	Interpolated	14.7%	84.8%	0.5%
1995	28,828	Interpolated	13.9%	85.6%	0.5%
1996	29,601	Interpolated	13.2%	86.3%	0.5%
1997	29,878	1997 VIUS	12.4%	87.1%	0.5%
1998	30,841	Interpolated	12.1%	87.4%	0.5%
1999	33,909	Interpolated	11.8%	87.6%	0.5%
2000	35,229	Interpolated	11.6%	87.9%	0.5%
2001	35,179	Interpolated	11.3%	88.1%	0.5%
2002	36,800	2002 VIUS	11.0%	88.4%	0.5%
2003	35,775	2002 VIUS	11.0%	88.4%	0.5%
2004	33,150	2002 VIUS	11.0%	88.4%	0.5%
2005	37,190	2002 VIUS	11.0%	88.4%	0.5%
2006	37,959 ^a	2002 VIUS	11.0%	88.4%	0.5%
2007	47,218	2002 VIUS	11.0%	88.4%	0.5%
2008	47,705	2002 VIUS	11.0%	88.4%	0.5%
2009	44,303	2002 VIUS	11.0%	88.4%	0.5%
2010	45,024	2002 VIUS	11.0%	88.4%	0.5%
2011	42,396	2002 VIUS	11.0%	88.4%	0.5%
2012	42,351	2002 VIUS	11.0%	88.4%	0.5%
2013	43,297	2002 VIUS	11.0%	88.4%	0.5%
2014	44,012	2002 VIUS	11.0%	88.4%	0.5%
2015	43,734	2002 VIUS	11.0%	88.4%	0.5%
Heat content used for conversion to btu:			125,000	138,700	90,800
			btu/gallon	btu/gallon	btu/gallon

^a Data are not continuous between 2006 and 2007 due to changes in methodology. See source for details.

Shares of Class 3-6 and 7-8 energy use by fuel type were calculated from the 2002 Vehicle Inventory and Use Survey (VIUS) and applied to all years 1970-2015.

Table A.7
Share of Medium and Heavy Truck Energy Use

Fuel type	Share of energy use		Total
	Class 3-6	Class 7-8	
Gasoline	92%	8%	100%
Diesel	14%	86%	100%
LPG	99%	1%	100%

2.2 OFF-HIGHWAY ENERGY USE

U.S. Environmental Protection Agency, MOVES2014a model, results generated August 2017. Gallons of fuel by fuel type were produced for agricultural equipment, airport equipment, construction and mining equipment, industrial equipment, lawn and garden equipment, logging equipment, railroad maintenance equipment, and recreational equipment. Some non-transportation-related equipment, such as generators, chain saws, compressors, and pumps, were excluded from the data.

2.3 NONHIGHWAY ENERGY USE

2.3.1 Air

General Aviation

DOT, FAA, *On-line General Aviation Activity and Air Taxi Activity Surveys: Annual Summary Report Calendar Year 2015*, Table 5.1, and annual. 2011 Data: *Aviation Forecasts*, Tables 28 and 29, May 2013. (Additional resources: www.faa.gov/data_research/aviation_data_statistics/general_aviation/CY2015/)

Table A.8
General Aviation Fuel Use

Year	Jet fuel (million gallons)	Aviation gasoline (million gallons)	Year	Jet fuel (million gallons)	Aviation gasoline (million gallons)
1970	208.0	551.0	1993	454.1	268.4
1971	226.0	508.0	1994	470.8	264.1
1972	245.0	584.0	1995	544.0	276.0
1973	304.0	411.0	1996	567.5	286.5
1974	357.0	443.0	1997	639.4	289.7
1975	453.0	412.0	1998	814.6	311.4
1976	495.0	432.0	1999	967.2	345.4
1977	536.0	456.0	2000	998.1	336.3
1978	763.0	518.0	2001	938.7	319.3
1979	736.0	570.0	2002	815.5	261.4
1980	766.0	520.0	2003	820.0	255.5
1981	759.0	489.0	2004	1,075.2	256.1
1982	887.0	448.0	2005	1,507.4	323.6
1983	613.0	428.0	2006	1,636.3	294.7
1984	738.9	462.4	2007	1,516.3	314.8
1985	691.0	421.0	2008	1,688.6	306.3
1986	732.1	408.6	2009	1,350.6	226.6
1987	672.7	401.8	2010	1,451.5	210.3
1988	746.0	398.0	2011	1,490.7	215.5
1989	688.0	342.8	2012	1,492.1	227.7
1990	662.0	353.0	2013	1,353.6	173.3
1991	579.0	348.0	2014	1,454.1	205.8
1992	496.0	306.0	2015	1,384.4	183.2
Heat content used for conversion to btu:	135,000 btu/gallon	120,200 btu/gallon		135,000 btu/gallon	120,200 btu/gallon

Domestic and International Air Carrier

DOT, Bureau of Transportation Statistics, "Fuel Cost and Consumption Tables," www.transtats.bts.gov/fuel. The table below shows all international fuel use. Because the data for international include fuel purchased abroad, for the tables in Chapter 2, the international total was divided in half to estimate domestic fuel use for international flights.

Table A.9
Air Carrier Fuel Use

Year	Domestic (thousand gallons)	International (thousand gallons)	Total (thousand gallons)
1970	Separate estimates for domestic and international are not available from 1970-1976.		10,085,000
1975			10,412,640
1976			10,400,040
1977	8,202,051	1,708,376	9,910,427
1978	8,446,117	1,741,918	10,188,035
1979	8,865,885	1,828,435	10,694,320
1980	8,519,233	1,747,306	10,266,539
1981	8,555,249	2,032,520	10,587,769
1982	8,432,465	1,967,733	10,400,198
1983	8,672,574	1,998,289	10,670,863
1984	9,625,958	2,286,407	11,912,365
1985	10,115,007	2,487,929	12,602,936
1986	11,137,331	2,544,996	13,682,327
1987	11,586,838	2,893,617	14,480,455
1988	11,917,904	3,262,824	15,180,728
1989	11,905,144	3,557,294	15,462,438
1990	12,429,305	3,963,081	16,392,386
1991	11,506,477	3,939,666	15,446,144
1992	11,762,852	4,120,132	15,882,983
1993	11,958,663	4,113,321	16,071,984
1994	12,475,549	4,310,879	16,786,428
1995	12,811,717	4,511,418	17,323,135
1996	13,187,305	4,658,093	17,845,398
1997	13,659,581	4,964,181	18,623,762
1998	13,876,971	5,185,562	19,062,533
1999	14,402,127	5,250,492	19,652,619
2000	14,844,592	5,474,685	20,319,277
2001	14,017,461	5,237,487	19,254,948
2002	12,848,329	4,990,798	17,839,127
2003	12,958,581	4,836,356	17,794,936
2004	13,622,603	4,931,546	18,554,149
2005	13,778,869	5,520,889	19,309,758
2006	13,694,437	6,017,638	19,712,075
2007	13,681,664	6,204,502	19,886,165
2008	12,666,911	6,186,747	18,853,658
2009	11,339,220	5,721,298	17,060,517
2010	11,256,900	6,041,500	17,288,400
2011	11,035,400	6,522,600	17,558,000
2012	10,439,700	6,506,300	16,946,000
2013	10,337,000	6,487,300	16,824,300
2014	10,458,600	6,321,400	16,780,000
2015	10,928,600	6,420,600	17,349,200
Heat content used for conversion to btu:	135,000 btu/gallon	135,000 btu/gallon	135,000 btu/gallon

2.3.2 Water

Freight

Total – DOE, EIA, *Petroleum and Other Liquids Database*, August 2017. Adjusted sales of distillate and residual fuel oil for vessel bunkering. (This may include some amounts of bunker fuels used for recreational purposes.)

Table A.10
Diesel and Residual Fuel Oil for Vessel Bunkering

Year	Distillate fuel oil (thousand gallons)	Residual fuel oil (thousand gallons)
1970	819,000	3,774,120
1975	1,097,880	4,060,140
1980	717,376	7,454,242
1981	1,723,143	7,922,512
1982	1,423,216	6,408,818
1983	1,418,890	5,724,115
1984	1,692,045	5,688,931
1985	1,894,265	5,269,733
1986	2,034,215	5,690,250
1987	2,223,258	5,869,154
1988	2,310,367	6,025,511
1989	2,356,444	6,621,100
1990	2,197,004	6,248,095
1991	2,167,640	6,786,055
1992	2,240,170	7,199,078
1993	2,043,745	6,269,882
1994	2,026,899	5,944,383
1995	1,978,105	6,431,238
1996	2,177,608	5,804,977
1997	2,107,561	4,789,861
1998	2,125,568	4,640,153
1999	2,064,590	5,598,630
2000	2,041,433	6,192,294
2001	2,099,011	4,345,284
2002	2,056,465	4,783,956
2003	1,863,150	3,801,425
2004	2,313,448	4,886,978
2005	2,115,381	5,533,552
2006	2,206,690	6,000,434
2007	2,158,930	6,773,950
2008	1,980,729	6,274,047
2009	2,138,690	5,331,657
2010	2,427,051	6,032,367
2011	2,651,859	5,207,886
2012	1,842,107	4,560,546
2013	1,655,258	3,876,795
2014	1,626,527	2,987,363
2015	2,415,253	3,103,402
Heat content used for conversion to btu:	138,700 btu/gallon	149,700 btu/gallon
Domestic share of total fuel use	77.5%	9.3%

Recreational Boating

Fuel use by recreational boating comes from the EPA's MOVES2014a model.

Table A.11
Recreational Boating Fuel Use

Year	Diesel use (gallons)	Gasoline use (gallons)
1970	39,589,953	1,213,397,311
1975	77,294,680	1,251,387,972
1976	84,835,632	1,258,986,070
1977	92,376,573	1,266,584,111
1978	99,917,523	1,274,182,341
1979	107,458,470	1,281,780,460
1980	114,999,421	1,289,378,532
1981	122,540,357	1,296,976,672
1982	130,081,302	1,304,574,832
1983	137,622,248	1,312,172,890
1984	145,163,202	1,319,771,007
1985	152,704,140	1,327,369,146
1986	160,245,074	1,334,967,322
1987	167,786,030	1,342,565,455
1988	175,326,970	1,362,856,034
1989	182,867,916	1,383,146,636
1990	190,408,869	1,403,437,194
1991	197,949,808	1,429,688,292
1992	205,490,749	1,455,939,504
1993	213,031,707	1,482,190,597
1994	220,572,649	1,539,794,180
1995	228,113,596	1,597,269,921
1996	235,654,521	1,654,446,069
1997	243,195,481	1,657,737,628
1998	250,736,414	1,659,056,085
1999	258,159,525	1,657,198,161
2000	265,582,657	1,652,906,973
2001	273,547,835	1,655,303,922
2002	281,512,965	1,653,583,696
2003	289,478,093	1,648,070,959
2004	297,443,197	1,639,713,127
2005	305,408,463	1,629,873,278
2006	313,420,594	1,619,603,593
2007	321,432,801	1,609,567,873
2008	329,445,068	1,599,830,522
2009	337,457,287	1,590,749,216
2010	345,469,668	1,578,405,558
2011	353,434,754	1,566,937,275
2012	361,399,927	1,557,381,573
2013	369,365,038	1,550,075,141
2014	377,330,139	1,544,411,821
2015	385,295,170	1,540,441,668
Heat content used for conversion to btu:	138,700 btu/gallon	125,000 btu/gallon

2.3.3 Pipeline

The sum of natural gas, crude petroleum and petroleum product, and coal slurry and water.

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 2015*, Table 1. Cubic feet were converted to Btu using 1,031 Btu/ft³. 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 horsepower 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.

Crude Petroleum and Petroleum Product

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

Coal Slurry and Water

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

Table A.12
Pipeline Fuel Use

Year	Natural gas (million cubic feet)	Estimated natural gas pipeline electricity use (million kWhr)	Electricity constant (trillion btu)
1970	722,166	3,272.9	70.0
1975	582,963	2,642.0	70.0
1976	548,323	2,485.0	70.0
1977	532,669	2,414.1	70.0
1978	530,451	2,404.0	70.0
1979	600,964	2,723.6	70.0
1980	634,622	2,876.1	70.0
1981	642,325	2,911.0	70.0
1982	596,411	2,703.0	70.0
1983	490,042	2,220.9	70.0
1984	528,754	2,396.3	70.0
1985	503,766	2,283.1	70.0
1986	485,041	2,198.2	70.0
1987	519,170	2,352.9	70.0
1988	613,912	2,782.3	70.0
1989	629,308	2,852.0	70.0
1990	659,816	2,990.3	70.0
1991	601,305	2,725.1	70.0
1992	587,710	2,663.5	70.0
1993	624,308	2,829.4	70.0
1994	685,362	3,106.1	70.0
1995	700,335	3,173.9	70.0
1996	711,446	3,224.3	70.0
1997	751,470	3,405.7	70.0
1998	635,477	2,880.0	70.0
1999	645,319	2,924.6	70.0
2000	642,210	2,910.5	70.0
2001	624,964	2,832.3	70.0
2002	666,920	3,022.5	70.0
2003	591,492	2,680.7	70.0
2004	566,187	2,566.0	70.0
2005	584,026	2,646.8	70.0
2006	584,213	2,647.7	70.0
2007	621,364	2,816.0	70.0
2008	647,956	2,936.6	70.0
2009	670,174	3,037.2	70.0
2010	674,124	3,055.1	70.0
2011	687,784	3,117.0	70.0
2012	730,790	3,312.0	70.0
2013	833,061	3,775.4	70.0
2014	700,150	3,173.1	70.0
2015	666,214	3,019.3	70.0
Heat content used for conversion to btu:	1,031 btu/cubic foot	3,412 Btu/kWhr	

Note: Formula for estimating electricity use for natural gas pipelines is:
 Natural gas use (in million cubic ft) \times 1,031 btu/cubic ft \times 0.015 \times 29.305 $\times 10^{-5}$ kWhr/btu.

2.3.4 Rail

Freight

AAR, *Railroad Facts*, 2016 Edition, Washington, DC, 2016.

Table A.13
Class I Freight Railroad Fuel Use

Year	Diesel fuel (thousand gallons)
1970	3,807,663
1971	3,822,907
1972	3,996,985
1973	4,160,730
1974	4,175,375
1975	3,736,484
1976	3,895,542
1977	3,985,069
1978	3,968,007
1979	4,072,187
1980	3,955,996
1981	3,756,439
1982	3,178,116
1983	3,137,295
1984	3,388,173
1985	3,144,190
1986	3,039,069
1987	3,102,227
1988	3,182,267
1989	3,190,815
1990	3,134,446
1991	2,925,970
1992	3,022,108
1993	3,111,981
1994	3,355,802
1995	3,503,096
1996	3,600,649
1997	3,602,793
1998	3,619,341
1999	3,749,428
2000	3,720,107
2001	3,729,985
2002	3,751,413
2003	3,849,229
2004	4,082,236
2005	4,119,879
2006	4,214,459
2007	4,087,405
2008	3,911,178
2009	3,220,059
2010	3,519,021
2011	3,710,485
2012	3,634,025
2013	3,712,582
2014	3,897,113
2015	3,723,491
Heat content used for conversion to btu:	138,700 Btu/gallon

Passenger

Commuter - APTA, *2016 Public Transportation Fact Book*, Washington, DC, 2016. Data for 2015 are directly from the U.S. Department of Transportation, Federal Transit Administration, National Transit Database.

Table A.14
Commuter Rail Fuel Use

Year	Diesel (thousand gallons)	Electricity (million kWhr)
1984	58,320	901
1985	55,372	1,043
1986	54,608	1,170
1987	51,594	1,155
1988	53,054	1,195
1989	52,516	1,293
1990	52,681	1,226
1991	54,315	1,239
1992	54,951	1,124
1993	59,766	1,196
1994	61,900	1,244
1995	63,064	1,253
1996	61,888	1,255
1997	63,195	1,270
1998	69,200	1,299
1999	73,005	1,322
2000	70,818	1,370
2001	72,204	1,354
2002	72,847	1,334
2003	72,264	1,383
2004	71,999	1,449
2005	76,714	1,484
2006	78,600	1,478
2007	80,700	1,763
2008	83,500	1,718
2009	95,000	1,780
2010	93,200	1,797
2011	93,900	1,813
2012	92,800	1,808
2013	98,700	1,816
2014	93,900	1,809
2015	95,728	1,792
Heat content used for conversion to btu:	138,700 Btu/gallon	3,412 Btu/kWhr

Transit – APTA, *2016 Public Transportation Fact Book*, Washington, DC, 2016. Includes light rail and heavy rail. Data for 2015 are directly from the U.S. Department of Transportation, Federal Transit Administration, National Transit Database.

Table A.15
Transit Rail Fuel Use

Year	Electricity (million kWhr)		Total
	Light rail	Heavy rail	
1970			2,561
1975			2,646
1976	Light rail and heavy rail data are not available separately from 1970 to 1985.		2,576
1977			2,303
1978			2,223
1979			2,473
1980			2,446
1981			2,655
1982			2,722
1983			2,930
1984			3,092
1985			2,928
1986	173	3,066	3,239
1987	191	3,219	3,410
1988	243	3,256	3,499
1989	242	3,286	3,528
1990	239	3,284	3,523
1991	274	3,248	3,522
1992	297	3,193	3,490
1993	281	3,287	3,568
1994	282	3,431	3,713
1995	288	3,401	3,689
1996	321	3,322	3,643
1997	363	3,253	3,616
1998	382	3,280	3,662
1999	416	3,385	3,801
2000	563	3,549	4,112
2001	587	3,646	4,233
2002	510	3,683	4,193
2003	507	3,632	4,138
2004	553	3,684	4,237
2005	571	3,769	4,339
2006	634	3,709	4,343
2007	687	3,817	4,505
2008	721	3,898	4,619
2009	738	3,866	4,624
2010	749	3,780	4,529
2011	789	3,854	4,643
2012	806	3,795	4,601
2013	882	3,856	4,738
2014	985	3,812	4,797
2015	898	3,816	4,713
Heat content used for conversion to btu:	3,412 Btu/kWhr	3,412 Btu/kWhr	3,412 Btu/kWhr

Intercity – Personal communication with Amtrak, Washington, DC, 2016.

Table A.16
Intercity Rail Fuel Use

Year	Diesel fuel (thousand gallons)	Electricity (thousand kWhr)
1994	73,516	308,948
1995	72,371	335,818
1996	71,226	362,689
1997	75,656	389,559
1998	75,999	416,429
1999	79,173	443,300
2000	94,968	470,170
2001	96,846	455,703
2002	84,432	518,306
2003	74,621	536,950
2004	68,605	550,695
2005	65,477	531,377
2006	62,463	548,856
2007	61,824	577,864
2008	63,428	582,022
2009	61,704	564,968
2010	63,474	558,662
2011	63,450	555,425
2012	63,058	549,201
2013	66,036	525,127
2014	65,711	515,332
2015	62,468	504,017
Heat content used for conversion to Btu	138,700 Btu/gallon	3,412 Btu/kWhr

2.4 CALCULATION OF MILLION BARRELS PER DAY CRUDE OIL EQUIVALENT

One gallon of gasoline, diesel fuel, or lpg is estimated to be the equivalent of one gallon of crude oil. Petroleum used for electricity was calculated using the following formula:

$$(((BTU * S) / G) / P) / 365 / 1000$$

- BTU = Btus of electricity
 S = Share of petroleum used in making primary electricity (Calculated from Table 2.6 from the EIA, Monthly Energy Review)
 G = Electricity generation and distribution (assumed 29%)
 P = Btus per barrel of petroleum product (Table A3 from the EIA, Monthly Energy Review).

3. PASSENGER TRAVEL AND ENERGY USE

3.1 CARS

Number of vehicles – DOT, FHWA, *Highway Statistics 2014*, Table MV-1 and annual editions back to 2009.

Vehicle-miles – See Appendix A, Section 7. Car and Light Truck Shares.

Passenger-miles – Vehicle-miles multiplied by an average load factor.

Load factor – 2009 NHTS shows car load factor as 1.55 persons per vehicle.

Energy intensities –

Btu per vehicle-mile – Car energy use divided by vehicle-miles.

Btu per passenger-mile – Car energy use divided by passenger-miles.

Energy use – See Section 2. Energy Use Sources. Data series shown in Table 2.9.

3.2 LIGHT TRUCKS

Number of vehicles – DOT, FHWA, *Highway Statistics 2014*, Table MV-9 and annual editions back to 2009. Columns for pickups, vans, sport utility vehicles, and other light trucks. Data were multiplied by the shares of light trucks which are for personal use (Table A.17) which were derived by ORNL from the 2002 VIUS Micro Data File on CD.

Vehicle-miles – See Appendix A, Section 7. Car and Light Truck Shares. Data were multiplied by the shares of vehicle miles which are for personal use (Table A.17) which were derived by ORNL from the 2002 VIUS Micro Data File on CD.

Passenger-miles – Vehicle-miles multiplied by an average load factor.

Load factor – 2009 NHTS shows personal light truck load factor as 1.84 persons per vehicle.

Energy intensities -

Btu per vehicle-mile – Personal light truck energy use divided by personal light truck vehicle-miles.

Btu per passenger-mile – Personal light truck energy use divided by personal light truck passenger-miles.

Energy use – See Section 2. Energy Use Sources (light trucks, medium/heavy trucks). Data by truck type were multiplied by the shares of truck fuel use which are for personal use (Table A.17) which were derived by ORNL from the 2002 VIUS Micro Data File on CD.

Table A.17
Share of Trucks, Truck Travel,
and Fuel Use for Personal Travel

Personal trucks	
85.6%	2-axle, 4-tire trucks
26.9%	Other single-unit and combination trucks
Personal truck travel	
80.9%	2-axle, 4-tire trucks
13.1%	Other single-unit and combination trucks
Personal truck fuel use	
78.0%	2-axle, 4-tire trucks
6.0%	Other single-unit and combination trucks

Note: Since these shares come from the 2002 VIUS, they may underestimate the amount of personal trucks, truck travel, and energy use for 2015.

3.3 MOTORCYCLES

Number of vehicles, vehicle-miles – DOT, FHWA, *Highway Statistics 2015*, Table VM-1.

Passenger-miles – Vehicle-miles multiplied by an average load factor.

Load factor - 2009 NHTS shows motorcycle load factor as 1.16 persons per vehicle.

Energy intensities –

Btu per vehicle-mile – Motorcycle energy use divided by vehicle-miles.

Btu per passenger-mile – Motorcycle energy use divided by passenger-miles.

Energy use – See Section 2. Energy Use Sources. Data series shown in Table 2.9.

3.4 DEMAND RESPONSE

Number of vehicles, vehicle-miles, passenger-miles – APTA, *2016 Public Transportation Fact Book*, Washington, DC, 2016.

Load factor – Passenger-miles divided by vehicle-miles.

Energy intensities –

Btu per vehicle-mile – Energy use divided by vehicle-miles.

Btu per passenger-mile – Energy use divided by passenger-miles.

Energy use – APTA, *2016 Public Transportation Fact Book*, Washington, DC, 2016.

Note that all Demand Response data are for 2014.

3.5 BUSES

3.5.1 Transit

Number of vehicles, vehicle-miles, passenger-miles – APTA, *2016 Public Transportation Fact Book*, Washington, DC, 2016. Data series shown on Table 5.18. Data for 2015 are directly from the U.S. Department of Transportation, Federal Transit Administration, National Transit Database.

Load factor – Passenger-miles divided by vehicle-miles.

Energy intensities –

Btu per vehicle-mile – Transit bus energy use divided by transit bus vehicle-miles.

Btu per passenger-mile – Transit bus energy use divided by transit bus passenger-miles.

Energy use – See Section 2. Energy Use Sources. Data series shown in Table 5.18.

3.5.2 Intercity

Energy use – See Section 2. Energy Use Sources. Because the data past 2000 are not available, the rate of change in bus VMT from FHWA, *Highway Statistics 2015*, was used to estimate the change in energy use.

3.5.3 School

Number of vehicles – DOT, FHWA, *Highway Statistics 2015*, Table MV-10.

Energy use – See Section 2. Energy Use Sources. Because the data past 2000 are not available, the rate of change in bus VMT from FHWA, *Highway Statistics 2015*, was used to estimate the change in energy use.

3.6 AIR

3.6.1 Certificated Air Carriers

Aircraft-miles, passenger-miles – DOT, BTS, U.S. Air Traffic Statistics Through December 2016, www.transtats.bts.gov, Washington, DC.

Load factor – Passenger-miles divided by aircraft-miles.

Energy intensities –

Btu per passenger-mile – Certificated air carrier energy use divided by passenger-miles.

Energy use – See Section 2. Energy Use Sources. All of domestic fuel use and half of international fuel use was considered to be domestic use.

Note: These data differ from the data in Table 9.2 because that table contains data on ALL domestic AND international air carrier energy use and passenger-miles.

3.6.2 General Aviation

Number of vehicles – DOT, FAA, *General Aviation and Air Taxi Activity Surveys - CY 2015*. 2011 Data: *Aviation Forecasts*, Tables 28 and 29, May 2013. Data series shown in Table 9.3.

Energy intensities –

Btu per passenger-mile – General aviation energy use divided by passenger-miles.

Energy use – See Section 2. Energy Use Sources. Data series shown in Table 9.3.

3.7 RECREATIONAL BOATING

Number of vehicles and energy use – U.S. EPA’s MOVES2014a model.

3.8 RAIL

3.8.1 Intercity

Number of vehicles, vehicle-miles, passenger-miles – AAR, *Railroad Facts, 2016 Edition*, Washington, DC, 2016.

Load factor – Passenger-miles divided by vehicle-miles.

Energy Intensities –

Btu per vehicle-mile – Intercity rail energy use divided by vehicle-miles.

Btu per passenger-mile – Intercity rail energy use divided by passenger-miles.

Energy use – See Section 2. Energy Use Sources. Data series shown in Table 9.10.

3.8.2 Transit

Number of vehicles, vehicle-miles, passenger-miles – APTA, *2016 Public Transportation Fact Book*, Washington, DC, 2016. Sum of light and heavy rail transit. Data series shown on Table 9.12. Data for 2015 are directly from the U.S. Department of Transportation, Federal Transit Administration, National Transit Database.

Load factor – Passenger-miles divided by vehicle-miles.

Energy intensities –

Btu per vehicle-mile – Light and heavy transit rail energy use divided by vehicle-miles.

Btu per passenger-mile – Light and heavy transit rail energy use divided by passenger-miles.

Energy use – See Section 2. Energy Use Sources. Data series shown in Table 9.12.

3.8.3 Commuter

Number of vehicles, vehicle-miles, passenger-miles – APTA, *2016 Public Transportation Fact Book*, Washington, DC, 2016. Data series shown on Table 9.11. Data for 2015 are directly from the U.S. Department of Transportation, Federal Transit Administration, National Transit Database.

Load factor – Passenger-miles divided by vehicle-miles.

Energy intensities –

Btu per vehicle-mile – Commuter rail energy use divided by vehicle-miles.

Btu per passenger-mile – Commuter rail energy use divided by passenger-miles.

Energy use – See Section 2. Energy Use Sources. Data series shown in Table 9.11.

4. HIGHWAY PASSENGER MODE ENERGY INTENSITIES

4.1 CARS

Btu per vehicle-mile – Car energy use divided by car vehicle miles of travel.

Energy use – See Section 2. Energy Use Sources. Data series shown in Table 2.9.

Vehicle-miles – 1970-2008: DOT, FHWA, *Highway Statistics 2009*, Table VM-1 and annual editions back to 1996 and DOT, FHWA, *Highway Statistics Summary to 1995*. Data series shown in Table 4.1.

2009-2015: See Appendix A, Section 7. Car and Light Truck Shares.

Btu per passenger-mile – Car energy use divided by car passenger-miles.

Energy use – See Section 2. Energy Use Sources. Data series shown in Table 2.9.

Passenger miles – Vehicle miles multiplied by an average load factor.

Vehicle-miles – 1970-2008: DOT, FHWA, *Highway Statistics 2009*, Table VM-1 and annual editions back to 1996 and DOT, FHWA, *Highway Statistics Summary to 1995*. Data series shown in Table 4.1.

2009-2015: See Appendix A, Section 7. Car and Light Truck Shares.

Load factor – NPTS 1969, 1977, 1983/84, 1990, and 1995; NHTS 2001 and 2009. Data series shown in Table A.18.

Table A.18
Car Load Factor used to Calculate Passenger-Miles

Year	Source	Load Factor
1970	1969 NPTS	1.90
1971	Interpolated	1.90
1972	Interpolated	1.90
1973	Interpolated	1.90
1974	Interpolated	1.90
1975	Interpolated	1.90
1976	Interpolated	1.90
1977	1977 NPTS	1.90
1978	Interpolated	1.88
1979	Interpolated	1.87
1980	Interpolated	1.85
1981	Interpolated	1.83
1982	Interpolated	1.82
1983	1983/84 NPTS	1.80
1984	Interpolated	1.77
1985	Interpolated	1.74
1986	Interpolated	1.71
1987	Interpolated	1.69
1988	Interpolated	1.66
1989	Interpolated	1.63
1990	1990 NPTS	1.60
1991	Interpolated	1.60
1992	Interpolated	1.60
1993	Interpolated	1.60
1994	Interpolated	1.60
1995	1995 NPTS	1.60
1996	Interpolated	1.60
1997	Interpolated	1.59
1998	Interpolated	1.59
1999	Interpolated	1.58
2000	Interpolated	1.58
2001	2001 NHTS	1.57
2002	2001 NHTS	1.57
2003	2001 NHTS	1.57
2004	2001 NHTS	1.57
2005	2001 NHTS	1.57
2006	2001 NHTS	1.57
2007	2001 NHTS	1.57
2008	2009 NHTS	1.55
2009	2009 NHTS	1.55
2010	2009 NHTS	1.55
2011	2009 NHTS	1.55
2012	2009 NHTS	1.55
2013	2009 NHTS	1.55
2014	2009 NHTS	1.55
2015	2009 NHTS	1.55

4.2 LIGHT TRUCKS

Btu per vehicle-mile – Light truck energy use divided by light truck vehicle miles of travel.

Energy use – See Section 2. Energy Use Sources. Data series shown in Table 2.9.

Vehicle-miles – 1970-2008: DOT, FHWA, *Highway Statistics 2008*, Table VM-1 and annual editions back to 1996 and DOT, FHWA, *Highway Statistics Summary to 1995*. Data series shown in Table 4.2. 2009-2015: See Appendix A, Section 7. Car and Light Truck Shares.

4.3 Buses

4.3.1 Transit

Btu per vehicle-mile – Transit bus energy use divided by transit bus vehicle-miles.

Energy use – See Section 2. Energy Use Sources. Data series shown in Table 7.9.

Vehicle-miles – APTA, *2016 Public Transportation Fact Book*, Washington, DC, 2016. Data series shown on Table 7.9. Data for 2015 are directly from the U.S. Department of Transportation, Federal Transit Administration, National Transit Database.

Btu per passenger-mile – Transit bus energy use divided by transit bus passenger-miles.

Energy use – See Section 2. Energy Use Sources. Data series shown in Table 7.9.

Passenger-miles – APTA, *2016 Public Transportation Fact Book*, Washington, DC, 2016. Data series shown on Table 7.9. Data for 2015 are directly from the U.S. Department of Transportation, Federal Transit Administration, National Transit Database.

4.3.2 Intercity

Btu per passenger-mile – Data are not available.

Energy use – See Section 2. Energy Use Sources. Because the data past 2000 are not available, the rate of change in bus VMT from FHWA, *Highway Statistics 2015*, was used to estimate the change in energy use.

Passenger-miles – Data are not available.

5. NONHIGHWAY MODE ENERGY INTENSITIES

5.1 AIR

5.1.1 Certificated Air Carriers

Btu per passenger-mile – Certificated air carrier energy use divided by passenger-miles.

Energy use – See Section 2. Energy Use Sources. All of domestic fuel use and half of international fuel use was considered to be domestic use.

Passenger-miles – DOT, BTS, *Air Carrier Traffic Statistics*, Washington, DC, www.transtats.bts.gov. Pre-1994 data are from various editions of the *FAA Statistical Handbook of Aviation* (no longer published). Scheduled service passenger-miles of domestic air carriers and half of international air carriers were used to coincide with fuel use.

Note: These data differ from the data in Table 9.2 because that table contains data on ALL domestic AND international air carrier energy use and passenger-miles.

5.1.2 General Aviation

Btu per passenger-mile – Data are not available.

Energy use – See Section 2. Energy Use Sources. Data series shown in Table 9.3.

Passenger-miles – Data are not available.

5.2 RAIL

5.2.1 Intercity

Btu per passenger-mile – Intercity rail energy use divided by passenger-miles.

Energy use – See Section 2. Energy Use Sources. Data series shown in Table 9.10.

Passenger-miles – AAR, *Railroad Facts, 2016 Edition*, and previous annual editions.

5.2.2 Transit

Btu per passenger-mile – Transit rail energy use divided by passenger-miles.

Energy use – See Section 2. Energy Use Sources. Data series shown in Table 9.12.

Passenger-miles – APTA, *2016 Public Transportation Fact Book*, Washington, DC, 2016. Data series shown on Table 9.12. Data for 2015 are directly from the U.S. Department of Transportation, Federal Transit Administration, National Transit Database.

5.2.3 Commuter

Btu per passenger-mile – Commuter rail energy use divided by passenger-miles.

Energy use – See Section 2. Energy Use Sources. Data series shown in Table 9.11.

Passenger-miles – APTA, *2016 Public Transportation Fact Book*, Washington, DC, 2016. Data series shown on Table 9.11. Data for 2015 are directly from the U.S. Department of Transportation, Federal Transit Administration, National Transit Database.

6. FREIGHT MODE ENERGY INTENSITIES

6.1 TRUCK

Btu per vehicle-mile – Heavy single-unit and combination truck energy use divided by vehicle miles

Energy use – See Section 2. Energy Use Sources (medium/heavy trucks).

Vehicle-miles – DOT, FHWA, *Highway Statistics 2015*, Table VM-1 and annual editions back to 1996 and DOT, FHWA, *Highway Statistics Summary to 1995*. Data series is the total of vehicle travel data on Tables 5.1 and 5.2.

6.2 RAIL

Btu per freight car-mile – Class I rail energy use divided by freight car-miles.

Energy use – See Section 2. Energy Use Sources. Data series shown in Table 9.8.

Freight car miles – AAR, *Railroad Facts, 2016 Edition*, Washington, DC, 2016. Data series shown in Table 9.8.

Btu per ton-mile – Class I rail energy use divided by ton-miles.

Energy use – See Section 2. Energy Use Sources. Data series shown in Table 9.8.

Ton-miles – AAR, *Railroad Facts, 2016 Edition*, Washington, DC, 2016. Data series shown in Table 9.8.

6.3 WATER

Btu per ton-mile – Domestic waterborne commerce energy use on taxable waterways divided by ton-miles on taxable waterways.

Energy use – Modeled by Chrisman A. Dager, University of Tennessee, Knoxville, using Waterborne Commerce Statistics Center detail records and annual IRS reports on the Inland Waterway Trust Fund tax on diesel fuel used on the inland waterway.

Note: These data are not available for 2015.

Ton-miles – Based on detailed records from the U.S. Department of the Army, Army Corps of Engineers, Waterborne Commerce Statistics Center. Includes only ton-miles on taxable waterways.

7. CAR AND LIGHT TRUCK SHARES

In 2011, the Federal Highway Administration (FHWA) changed the methodology for producing the data on the VM-1 Table in the annual *Highway Statistics* publication. Historically, VM-1 included individual categories for passenger cars and 2-axle, 4-tire trucks. VM-1 included the vehicle miles of travel (VMT), registrations, fuel use, and fuel economy of passenger cars and 2-axle, 4-tire trucks. After the methodology change, the categories of light vehicles on VM-1 changed to Light-Duty Vehicles with Short wheelbase (less than or equal to 121 inches) and Light-Duty Vehicles with Long Wheelbase (over 121 inches). As some passenger cars have long wheelbases and some 2-axle, 4-tire trucks have short wheelbases, the categories of cars and 2-axle, 4-tire trucks are no longer available. Despite these changes, there are many transportation analysts who require information on cars and 2-axle, 4-tire trucks. Thus, a new methodology to estimate the data in these categories was developed for years 2009 through 2015.

7.1 CARS

Registrations – DOT, FHWA, *Highway Statistics 2015*, Table MV-1 and annual editions back to 2009.

Vehicle travel –

Total for all light vehicles – DOT, FHWA, *Highway Statistics 2015*, Table VM-1 and annual editions back to 2009; sum of light-duty short wheelbase and light-duty long wheelbase VMT.

Cars – Using historical shares of passenger cars/2-axle, 4-tire trucks from the *Highway Statistics*, the percent of light vehicle travel attributable to cars was estimated for 2009-2015, keeping in mind the economic conditions present in those years and the general trend in total light vehicle VMT. The estimated share was applied to total VMT as shown in Table A.19.

Table A.19
Estimated Car VMT

Year	Total Light Vehicle VMT (billions)	Share Attributable to Cars	Total Car VMT (billions)
2009	2,633.3	59.5%	1,566.8
2010	2,648.5	56.5%	1,496.4
2011	2,650.5	55.0%	1,457.8
2012	2,664.1	54.0%	1,438.6
2013	2,677.8	54.0%	1,446.0
2014	2,710.6	53.0%	1,436.6
2015	2,779.7	52.0%	1,445.4

Miles per Vehicle – Vehicle travel divided by registrations.

Fuel Use – Vehicle travel divided by fuel economy.

Fuel Economy – DOE, EIA, *Annual Energy Outlook 2017*, June 2017 and annual editions back to 2012.

7.2 2-AXLE, 4-TIRE TRUCKS

Registrations – DOT, FHWA, *Highway Statistics 2015*, Table MV-1 and annual editions back to 2009.

Vehicle travel –

Total for all light vehicles – DOT, FHWA, *Highway Statistics 2015*, Table VM-1 and annual editions back to 2009; sum of light-duty short wheelbase and light-duty long wheelbase VMT.

2-axle, 4-tire truck VMT – Using historical shares of passenger cars/2-axle, 4-tire trucks from the *Highway Statistics*, the percent of light vehicle travel attributable to cars was estimated for 2009-2015, keeping in mind the economic conditions present in those years and the general trend in total light vehicle VMT. The estimated share was applied to total VMT as shown in Table A.20.

Table A.20
Estimated 2-axle, 4-tire Truck VMT

Year	Total Light Vehicle VMT (billions)	Share Attributable to 2-axle, 4-tire Trucks	Total 2-axle, 4-tire Truck VMT (billions)
2009	2,633.2	40.5%	1,066.5
2010	2,648.5	43.5%	1,152.1
2011	2,650.5	45.0%	1,192.7
2012	2,664.1	46.0%	1,225.5
2013	2,677.8	46.0%	1,231.8
2014	2,710.6	47.0%	1,274.0
2015	2,779.7	48.0%	1,334.3

Miles per Vehicle – Vehicle travel divided by registrations.

Fuel Use – Vehicle travel divided by fuel economy.

Fuel Economy – DOE, EIA, *Annual Energy Outlook 2017*, June 2017 and annual editions back to 2012.

APPENDIX B

CONVERSIONS

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.4 may differ from values in other publications. The figures in this report are representative or average values, not absolute ones. The gross (higher) heating values used here agree with those used by the Energy Information Administration (EIA).

Heating values fall into two categories, usually referred to as “higher” (or gross) and “lower” (or 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 the 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.

The Transportation Energy Data Book has always used gross heating values for fuel conversion.

Table B.1
Hydrogen Heat Content

1 kilogram hydrogen =	
Higher heating value	Lower heating value
134,200 Btu	113,400 Btu
39.3 kWhr	33.2 kWhr
141,600 kJ	119,600 kJ
33,800 kCal	28,560 kCal

Table B.2
Hydrogen Conversions

	Weight		Gas		Liquid	
	Pounds (lb)	Kilograms (kg)	Standard cubic feet (SCF)	Normal cubic meter (Nm ³)	Gallons (gal)	Liters (L)
1 lb	1.0	0.4536	192.00	5.047	1.6928	6.408
1 kg	2.205	1.0	423.3	11.126	3.733	14.128
1 SCF gas	0.005209	0.002363	1.0	0.02628	0.00882	0.0339
1 Nm ³ gas	0.19815	0.08988	38.04	1.0	0.3355	1.2699
1 gal liquid	0.5906	0.2679	113.41	2.981	1.0	3.785
1 L liquid	0.15604	0.07078	29.99	0.77881	0.2642	1.0

Table B.3
Pressure Conversions

	Bar	Atmosphere	lb/in ² (or psi)
Bar	1.0	0.987	14.5
Atmosphere	1.013	1.0	14.696
lb/in ² (or psi)	0.0689	0.0680	1.0

Table B.4
Heat Content for Various Fuels

Conventional gasoline	125,000 Btu/gal (gross) = 115,400 Btu/gal (net)
E10	120,900 Btu/gal (gross) = 112,400 Btu/gal (net)
E15	119,000 Btu/gal (gross) = 109,400 Btu/gal (net)
Hydrogen	134,200 Btu/kg (gross) = 113,400 Btu/kg (net)
Low-sulfur diesel	138,700 Btu/gal (gross) = 128,700 Btu/gal (net)
Biodiesel	126,200 Btu/gal (gross) = 117,100 Btu/gal (net)
Methanol	64,600 Btu/gal (gross) = 56,600 Btu/gal (net)
Ethanol	84,600 Btu/gal (gross) = 75,700 Btu/gal (net)
E85	90,700 Btu/gal (gross) = 81,600 Btu/gal (net)
Aviation gasoline	120,200 Btu/gal (gross) = 112,000 Btu/gal (net)
Liquefied petroleum gas (LPG)	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)
Liquefied natural gas (LNG)	23,700 Btu/lb (gross) = 20,900 Btu/lb (net)
Compressed natural gas (CNG)	22,500 Btu/lb (gross) = 20,200 Btu/lb (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	
Production average	19.880 x 10 ⁶ Btu/short ton
Consumption average	19.499 x 10 ⁶ Btu/short ton

Note: Heat content values are approximate. Data are rounded to the nearest hundred.

Table B.5
Fuel Equivalents

1 million bbl crude oil/day	= 0.365 billion bbl crude oil/year = 2.089 quadrillion Btu/year = 107.110 million short tons coal/year = 97.170 million metric tons coal/year = 2.016 trillion ft ³ natural gas/year = 2,203 petajoules/year
1 billion bbl crude oil/year	= 2.740 million bbl crude oil/day = 5.722 quadrillion Btu/year = 293.451 million short tons coal/year = 266.219 million metric tons coal/year = 5.523 trillion ft ³ natural gas/year = 6,037 petajoules/year
1 quadrillion Btu/year	= 8.000 million gasoline gallon equivalents = 0.479 million bbl crude oil/day = 174.764 million bbl crude oil/year = 51.285 million short tons coal/year = 46.525 million metric tons coal/year = 965.251 billion ft ³ natural gas/year = 1,055 petajoules/year
1 billion short tons coal/year	= 0.907 billion metric tons coal/year = 9.336 million bbl crude oil/day = 3.408 billion bbl crude oil/year = 19.499 quadrillion Btu/year = 18.821 trillion ft ³ natural gas/year = 20,572 petajoules/year
1 billion metric tons coal/year	= 1.102 billion short tons coal/year = 8.470 million bbl crude oil/day = 3.091 billion bbl crude oil/year = 17.689 quadrillion Btu/year = 17.075 trillion ft ³ natural gas/year = 18,662 petajoules/year
1 trillion ft ³ natural gas/year	= 0.496 million bbl crude oil/day = 0.181 billion bbl crude oil/year = 1.036 quadrillion Btu/year = 53.131 million short tons coal/year = 48.200 million metric tons coal/year = 1,093 petajoules/year
1 petajoule/year	= 453.844 bbl crude oil/day = 165.653 thousand bbl crude oil/year = 0.948 trillion Btu/year = 48.661 thousand short tons coal/year = 44.100 thousand metric tons coal/year = 0.915 billion ft ³ natural gas/year

Table B.6
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

^aThis figure does not take into account the fact that electricity generation and distribution efficiency is approximately 33%. If generation and distribution efficiency are taken into account, 1 kWhr = 10,339 Btu.

Table B.7
International Energy Conversions

To:	Petajoules	Giga-calories	Million metric tons of oil equivalent	Million Btu	Gigawatt-hours
From:	<i>multiply by:</i>				
Petajoules	1	238.8 x 10 ³	2.388 x 10 ⁻²	947.8 x 10 ³	277.8
Gigacalories	4.1868 x 10 ⁻⁶	1	10 ⁻⁷	3.968	1.163 x 10 ⁻³
Million metric tons of oil equivalent	41.868	10 ⁷	1	3.968 x 10 ⁷	11,630
Million Btu	1.0551 x 10 ⁻⁶	0.252	2.52 X 10 ⁻⁸	1	2.931 x 10 ⁻⁴
Gigawatthours	3.6 x 10 ⁻³	860	8.6 x 10 ⁻⁵	3412	1

Table B.8
Distance and Velocity Conversions

1 in	= 83.33 x 10 ⁻³ ft	1 ft	= 12.0 in
	= 27.78 x 10 ⁻³ yd		= 0.33 yd
	= 15.78 x 10 ⁻⁶ mile		= 189.4 x 10 ⁻³ mile
	= 25.40 x 10 ⁻³ m		= 0.3048 m
	= 0.2540 x 10 ⁻⁶ km		= 0.3048 x 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.9
Alternative Measures of Greenhouse Gases

1 pound methane, measured in carbon units (CH ₄)	=	1.333 pounds methane, measured at full molecular weight (CH ₄)
1 pound carbon dioxide, measured in carbon units (CO ₂ -C)	=	3.6667 pounds carbon dioxide, measured at full molecular weight (CO ₂)
1 pound carbon monoxide, measured in carbon units (CO-C)	=	2.333 pounds carbon monoxide, measured at full molecular weight (CO)
1 pound nitrous oxide, measured in nitrogen units (N ₂ O-N)	=	1.571 pounds nitrous oxide, measured at full molecular weight (N ₂ O)

Table B.10
Volume and Flow Rate Conversions^a

A U.S. gallon of gasoline weighs 6.2 pounds			
1 U.S. gal	= 231 in ³ = 0.1337 ft ³ = 3.785 liters = 0.8327 imperial gal = 0.0238 bbl = 0.003785 m ³	1 liter	= 61.02 in ³ = 3.531 x 10 ⁻² ft ³ = 0.2642 U.S. gal = 0.2200 imperial gal = 6.29 x 10 ⁻³ bbl = 0.001 m ³
1 imperial gal	= 277.4 in ³ = 0.1605 ft ³ = 4.546 liters = 1.201 U.S. gal = 0.0286 bbl = 0.004546 m ³	1 bbl	= 9702 in ³ = 5.615 ft ³ = 158.97 liters = 42 U.S. gal = 34.97 imperial gal = 0.15898 m ³
1 U.S. gal/hr	= 3.208 ft ³ /day = 90.85 liter/day = 19.78 imperial gal/day = 0.5714 bbl/day		= 1171 ft ³ /year = 33160 liter/year = 7220 imperial gal/year = 208.57 bbl/year
1 liter/hr	= 0.8476 ft ³ /day = 6.340 U.S. gal/day = 5.28 imperial gal/day = 0.1510 bbl/day		= 309.3 ft ³ /year = 2308 U.S. gal/year = 1927 imperial gal/year = 55.10 bbl/year
1 bbl/hr	= 134.7 ft ³ /day = 1008 U.S. gal/day = 839.3 imperial gal/day = 3816 liter/day		= 49184 ft ³ /year = 3.679 x 10 ⁵ U.S. gal/year = 3.063 x 10 ⁵ imperial gal/year = 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. Conversions to/from barrels (bbl) are based on barrels of petroleum.

Table B.11
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.12
Mass Conversions

FROM	TO				
	Pound	Kilogram	Short ton	Long ton	Metric ton
Pound	1	0.4536	5.0×10^{-4}	4.4643×10^{-4}	4.5362×10^{-4}
Kilogram	2.205	1	1.1023×10^{-3}	9.8425×10^{-4}	1.0×10^{-3}
Short ton	2,000	907.2	1	0.8929	0.9072
Long ton	2,240	1,106	1.12	1	1.016
Metric ton	2,205	1,000	1.102	0.9842	1

Table B.13
Fuel Efficiency Conversions

MPG	Miles/liter	Kilometers/L	L/100 kilometers	Grams of CO ₂ per mile ^a	Pounds of CO ₂ per mile ^a
10	2.64	4.25	23.52	877.80	1.94
15	3.96	6.38	15.68	585.20	1.29
20	5.28	8.50	11.76	438.90	0.97
25	6.60	10.63	9.41	351.12	0.78
30	7.92	12.75	7.84	292.60	0.65
35	9.25	14.88	6.72	250.80	0.55
40	10.57	17.00	5.88	219.45	0.49
45	11.89	19.13	5.23	195.07	0.43
50	13.21	21.25	4.70	175.56	0.39
55	14.53	23.38	4.28	159.60	0.35
60	15.85	25.51	3.92	146.30	0.32
65	17.17	27.63	3.62	135.05	0.30
70	18.49	29.76	3.36	125.40	0.28
75	19.81	31.88	3.14	117.04	0.26
80	21.13	34.01	2.94	109.73	0.24
85	22.45	36.13	2.77	103.27	0.23
90	23.77	38.26	2.61	97.53	0.22
95	25.09	40.38	2.48	92.40	0.20
100	26.42	42.51	2.35	87.78	0.19
105	27.74	44.64	2.24	83.60	0.18
110	29.06	46.76	2.14	79.80	0.18
115	30.38	48.89	2.05	76.33	0.17
120	31.70	51.01	1.96	73.15	0.16
125	33.02	53.14	1.88	70.22	0.16
130	34.34	55.26	1.81	67.52	0.15
135	35.66	57.39	1.74	65.02	0.14
140	36.98	59.51	1.68	62.70	0.14
145	38.30	61.64	1.62	60.54	0.13
150	39.62	63.76	1.57	58.52	0.13
Formula	MPG/3.785	MPG/[3.785/1.609]	235.24/MPG	8,778/MPG	19.4/MPG

^a For gasoline-fueled vehicles.

Table B.14
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

^aCare 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.15
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

Table B.16
Carbon Coefficients
(Million metric tons carbon per quadrillion Btu)

Energy Source	Fuel Type	Carbon Coefficients
Coal	Anthracite	28.28
	Bituminous	25.45
	Subbituminous	26.51
	Lignite	26.65
	Coke	31.12
	Coal (All types)	26.00
Natural gas	Natural Gas	14.47
	Flared natural gas	14.92
	Propane	17.20
	Butane	17.71
	Butane/Propane Mix	17.46
Petroleum	Gasoline	19.45
	Diesel fuel	19.95
	Jet Fuel	19.34
	Aviation Gas	18.87
	Kerosene	19.72
	Residual Heating Fuel	21.49
	Petroleum coke	27.85
	Asphalt and Road Oil	20.62
	Lubricants	20.24
	Petrochemical Feedstocks	19.37
	Special Naphthas (solvents)	19.85
	Waxes	19.81
	Other petroleum & miscellaneous	19.81

Note: Additional information:

www.eia.gov/environment/emissions/co2_vol_mass.cfm

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 2010 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.17 and Table B.18). Table B.17 shows conversion factors for the Consumer Price Index inflation factors. Table B.18 shows conversion factors using the Gross National Product Implicit Price Deflator.

Table B.17
Consumer Price Inflation (CPI) Index

From:	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
1970	1.000	1.044	1.077	1.144	1.271	1.387	1.466	1.562	1.680	1.871
1971	0.958	1.000	1.032	1.096	1.217	1.328	1.405	1.496	1.610	1.793
1972	0.928	0.969	1.000	1.062	1.179	1.287	1.361	1.450	1.560	1.737
1973	0.874	0.912	0.941	1.000	1.110	1.212	1.282	1.365	1.468	1.635
1974	0.787	0.822	0.848	0.901	1.000	1.091	1.154	1.229	1.323	1.473
1975	0.721	0.753	0.777	0.825	0.916	1.000	1.058	1.126	1.212	1.349
1976	0.682	0.712	0.735	0.780	0.866	0.946	1.000	1.065	1.146	1.276
1977	0.640	0.668	0.690	0.733	0.814	0.888	0.939	1.000	1.076	1.198
1978	0.595	0.621	0.641	0.681	0.756	0.825	0.873	0.929	1.000	1.113
1979	0.534	0.558	0.576	0.612	0.679	0.741	0.784	0.835	0.898	1.000
1980	0.471	0.492	0.507	0.539	0.598	0.653	0.691	0.735	0.791	0.881
1981	0.427	0.446	0.460	0.488	0.542	0.592	0.626	0.667	0.717	0.799
1982	0.402	0.420	0.433	0.460	0.511	0.558	0.590	0.628	0.676	0.752
1983	0.390	0.407	0.420	0.446	0.495	0.540	0.571	0.608	0.655	0.729
1984	0.373	0.390	0.402	0.427	0.474	0.518	0.548	0.583	0.628	0.699
1985	0.361	0.376	0.388	0.413	0.458	0.500	0.529	0.563	0.606	0.675
1986	0.354	0.370	0.381	0.405	0.450	0.491	0.519	0.553	0.595	0.662
1987	0.342	0.357	0.368	0.391	0.434	0.474	0.501	0.533	0.574	0.639
1988	0.328	0.342	0.353	0.375	0.417	0.455	0.481	0.512	0.551	0.614
1989	0.313	0.327	0.337	0.358	0.398	0.434	0.459	0.489	0.526	0.585
1990	0.297	0.310	0.320	0.340	0.377	0.412	0.435	0.464	0.499	0.555
1991	0.285	0.297	0.307	0.326	0.362	0.395	0.418	0.445	0.479	0.533
1992	0.277	0.289	0.298	0.316	0.351	0.383	0.406	0.432	0.465	0.517
1993	0.269	0.280	0.289	0.307	0.341	0.372	0.394	0.419	0.451	0.502
1994	0.262	0.273	0.282	0.300	0.333	0.363	0.384	0.409	0.440	0.490
1995	0.255	0.266	0.274	0.291	0.323	0.353	0.373	0.398	0.428	0.476
1996	0.247	0.258	0.266	0.283	0.314	0.343	0.363	0.386	0.416	0.463
1997	0.242	0.252	0.260	0.277	0.307	0.335	0.355	0.378	0.406	0.452
1998	0.238	0.248	0.256	0.272	0.302	0.330	0.349	0.372	0.400	0.445
1999	0.233	0.243	0.251	0.267	0.296	0.323	0.342	0.364	0.391	0.436
2000	0.225	0.235	0.243	0.258	0.286	0.312	0.330	0.352	0.379	0.422
2001	0.219	0.229	0.236	0.251	0.278	0.304	0.321	0.342	0.368	0.410
2002	0.216	0.225	0.232	0.247	0.274	0.299	0.316	0.337	0.362	0.404
2003	0.211	0.220	0.227	0.241	0.268	0.292	0.309	0.329	0.354	0.395
2004	0.205	0.214	0.221	0.235	0.261	0.285	0.301	0.321	0.345	0.384
2005	0.199	0.207	0.214	0.227	0.252	0.275	0.291	0.310	0.334	0.372
2006	0.192	0.201	0.207	0.220	0.245	0.267	0.282	0.301	0.323	0.360
2007	0.187	0.195	0.202	0.214	0.238	0.259	0.274	0.292	0.314	0.350
2008	0.180	0.188	0.194	0.206	0.229	0.250	0.264	0.281	0.303	0.337
2009	0.181	0.189	0.195	0.207	0.230	0.251	0.265	0.282	0.304	0.338
2010	0.178	0.186	0.192	0.204	0.226	0.247	0.261	0.278	0.299	0.333
2011	0.172	0.180	0.186	0.197	0.219	0.239	0.253	0.269	0.290	0.323
2012	0.169	0.176	0.182	0.193	0.215	0.234	0.248	0.264	0.284	0.316
2013	0.167	0.174	0.179	0.191	0.212	0.231	0.244	0.260	0.280	0.312
2014	0.164	0.171	0.177	0.188	0.208	0.227	0.240	0.256	0.275	0.307
2015	0.164	0.171	0.176	0.187	0.208	0.227	0.240	0.256	0.275	0.306

Table B.17
Consumer Price Inflation (CPI) Index (Continued)

From:	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
1970	2.124	2.343	2.487	2.567	2.678	2.773	2.825	2.928	3.049	3.196
1971	2.035	2.244	2.383	2.459	2.565	2.657	2.706	2.805	2.921	3.062
1972	1.971	2.175	2.309	2.383	2.486	2.574	2.622	2.718	2.830	2.967
1973	1.856	2.047	2.173	2.243	2.340	2.423	2.468	2.559	2.664	2.793
1974	1.671	1.844	1.957	2.020	2.108	2.183	2.223	2.304	2.400	2.515
1975	1.532	1.690	1.794	1.851	1.931	2.000	2.037	2.112	2.199	2.305
1976	1.448	1.598	1.696	1.750	1.826	1.891	1.926	1.996	2.079	2.179
1977	1.360	1.500	1.592	1.644	1.715	1.776	1.809	1.875	1.952	2.046
1978	1.264	1.394	1.480	1.528	1.594	1.650	1.681	1.742	1.814	1.902
1979	1.135	1.252	1.329	1.372	1.431	1.482	1.510	1.565	1.629	1.708
1980	1.000	1.103	1.171	1.209	1.261	1.306	1.330	1.379	1.436	1.505
1981	0.906	1.000	1.062	1.096	1.143	1.184	1.206	1.250	1.301	1.364
1982	0.854	0.942	1.000	1.032	1.077	1.115	1.136	1.177	1.226	1.285
1983	0.827	0.913	0.969	1.000	1.043	1.080	1.100	1.141	1.188	1.245
1984	0.793	0.875	0.929	0.959	1.000	1.036	1.055	1.093	1.139	1.193
1985	0.766	0.845	0.897	0.926	0.966	1.000	1.019	1.056	1.099	1.152
1986	0.752	0.829	0.880	0.909	0.948	0.982	1.000	1.036	1.079	1.131
1987	0.725	0.800	0.849	0.877	0.915	0.947	0.965	1.000	1.041	1.092
1988	0.697	0.768	0.816	0.842	0.878	0.910	0.926	0.960	1.000	1.048
1989	0.665	0.733	0.778	0.803	0.838	0.868	0.884	0.916	0.954	1.000
1990	0.630	0.695	0.738	0.762	0.795	0.823	0.839	0.869	0.905	0.949
1991	0.605	0.667	0.709	0.731	0.763	0.790	0.805	0.834	0.869	0.910
1992	0.587	0.648	0.688	0.710	0.741	0.767	0.781	0.810	0.843	0.884
1993	0.570	0.629	0.668	0.689	0.719	0.745	0.758	0.786	0.819	0.858
1994	0.556	0.613	0.651	0.672	0.701	0.726	0.740	0.767	0.798	0.837
1995	0.541	0.596	0.633	0.654	0.682	0.706	0.719	0.745	0.776	0.814
1996	0.525	0.579	0.615	0.635	0.662	0.686	0.699	0.724	0.754	0.790
1997	0.513	0.566	0.601	0.621	0.647	0.670	0.683	0.708	0.737	0.773
1998	0.506	0.558	0.592	0.611	0.637	0.660	0.672	0.697	0.726	0.761
1999	0.495	0.546	0.579	0.598	0.624	0.646	0.658	0.682	0.710	0.744
2000	0.479	0.528	0.560	0.578	0.603	0.625	0.636	0.660	0.687	0.720
2001	0.465	0.513	0.545	0.562	0.587	0.608	0.619	0.641	0.668	0.700
2002	0.458	0.505	0.536	0.554	0.578	0.598	0.609	0.631	0.658	0.689
2003	0.448	0.494	0.524	0.541	0.565	0.585	0.596	0.617	0.643	0.674
2004	0.436	0.481	0.511	0.527	0.550	0.570	0.580	0.601	0.626	0.656
2005	0.422	0.465	0.494	0.510	0.532	0.551	0.561	0.582	0.606	0.635
2006	0.409	0.451	0.479	0.494	0.515	0.534	0.544	0.563	0.587	0.615
2007	0.397	0.438	0.465	0.480	0.501	0.519	0.529	0.548	0.571	0.598
2008	0.383	0.422	0.448	0.463	0.483	0.500	0.509	0.528	0.549	0.576
2009	0.384	0.424	0.450	0.464	0.484	0.502	0.511	0.530	0.551	0.578
2010	0.378	0.417	0.443	0.457	0.476	0.493	0.503	0.521	0.543	0.569
2011	0.366	0.404	0.429	0.443	0.462	0.478	0.487	0.505	0.526	0.551
2012	0.359	0.396	0.420	0.434	0.453	0.469	0.477	0.495	0.515	0.540
2013	0.354	0.390	0.414	0.428	0.446	0.462	0.470	0.488	0.508	0.532
2014	0.348	0.384	0.408	0.421	0.439	0.455	0.463	0.480	0.500	0.524
2015	0.348	0.384	0.407	0.420	0.438	0.454	0.462	0.479	0.499	0.523

Table B.17
Consumer Price Inflation (CPI) Index (Continued)

From:	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1970	3.369	3.510	3.616	3.724	3.820	3.928	4.044	4.137	4.201	4.294
1971	3.227	3.363	3.464	3.568	3.659	3.763	3.874	3.963	4.025	4.114
1972	3.127	3.258	3.356	3.457	3.545	3.646	3.754	3.840	3.900	3.986
1973	2.944	3.068	3.160	3.255	3.338	3.432	3.534	3.615	3.671	3.752
1974	2.651	2.763	2.846	2.931	3.006	3.091	3.183	3.256	3.306	3.379
1975	2.429	2.532	2.608	2.686	2.755	2.833	2.916	2.983	3.030	3.097
1976	2.297	2.394	2.466	2.540	2.605	2.678	2.757	2.821	2.865	2.928
1977	2.157	2.248	2.315	2.384	2.446	2.515	2.589	2.649	2.690	2.749
1978	2.005	2.089	2.152	2.216	2.273	2.337	2.406	2.462	2.500	2.555
1979	1.800	1.876	1.933	1.990	2.041	2.099	2.161	2.211	2.245	2.295
1980	1.586	1.653	1.703	1.754	1.799	1.850	1.904	1.948	1.978	2.022
1981	1.438	1.498	1.543	1.590	1.630	1.677	1.726	1.766	1.793	1.833
1982	1.354	1.411	1.454	1.497	1.536	1.579	1.626	1.663	1.689	1.726
1983	1.312	1.367	1.409	1.451	1.488	1.530	1.575	1.611	1.637	1.673
1984	1.258	1.311	1.350	1.391	1.426	1.467	1.510	1.545	1.569	1.603
1985	1.215	1.266	1.304	1.343	1.377	1.416	1.458	1.492	1.515	1.548
1986	1.193	1.243	1.280	1.318	1.352	1.391	1.432	1.464	1.487	1.520
1987	1.151	1.199	1.235	1.272	1.305	1.342	1.381	1.413	1.435	1.467
1988	1.105	1.151	1.186	1.221	1.253	1.288	1.326	1.357	1.378	1.408
1989	1.054	1.098	1.131	1.165	1.195	1.229	1.265	1.294	1.315	1.344
1990	1.000	1.042	1.073	1.106	1.134	1.166	1.200	1.228	1.247	1.275
1991	0.960	1.000	1.030	1.061	1.088	1.119	1.152	1.178	1.197	1.223
1992	0.932	0.971	1.000	1.030	1.056	1.086	1.118	1.144	1.162	1.187
1993	0.904	0.943	0.971	1.000	1.026	1.055	1.086	1.111	1.128	1.153
1994	0.882	0.919	0.947	0.975	1.000	1.028	1.059	1.083	1.100	1.124
1995	0.858	0.894	0.921	0.948	0.972	1.000	1.030	1.053	1.070	1.093
1996	0.833	0.868	0.894	0.921	0.945	0.971	1.000	1.023	1.039	1.062
1997	0.814	0.849	0.874	0.900	0.923	0.950	0.978	1.000	1.016	1.038
1998	0.802	0.836	0.861	0.887	0.909	0.935	0.963	0.985	1.000	1.022
1999	0.785	0.818	0.842	0.867	0.890	0.915	0.942	0.963	0.978	1.000
2000	0.759	0.791	0.815	0.839	0.861	0.885	0.911	0.932	0.947	0.967
2001	0.738	0.769	0.792	0.816	0.837	0.861	0.886	0.906	0.920	0.941
2002	0.727	0.757	0.780	0.803	0.824	0.847	0.872	0.892	0.906	0.926
2003	0.710	0.740	0.763	0.785	0.805	0.828	0.853	0.872	0.886	0.905
2004	0.692	0.721	0.743	0.765	0.785	0.807	0.831	0.850	0.863	0.882
2005	0.669	0.697	0.718	0.740	0.759	0.780	0.803	0.822	0.835	0.853
2006	0.648	0.676	0.696	0.717	0.735	0.756	0.778	0.796	0.809	0.826
2007	0.630	0.657	0.677	0.697	0.715	0.735	0.757	0.774	0.786	0.804
2008	0.607	0.633	0.652	0.671	0.688	0.708	0.729	0.745	0.757	0.774
2009	0.609	0.635	0.654	0.674	0.691	0.710	0.731	0.748	0.760	0.777
2010	0.599	0.625	0.643	0.663	0.680	0.699	0.720	0.736	0.748	0.764
2011	0.581	0.605	0.624	0.642	0.659	0.678	0.698	0.714	0.725	0.741
2012	0.569	0.593	0.611	0.629	0.645	0.664	0.683	0.699	0.710	0.726
2013	0.561	0.585	0.602	0.620	0.636	0.654	0.674	0.689	0.700	0.715
2014	0.552	0.575	0.593	0.610	0.626	0.644	0.663	0.678	0.689	0.704
2015	0.551	0.575	0.592	0.610	0.625	0.643	0.662	0.677	0.688	0.703

Table B.17
Consumer Price Inflation (CPI) Index (Continued)

From:	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
1970	4.438	4.564	4.637	4.742	4.869	5.034	5.196	5.344	5.549	5.529
1971	4.252	4.373	4.442	4.543	4.664	4.822	4.978	5.120	5.316	5.297
1972	4.120	4.237	4.304	4.402	4.519	4.672	4.823	4.960	5.151	5.132
1973	3.878	3.989	4.052	4.144	4.255	4.399	4.541	4.670	4.849	4.832
1974	3.493	3.592	3.649	3.732	3.832	3.961	4.089	4.206	4.367	4.352
1975	3.201	3.292	3.344	3.420	3.511	3.630	3.747	3.854	4.002	3.988
1976	3.026	3.112	3.162	3.234	3.320	3.432	3.543	3.644	3.784	3.770
1977	2.842	2.922	2.969	3.036	3.117	3.223	3.327	3.421	3.553	3.540
1978	2.641	2.716	2.759	2.822	2.897	2.995	3.092	3.180	3.302	3.290
1979	2.372	2.439	2.478	2.534	2.602	2.690	2.777	2.856	2.966	2.955
1980	2.090	2.149	2.183	2.233	2.292	2.370	2.447	2.516	2.613	2.604
1981	1.894	1.948	1.979	2.024	2.078	2.149	2.218	2.281	2.369	2.360
1982	1.784	1.835	1.864	1.907	1.958	2.024	2.089	2.149	2.231	2.223
1983	1.729	1.778	1.806	1.847	1.897	1.961	2.024	2.082	2.162	2.154
1984	1.657	1.705	1.731	1.771	1.818	1.880	1.940	1.996	2.072	2.065
1985	1.600	1.646	1.672	1.710	1.756	1.815	1.874	1.927	2.001	1.994
1986	1.571	1.616	1.641	1.679	1.724	1.782	1.839	1.892	1.964	1.957
1987	1.516	1.559	1.584	1.620	1.663	1.719	1.775	1.825	1.895	1.889
1988	1.456	1.497	1.521	1.555	1.597	1.651	1.704	1.753	1.820	1.813
1989	1.389	1.428	1.451	1.484	1.523	1.575	1.626	1.672	1.736	1.730
1990	1.318	1.355	1.376	1.408	1.445	1.494	1.542	1.586	1.647	1.641
1991	1.264	1.300	1.321	1.351	1.387	1.434	1.480	1.522	1.581	1.575
1992	1.227	1.262	1.282	1.311	1.346	1.392	1.437	1.478	1.535	1.529
1993	1.192	1.226	1.245	1.273	1.307	1.352	1.395	1.435	1.490	1.485
1994	1.162	1.195	1.214	1.242	1.275	1.318	1.360	1.399	1.453	1.448
1995	1.130	1.162	1.180	1.207	1.240	1.281	1.323	1.360	1.413	1.408
1996	1.098	1.129	1.147	1.173	1.204	1.245	1.285	1.321	1.372	1.367
1997	1.073	1.103	1.121	1.146	1.177	1.217	1.256	1.292	1.341	1.337
1998	1.056	1.087	1.104	1.129	1.159	1.198	1.237	1.272	1.321	1.316
1999	1.034	1.063	1.080	1.104	1.134	1.172	1.210	1.245	1.292	1.288
2000	1.000	1.028	1.045	1.069	1.097	1.134	1.171	1.204	1.250	1.246
2001	0.972	1.000	1.016	1.039	1.067	1.103	1.138	1.171	1.216	1.211
2002	0.957	0.984	1.000	1.023	1.050	1.086	1.121	1.153	1.197	1.193
2003	0.936	0.963	0.978	1.000	1.027	1.061	1.096	1.127	1.170	1.166
2004	0.912	0.938	0.952	0.974	1.000	1.034	1.067	1.098	1.140	1.136
2005	0.882	0.907	0.921	0.942	0.967	1.000	1.032	1.062	1.102	1.098
2006	0.854	0.878	0.892	0.913	0.937	0.969	1.000	1.028	1.068	1.064
2007	0.831	0.854	0.868	0.887	0.911	0.942	0.972	1.000	1.038	1.035
2008	0.800	0.823	0.836	0.855	0.877	0.907	0.936	0.963	1.000	0.996
2009	0.803	0.825	0.839	0.858	0.881	0.910	0.940	0.966	1.004	1.000
2010	0.790	0.812	0.825	0.844	0.866	0.896	0.925	0.951	0.987	0.984
2011	0.766	0.787	0.800	0.818	0.840	0.868	0.896	0.922	0.957	0.954
2012	0.750	0.771	0.784	0.801	0.823	0.851	0.878	0.903	0.938	0.934
2013	0.739	0.760	0.772	0.790	0.811	0.838	0.865	0.890	0.924	0.921
2014	0.727	0.748	0.760	0.777	0.798	0.825	0.852	0.876	0.909	0.906
2015	0.727	0.747	0.759	0.776	0.797	0.824	0.851	0.875	0.908	0.905

Table B.17
Consumer Price Inflation (CPI) Index (Continued)

From:	2010	2011	2012	2013	2014	2015
1970	5.620	5.797	5.917	6.004	6.101	6.109
1971	5.384	5.554	5.669	5.752	5.845	5.852
1972	5.217	5.381	5.493	5.573	5.664	5.670
1973	4.911	5.066	5.171	5.247	5.332	5.338
1974	4.423	4.563	4.657	4.725	4.802	4.808
1975	4.053	4.181	4.268	4.330	4.400	4.406
1976	3.832	3.953	4.035	4.094	4.161	4.166
1977	3.598	3.712	3.789	3.844	3.907	3.911
1978	3.344	3.450	3.521	3.573	3.631	3.635
1979	3.004	3.098	3.162	3.209	3.261	3.265
1980	2.646	2.730	2.786	2.827	2.873	2.876
1981	2.399	2.475	2.526	2.563	2.604	2.607
1982	2.260	2.331	2.379	2.414	2.453	2.456
1983	2.189	2.258	2.305	2.339	2.377	2.380
1984	2.099	2.165	2.210	2.242	2.278	2.281
1985	2.027	2.091	2.134	2.165	2.200	2.203
1986	1.990	2.052	2.095	2.126	2.160	2.163
1987	1.920	1.980	2.021	2.051	2.084	2.086
1988	1.843	1.901	1.941	1.969	2.001	2.004
1989	1.759	1.814	1.852	1.879	1.909	1.911
1990	1.668	1.721	1.757	1.782	1.811	1.813
1991	1.601	1.652	1.686	1.710	1.738	1.740
1992	1.554	1.603	1.636	1.660	1.687	1.689
1993	1.509	1.557	1.589	1.612	1.638	1.640
1994	1.471	1.518	1.549	1.572	1.597	1.599
1995	1.431	1.476	1.507	1.529	1.553	1.555
1996	1.390	1.434	1.463	1.485	1.509	1.511
1997	1.359	1.401	1.430	1.451	1.475	1.477
1998	1.338	1.380	1.409	1.429	1.452	1.454
1999	1.309	1.350	1.378	1.398	1.421	1.423
2000	1.266	1.306	1.333	1.353	1.375	1.376
2001	1.231	1.270	1.296	1.315	1.337	1.338
2002	1.212	1.250	1.276	1.295	1.316	1.317
2003	1.185	1.222	1.248	1.266	1.287	1.288
2004	1.154	1.191	1.215	1.233	1.253	1.255
2005	1.117	1.152	1.176	1.193	1.212	1.214
2006	1.082	1.116	1.139	1.156	1.174	1.176
2007	1.052	1.085	1.107	1.124	1.142	1.143
2008	1.013	1.045	1.066	1.082	1.100	1.101
2009	1.016	1.048	1.070	1.086	1.103	1.105
2010	1.000	1.032	1.053	1.068	1.086	1.087
2011	0.969	1.000	1.021	1.036	1.052	1.054
2012	0.950	0.980	1.000	1.015	1.031	1.032
2013	0.936	0.966	0.986	1.000	1.016	1.017
2014	0.921	0.950	0.970	0.984	1.000	1.001
2015	0.920	0.949	0.969	0.983	0.999	1.000

Source:

U.S. Bureau of Labor Statistics.

Table B.18
Gross National Product Implicit Price Deflator

From:	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
1970	1.000	1.051	1.097	1.156	1.260	1.377	1.453	1.543	1.651	1.788
1971	0.952	1.000	1.043	1.100	1.199	1.310	1.382	1.468	1.571	1.701
1972	0.912	0.958	1.000	1.055	1.149	1.256	1.325	1.407	1.506	1.630
1973	0.865	0.909	0.948	1.000	1.090	1.191	1.256	1.334	1.428	1.546
1974	0.794	0.834	0.870	0.918	1.000	1.093	1.153	1.224	1.311	1.419
1975	0.726	0.763	0.796	0.840	0.915	1.000	1.055	1.121	1.199	1.298
1976	0.688	0.723	0.755	0.796	0.867	0.948	1.000	1.062	1.137	1.231
1977	0.648	0.681	0.711	0.749	0.817	0.892	0.942	1.000	1.070	1.159
1978	0.606	0.636	0.664	0.700	0.763	0.834	0.880	0.934	1.000	1.083
1979	0.559	0.588	0.613	0.647	0.705	0.770	0.813	0.863	0.924	1.000
1980	0.513	0.539	0.563	0.593	0.647	0.707	0.745	0.792	0.847	0.917
1981	0.469	0.493	0.515	0.543	0.591	0.646	0.682	0.724	0.775	0.839
1982	0.442	0.464	0.485	0.511	0.557	0.608	0.642	0.682	0.730	0.790
1983	0.425	0.447	0.466	0.492	0.536	0.585	0.617	0.656	0.702	0.760
1984	0.411	0.431	0.450	0.475	0.517	0.565	0.596	0.633	0.678	0.734
1985	0.398	0.418	0.436	0.460	0.501	0.548	0.578	0.614	0.657	0.711
1986	0.390	0.410	0.428	0.451	0.491	0.537	0.566	0.602	0.644	0.697
1987	0.380	0.399	0.417	0.440	0.479	0.523	0.552	0.586	0.628	0.679
1988	0.367	0.386	0.403	0.425	0.463	0.506	0.533	0.567	0.606	0.656
1989	0.353	0.371	0.388	0.409	0.445	0.487	0.513	0.545	0.584	0.632
1990	0.341	0.358	0.374	0.394	0.429	0.469	0.495	0.526	0.563	0.609
1991	0.330	0.346	0.362	0.381	0.415	0.454	0.479	0.509	0.544	0.589
1992	0.322	0.339	0.353	0.373	0.406	0.444	0.468	0.497	0.532	0.576
1993	0.315	0.331	0.345	0.364	0.397	0.434	0.457	0.486	0.520	0.563
1994	0.308	0.324	0.338	0.357	0.389	0.425	0.448	0.476	0.509	0.551
1995	0.302	0.317	0.331	0.349	0.381	0.416	0.439	0.466	0.499	0.540
1996	0.297	0.312	0.325	0.343	0.374	0.408	0.431	0.458	0.490	0.530
1997	0.292	0.306	0.320	0.337	0.367	0.401	0.424	0.450	0.481	0.521
1998	0.288	0.303	0.316	0.334	0.363	0.397	0.419	0.445	0.476	0.516
1999	0.284	0.299	0.312	0.329	0.358	0.392	0.413	0.439	0.470	0.508
2000	0.278	0.292	0.305	0.322	0.350	0.383	0.404	0.429	0.459	0.497
2001	0.272	0.286	0.298	0.314	0.343	0.374	0.395	0.419	0.449	0.486
2002	0.268	0.281	0.294	0.310	0.337	0.369	0.389	0.413	0.442	0.479
2003	0.262	0.276	0.288	0.303	0.331	0.361	0.381	0.405	0.433	0.469
2004	0.255	0.268	0.280	0.295	0.322	0.352	0.371	0.394	0.422	0.457
2005	0.248	0.260	0.271	0.286	0.312	0.341	0.360	0.382	0.409	0.442
2006	0.240	0.252	0.263	0.278	0.303	0.331	0.349	0.370	0.397	0.429
2007	0.234	0.246	0.256	0.270	0.295	0.322	0.340	0.361	0.386	0.418
2008	0.229	0.241	0.252	0.265	0.289	0.316	0.333	0.354	0.379	0.410
2009	0.228	0.239	0.250	0.263	0.287	0.313	0.331	0.351	0.376	0.407
2010	0.225	0.236	0.246	0.260	0.283	0.309	0.326	0.347	0.371	0.402
2011	0.220	0.232	0.242	0.255	0.278	0.303	0.320	0.340	0.364	0.394
2012	0.217	0.228	0.237	0.250	0.273	0.298	0.315	0.334	0.358	0.387
2013	0.213	0.224	0.234	0.247	0.269	0.294	0.310	0.329	0.352	0.381
2014	0.210	0.220	0.230	0.243	0.264	0.289	0.305	0.324	0.346	0.375
2015	0.207	0.217	0.226	0.239	0.260	0.284	0.300	0.319	0.341	0.369
2016	0.204	0.214	0.224	0.236	0.257	0.281	0.296	0.315	0.337	0.365

Table B.18
Gross National Product Implicit Price Deflator (Continued)

From:	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
1970	1.949	2.131	2.263	2.353	2.436	2.514	2.565	2.631	2.723	2.830
1971	1.854	2.028	2.153	2.239	2.318	2.392	2.441	2.504	2.591	2.693
1972	1.777	1.943	2.064	2.145	2.222	2.293	2.339	2.399	2.484	2.580
1973	1.685	1.843	1.957	2.034	2.107	2.174	2.218	2.275	2.355	2.447
1974	1.547	1.691	1.796	1.867	1.933	1.995	2.036	2.088	2.161	2.246
1975	1.415	1.548	1.644	1.709	1.769	1.826	1.863	1.911	1.978	2.055
1976	1.341	1.467	1.558	1.619	1.677	1.731	1.766	1.811	1.875	1.948
1977	1.263	1.381	1.467	1.525	1.579	1.629	1.662	1.705	1.765	1.834
1978	1.180	1.290	1.370	1.425	1.475	1.522	1.553	1.593	1.649	1.714
1979	1.090	1.192	1.266	1.316	1.363	1.406	1.435	1.472	1.523	1.583
1980	1.000	1.093	1.161	1.207	1.250	1.290	1.316	1.350	1.398	1.452
1981	0.915	1.000	1.062	1.104	1.143	1.180	1.204	1.235	1.278	1.328
1982	0.861	0.942	1.000	1.040	1.076	1.111	1.133	1.163	1.203	1.250
1983	0.828	0.906	0.962	1.000	1.035	1.069	1.090	1.118	1.158	1.203
1984	0.800	0.875	0.929	0.966	1.000	1.032	1.053	1.080	1.118	1.162
1985	0.775	0.848	0.900	0.936	0.969	1.000	1.020	1.047	1.083	1.126
1986	0.760	0.831	0.882	0.917	0.950	0.980	1.000	1.026	1.062	1.103
1987	0.741	0.810	0.860	0.894	0.926	0.956	0.975	1.000	1.035	1.075
1988	0.716	0.782	0.831	0.864	0.895	0.923	0.942	0.966	1.000	1.039
1989	0.689	0.753	0.800	0.831	0.861	0.888	0.906	0.930	0.962	1.000
1990	0.664	0.726	0.771	0.802	0.830	0.857	0.874	0.897	0.928	0.964
1991	0.643	0.703	0.746	0.776	0.803	0.829	0.846	0.867	0.898	0.933
1992	0.628	0.687	0.730	0.758	0.785	0.810	0.827	0.848	0.878	0.912
1993	0.614	0.671	0.713	0.741	0.767	0.792	0.808	0.828	0.858	0.891
1994	0.601	0.657	0.698	0.725	0.751	0.775	0.791	0.811	0.840	0.872
1995	0.588	0.644	0.683	0.710	0.736	0.759	0.775	0.795	0.822	0.855
1996	0.578	0.632	0.671	0.698	0.722	0.746	0.761	0.780	0.808	0.839
1997	0.568	0.621	0.660	0.686	0.710	0.733	0.748	0.767	0.794	0.825
1998	0.562	0.615	0.653	0.679	0.703	0.725	0.740	0.759	0.786	0.816
1999	0.554	0.606	0.644	0.669	0.693	0.715	0.729	0.748	0.774	0.805
2000	0.542	0.592	0.629	0.654	0.677	0.699	0.713	0.732	0.757	0.787
2001	0.530	0.579	0.615	0.639	0.662	0.683	0.697	0.715	0.740	0.769
2002	0.522	0.570	0.606	0.630	0.652	0.673	0.687	0.704	0.729	0.757
2003	0.511	0.559	0.594	0.617	0.639	0.660	0.673	0.691	0.715	0.743
2004	0.498	0.544	0.578	0.601	0.622	0.642	0.655	0.672	0.696	0.723
2005	0.482	0.527	0.560	0.582	0.603	0.622	0.635	0.651	0.674	0.700
2006	0.468	0.512	0.543	0.565	0.585	0.604	0.616	0.632	0.654	0.679
2007	0.456	0.498	0.529	0.550	0.570	0.588	0.600	0.615	0.637	0.662
2008	0.447	0.489	0.519	0.540	0.559	0.577	0.588	0.604	0.625	0.649
2009	0.444	0.485	0.515	0.536	0.555	0.572	0.584	0.599	0.620	0.644
2010	0.438	0.479	0.508	0.529	0.547	0.565	0.576	0.591	0.612	0.636
2011	0.429	0.469	0.499	0.518	0.537	0.554	0.565	0.580	0.600	0.623
2012	0.422	0.461	0.490	0.509	0.527	0.544	0.555	0.570	0.590	0.613
2013	0.416	0.455	0.483	0.502	0.520	0.536	0.547	0.561	0.581	0.604
2014	0.409	0.447	0.475	0.493	0.511	0.527	0.538	0.552	0.571	0.593
2015	0.402	0.440	0.467	0.486	0.503	0.519	0.530	0.543	0.562	0.584
2016	0.397	0.435	0.461	0.480	0.497	0.513	0.523	0.537	0.555	0.577

Table B.18
Gross National Product Implicit Price Deflator (Continued)

From:	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1970	2.935	3.033	3.102	3.176	3.243	3.311	3.372	3.429	3.467	3.517
1971	2.793	2.886	2.952	3.022	3.086	3.151	3.209	3.263	3.299	3.346
1972	2.676	2.766	2.829	2.896	2.958	3.020	3.075	3.128	3.162	3.207
1973	2.538	2.623	2.683	2.746	2.805	2.863	2.916	2.966	2.998	3.041
1974	2.329	2.407	2.462	2.520	2.574	2.628	2.676	2.722	2.751	2.791
1975	2.131	2.203	2.253	2.307	2.356	2.405	2.449	2.491	2.518	2.554
1976	2.020	2.088	2.135	2.186	2.233	2.279	2.321	2.361	2.387	2.421
1977	1.902	1.966	2.011	2.058	2.102	2.146	2.185	2.223	2.247	2.279
1978	1.777	1.837	1.879	1.923	1.964	2.005	2.042	2.077	2.099	2.130
1979	1.642	1.697	1.735	1.776	1.814	1.852	1.886	1.918	1.939	1.967
1980	1.506	1.556	1.592	1.630	1.664	1.699	1.730	1.760	1.779	1.805
1981	1.377	1.423	1.456	1.490	1.522	1.554	1.582	1.609	1.627	1.650
1982	1.297	1.340	1.371	1.403	1.433	1.463	1.490	1.516	1.532	1.554
1983	1.247	1.289	1.319	1.350	1.379	1.408	1.433	1.458	1.474	1.495
1984	1.205	1.245	1.273	1.304	1.331	1.359	1.384	1.408	1.423	1.444
1985	1.167	1.206	1.234	1.263	1.290	1.317	1.341	1.364	1.379	1.399
1986	1.144	1.182	1.209	1.238	1.264	1.291	1.315	1.337	1.352	1.371
1987	1.115	1.153	1.179	1.207	1.233	1.259	1.282	1.303	1.318	1.337
1988	1.078	1.114	1.139	1.166	1.191	1.216	1.238	1.259	1.273	1.291
1989	1.037	1.072	1.096	1.122	1.146	1.170	1.192	1.212	1.225	1.243
1990	1.000	1.033	1.057	1.082	1.105	1.128	1.149	1.169	1.181	1.198
1991	0.968	1.000	1.023	1.047	1.069	1.092	1.112	1.131	1.143	1.159
1992	0.946	0.978	1.000	1.024	1.046	1.067	1.087	1.106	1.118	1.134
1993	0.924	0.955	0.977	1.000	1.021	1.043	1.062	1.080	1.092	1.107
1994	0.905	0.935	0.956	0.979	1.000	1.021	1.040	1.057	1.069	1.084
1995	0.886	0.916	0.937	0.959	0.979	1.000	1.018	1.036	1.047	1.062
1996	0.870	0.899	0.920	0.942	0.962	0.982	1.000	1.017	1.028	1.043
1997	0.856	0.884	0.905	0.926	0.946	0.966	0.983	1.000	1.011	1.025
1998	0.847	0.875	0.895	0.916	0.936	0.955	0.973	0.989	1.000	1.014
1999	0.835	0.862	0.882	0.903	0.922	0.942	0.959	0.975	0.986	1.000
2000	0.816	0.843	0.863	0.883	0.902	0.921	0.938	0.954	0.964	0.978
2001	0.798	0.824	0.843	0.863	0.882	0.900	0.917	0.932	0.942	0.956
2002	0.786	0.812	0.830	0.850	0.868	0.886	0.903	0.918	0.928	0.941
2003	0.770	0.796	0.814	0.834	0.851	0.869	0.885	0.900	0.910	0.923
2004	0.750	0.775	0.792	0.811	0.829	0.846	0.861	0.876	0.886	0.898
2005	0.726	0.751	0.768	0.786	0.803	0.820	0.835	0.849	0.858	0.870
2006	0.705	0.728	0.745	0.763	0.779	0.795	0.810	0.824	0.832	0.844
2007	0.686	0.709	0.726	0.743	0.759	0.775	0.789	0.802	0.811	0.823
2008	0.673	0.696	0.712	0.729	0.744	0.760	0.773	0.787	0.795	0.807
2009	0.668	0.690	0.706	0.723	0.738	0.754	0.768	0.781	0.789	0.800
2010	0.659	0.681	0.697	0.713	0.729	0.744	0.758	0.770	0.779	0.790
2011	0.647	0.668	0.683	0.700	0.715	0.729	0.743	0.756	0.764	0.775
2012	0.635	0.657	0.672	0.688	0.702	0.717	0.730	0.743	0.751	0.761
2013	0.626	0.647	0.662	0.677	0.692	0.706	0.719	0.732	0.740	0.750
2014	0.616	0.636	0.651	0.666	0.680	0.695	0.707	0.719	0.727	0.738
2015	0.606	0.626	0.641	0.656	0.670	0.684	0.696	0.708	0.716	0.727
2016	0.598	0.618	0.633	0.648	0.661	0.675	0.688	0.699	0.707	0.718

Table B.18
Gross National Product Implicit Price Deflator (Continued)

From:	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
1970	3.596	3.679	3.735	3.810	3.915	4.040	4.164	4.275	4.359	4.393
1971	3.422	3.501	3.555	3.626	3.725	3.845	3.963	4.068	4.148	4.180
1972	3.280	3.355	3.407	3.475	3.570	3.685	3.798	3.899	3.976	4.006
1973	3.110	3.181	3.230	3.295	3.385	3.494	3.601	3.697	3.770	3.799
1974	2.854	2.920	2.965	3.024	3.107	3.206	3.305	3.393	3.460	3.487
1975	2.612	2.672	2.713	2.767	2.843	2.934	3.025	3.105	3.166	3.191
1976	2.476	2.532	2.571	2.623	2.695	2.781	2.867	2.943	3.001	3.024
1977	2.331	2.384	2.421	2.470	2.537	2.619	2.699	2.771	2.825	2.847
1978	2.178	2.228	2.262	2.307	2.371	2.447	2.522	2.589	2.640	2.660
1979	2.012	2.058	2.090	2.131	2.190	2.260	2.330	2.392	2.439	2.457
1980	1.846	1.888	1.917	1.955	2.009	2.073	2.137	2.194	2.237	2.254
1981	1.688	1.726	1.753	1.788	1.837	1.896	1.954	2.006	2.046	2.062
1982	1.589	1.626	1.651	1.684	1.730	1.785	1.840	1.889	1.926	1.941
1983	1.529	1.564	1.588	1.620	1.664	1.717	1.770	1.817	1.853	1.867
1984	1.476	1.510	1.533	1.564	1.607	1.659	1.710	1.755	1.789	1.803
1985	1.431	1.463	1.486	1.516	1.557	1.607	1.657	1.701	1.734	1.747
1986	1.402	1.434	1.456	1.485	1.526	1.575	1.624	1.667	1.700	1.713
1987	1.367	1.398	1.420	1.448	1.488	1.536	1.583	1.625	1.657	1.670
1988	1.321	1.351	1.372	1.399	1.437	1.484	1.529	1.570	1.601	1.613
1989	1.271	1.300	1.320	1.347	1.383	1.428	1.472	1.511	1.541	1.553
1990	1.225	1.254	1.273	1.298	1.334	1.377	1.419	1.457	1.485	1.497
1991	1.186	1.213	1.232	1.256	1.291	1.332	1.373	1.410	1.437	1.448
1992	1.159	1.186	1.204	1.228	1.262	1.302	1.343	1.378	1.405	1.416
1993	1.132	1.158	1.176	1.200	1.233	1.272	1.311	1.346	1.373	1.383
1994	1.109	1.134	1.152	1.175	1.207	1.246	1.284	1.318	1.344	1.355
1995	1.086	1.111	1.128	1.151	1.182	1.220	1.258	1.291	1.317	1.327
1996	1.067	1.091	1.108	1.130	1.161	1.198	1.235	1.268	1.293	1.303
1997	1.049	1.073	1.089	1.111	1.141	1.178	1.214	1.247	1.271	1.281
1998	1.037	1.061	1.077	1.099	1.129	1.165	1.201	1.233	1.257	1.267
1999	1.023	1.046	1.062	1.083	1.113	1.149	1.184	1.216	1.240	1.249
2000	1.000	1.023	1.039	1.059	1.088	1.123	1.158	1.189	1.212	1.222
2001	0.978	1.000	1.015	1.036	1.064	1.098	1.132	1.162	1.185	1.194
2002	0.963	0.985	1.000	1.020	1.048	1.082	1.115	1.145	1.167	1.176
2003	0.944	0.966	0.980	1.000	1.027	1.060	1.093	1.122	1.144	1.153
2004	0.919	0.940	0.954	0.973	1.000	1.032	1.064	1.092	1.114	1.122
2005	0.890	0.911	0.925	0.943	0.969	1.000	1.031	1.058	1.079	1.087
2006	0.864	0.883	0.897	0.915	0.940	0.970	1.000	1.027	1.047	1.055
2007	0.841	0.861	0.874	0.891	0.916	0.945	0.974	1.000	1.020	1.028
2008	0.825	0.844	0.857	0.874	0.898	0.927	0.955	0.981	1.000	1.008
2009	0.819	0.837	0.850	0.867	0.891	0.920	0.948	0.973	0.992	1.000
2010	0.808	0.826	0.839	0.856	0.879	0.908	0.936	0.960	0.979	0.987
2011	0.792	0.810	0.823	0.839	0.862	0.890	0.917	0.942	0.960	0.968
2012	0.779	0.797	0.809	0.825	0.848	0.875	0.902	0.926	0.944	0.951
2013	0.767	0.785	0.797	0.813	0.835	0.862	0.888	0.912	0.930	0.937
2014	0.755	0.772	0.784	0.800	0.822	0.848	0.874	0.898	0.915	0.922
2015	0.744	0.761	0.772	0.788	0.809	0.835	0.861	0.884	0.901	0.908
2016	0.734	0.751	0.762	0.778	0.799	0.825	0.850	0.873	0.890	0.897

Table B.18
Gross National Product Implicit Price Deflator (Continued)

From:	2010	2011	2012	2013	2014	2015	2016
1970	4.451	4.539	4.618	4.688	4.767	4.841	4.903
1971	4.236	4.319	4.395	4.461	4.536	4.607	4.666
1972	4.059	4.140	4.212	4.275	4.348	4.415	4.472
1973	3.849	3.925	3.994	4.054	4.123	4.187	4.241
1974	3.533	3.602	3.665	3.720	3.784	3.842	3.892
1975	3.233	3.297	3.354	3.405	3.463	3.516	3.562
1976	3.064	3.125	3.179	3.227	3.282	3.333	3.376
1977	2.885	2.942	2.993	3.038	3.090	3.138	3.179
1978	2.696	2.749	2.797	2.839	2.887	2.932	2.970
1979	2.490	2.539	2.583	2.622	2.667	2.708	2.743
1980	2.284	2.329	2.370	2.406	2.447	2.485	2.517
1981	2.089	2.130	2.167	2.200	2.237	2.272	2.301
1982	1.967	2.006	2.041	2.072	2.107	2.139	2.167
1983	1.892	1.929	1.963	1.993	2.027	2.058	2.085
1984	1.827	1.863	1.896	1.924	1.957	1.987	2.013
1985	1.771	1.806	1.837	1.865	1.896	1.926	1.951
1986	1.735	1.770	1.801	1.828	1.859	1.888	1.912
1987	1.692	1.725	1.755	1.782	1.812	1.840	1.864
1988	1.634	1.667	1.696	1.721	1.751	1.778	1.801
1989	1.573	1.604	1.632	1.657	1.685	1.711	1.733
1990	1.517	1.547	1.574	1.597	1.625	1.650	1.671
1991	1.468	1.497	1.523	1.546	1.572	1.596	1.617
1992	1.435	1.463	1.489	1.511	1.537	1.561	1.581
1993	1.402	1.429	1.454	1.476	1.501	1.525	1.544
1994	1.372	1.400	1.424	1.445	1.470	1.493	1.512
1995	1.344	1.371	1.395	1.416	1.440	1.462	1.481
1996	1.320	1.346	1.370	1.390	1.414	1.436	1.454
1997	1.298	1.324	1.347	1.367	1.390	1.412	1.430
1998	1.284	1.309	1.332	1.352	1.375	1.397	1.415
1999	1.266	1.291	1.313	1.333	1.354	1.375	1.393
2000	1.238	1.262	1.284	1.303	1.324	1.345	1.362
2001	1.210	1.234	1.255	1.274	1.295	1.315	1.332
2002	1.192	1.215	1.236	1.255	1.275	1.295	1.312
2003	1.168	1.191	1.212	1.230	1.250	1.270	1.286
2004	1.137	1.160	1.180	1.198	1.217	1.236	1.252
2005	1.102	1.123	1.143	1.160	1.179	1.197	1.213
2006	1.069	1.090	1.109	1.126	1.144	1.161	1.176
2007	1.041	1.062	1.080	1.097	1.114	1.131	1.146
2008	1.021	1.041	1.059	1.075	1.092	1.109	1.124
2009	1.013	1.033	1.051	1.067	1.084	1.101	1.115
2010	1.000	1.020	1.038	1.053	1.070	1.086	1.100
2011	0.981	1.000	1.017	1.033	1.048	1.064	1.078
2012	0.964	0.983	1.000	1.015	1.030	1.045	1.059
2013	0.949	0.968	0.985	1.000	1.015	1.029	1.042
2014	0.935	0.954	0.971	0.986	1.000	1.010	1.024
2015	0.920	0.940	0.957	0.972	0.990	1.000	1.013
2016	0.909	0.928	0.945	0.960	0.977	0.987	1.000

Source:

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

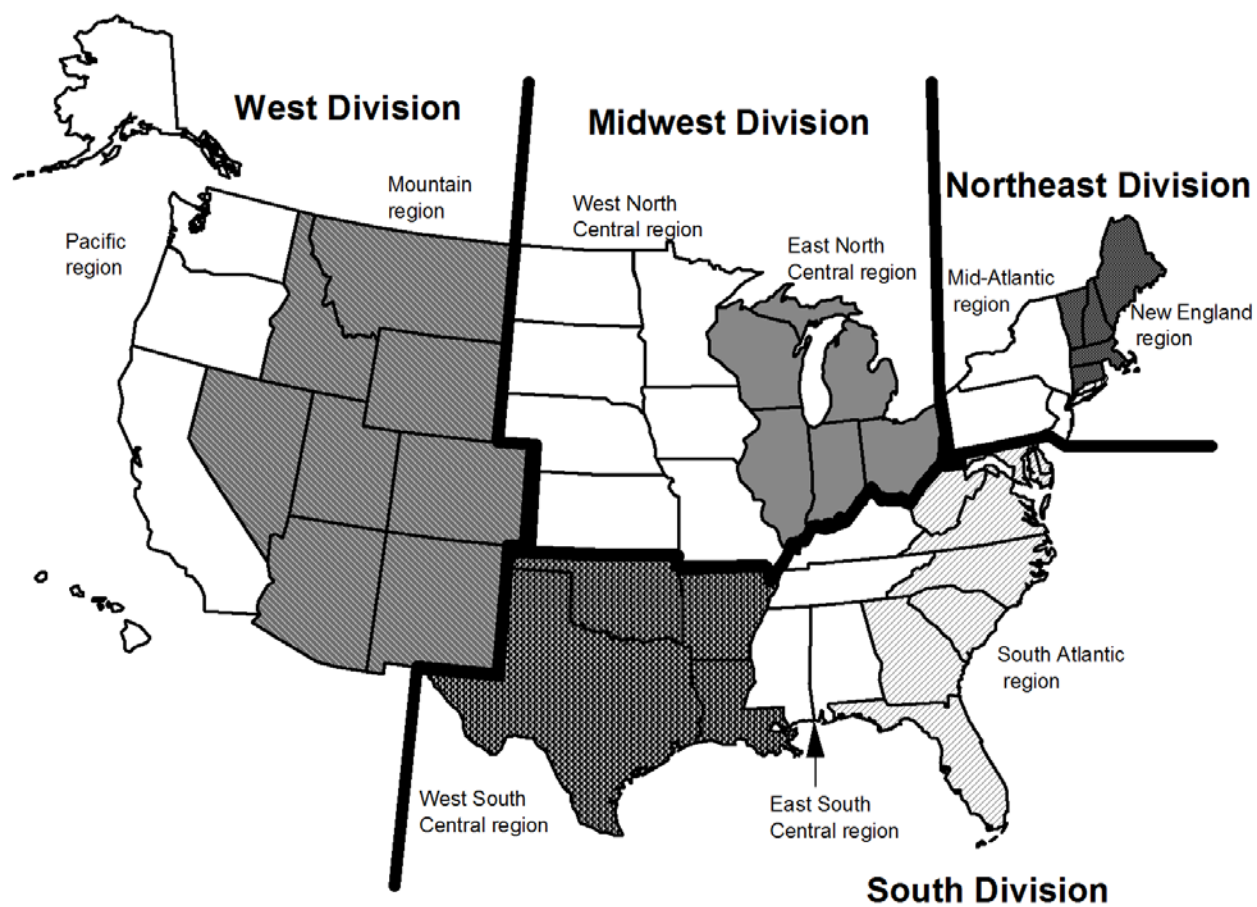
APPENDIX C

MAPS

Table C.1
Census Regions and Divisions

Northeast Region			
Mid-Atlantic division		New England division	
New Jersey	Pennsylvania	Connecticut	New Hampshire
New York		Maine	Rhode Island
		Massachusetts	Vermont
South Region			
West South Central division	East South Central division	South Atlantic division	
Arkansas	Alabama	Delaware	South Carolina
Louisiana	Kentucky	Florida	Virginia
Oklahoma	Mississippi	Georgia	Washington, DC
Texas	Tennessee	Maryland	West Virginia
		North Carolina	
West Region			
Pacific division		Mountain division	
Alaska	Oregon	Arizona	Nevada
California	Washington	Colorado	New Mexico
Hawaii		Idaho	Utah
		Montana	Wyoming
Midwest Region			
West North Central division		East North Central division	
Iowa	Nebraska	Illinois	Ohio
Kansas	North Dakota	Indiana	Wisconsin
Minnesota	South Dakota	Michigan	
Missouri			

Source:
U.S. Census Bureau.

Figure C.1. Census Regions and Divisions

Source:
See Table C.1.

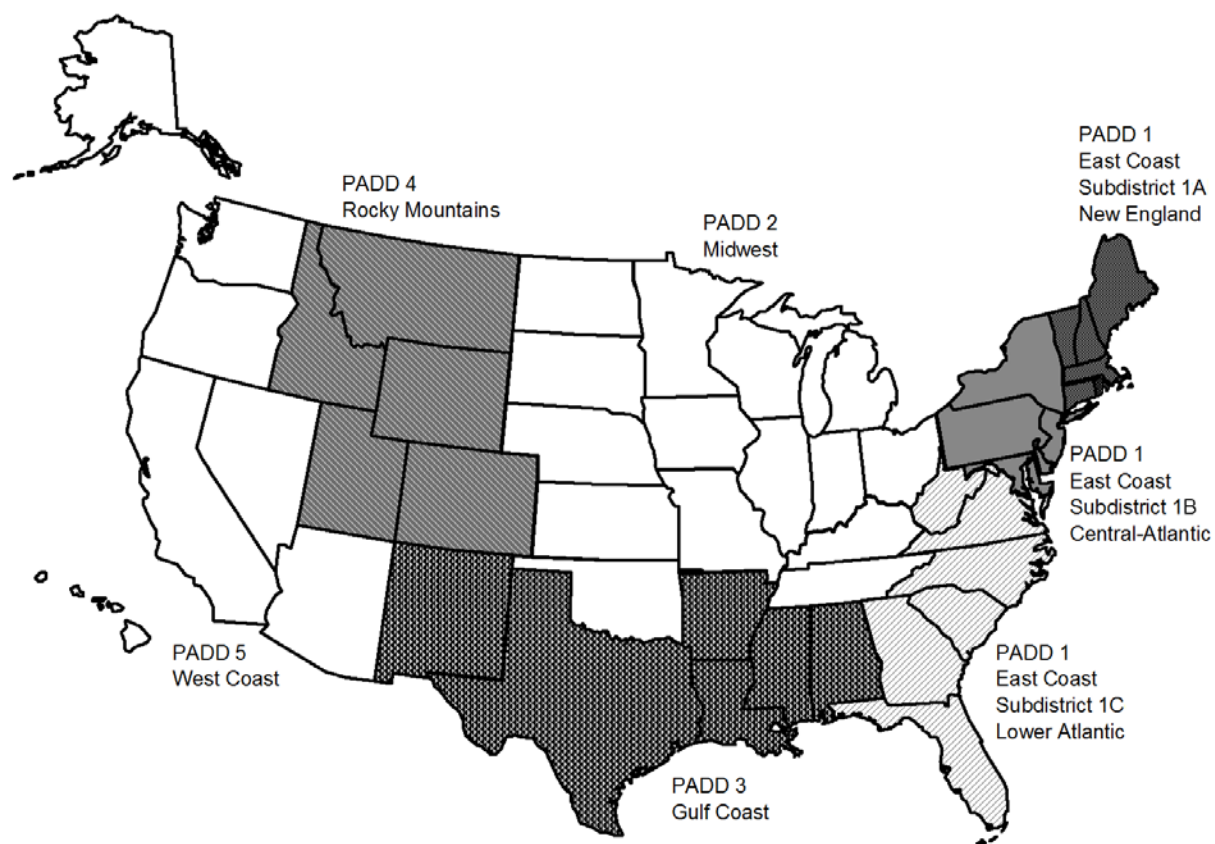
Table C.2
Petroleum Administration for Defense Districts (PADD)

District	Subdistrict	States
PAD District 1 East Coast	Subdistrict 1A New England	Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, Vermont
	Subdistrict 1B Central Atlantic	Delaware, District of Columbia, Maryland, New Jersey, New York, Pennsylvania
	Subdistrict 1C Lower Atlantic	Florida, Georgia, North Carolina, South Carolina, Virginia, West Virginia
PAD District 2 Midwest		Illinois, Indiana, Iowa, Kansas, Kentucky, Michigan, Minnesota, Missouri, Nebraska, North Dakota, South Dakota, Ohio, Oklahoma, Tennessee, Wisconsin
PAD District 3 Gulf Coast		Alabama, Arkansas, Louisiana, Mississippi, New Mexico, Texas
PAD District 4 Rocky Mountains		Colorado Idaho, Montana, Utah, Wyoming
PAD District 5 West Coast		Alaska, Arizona, California, Hawaii, Nevada, Oregon, Washington

Source:

Energy Information Administration web site:

http://www.eia.gov/tools/glossary/index.cfm?id=P#PADD_def

Figure C.2. Petroleum Administration for Defense Districts

Source:
See Table C.2.

Table C.3. Counties Where Reformulated Gasoline is Sold

Reformulated Gasoline (RFG) used in entire county		
California		
Fresno County	Orange County	Stanislaus County
Kings County	Sacramento County	Tulare County
Los Angeles County	San Diego County	Ventura County
Madera County	San Joaquin	Yolo County
Merced County		
Connecticut		
Fairfield County	Windham County	
Delaware		
New Castle County	Kent County	Sussex County
Illinois		
Cook County	Lake County	Monroe County
Du Page County	McHenry County	St. Clair County
Jersey County	Madison County	Will County
Kane County		
Indiana		
Lake County	Porter County	
Kentucky		
Boone County	Jefferson County	Kenton County
Campbell County		
Maine		
Androscoggin County	Knox County	Sagadahoc County
Cumberland County	Lincoln County	York County
Kennebec County		
Maryland		
Anne Arundel County	Cecil County	Montgomery County
Baltimore County	Frederick County	Prince George's County
Calvert County	Harford County	The City of Baltimore
Carroll County	Howard County	Queen Anne's County
Charles County	Kent County	
Massachusetts		
Barnstable County	Franklin County	Norfolk County
Berkshire County	Hampden County	Plymouth County
Bristol County	Hampshire County	Suffolk County
Dukes County	Middlesex County	Worcester County
Essex County	Nantucket County	
Missouri		
Franklin County	St. Louis County	St. Charles County
Jefferson County	St Louis (city)	
New Hampshire		
Hillsborough County	Merrimack County	Strafford County
Rockingham County		
New Jersey		
Bergen County	Gloucester County	Ocean County
Burlington County	Hudson County	Passaic County
Camden County	Hunterdon County	Salem County
Cumberland County	Mercer County	Somerset County
Atlantic County	Middlesex County	Sussex County
Cape May County	Monmouth County	Union County
Essex County	Morris County	Warren County
New York		
Bronx County	New York County	Richmond County
Dutchess County	Orange County	Rockland County
Kings County	Putnam	Suffolk County
Nassau County	Queens County	Westchester County

Table C.3. Counties Where Reformulated Gasoline is Sold (continued)

RFG used in entire county (continued)		
Pennsylvania		
Bucks County	Delaware County	Philadelphia County
Chester County	Montgomery County	
Rhode Island		
Bristol County	Newport County	Washington County
Kent County	Providence County	
Texas		
Brazoria County	Denton County	Liberty County
Chambers County	Fort Bend County	Montgomery County
Collin County	Galveston County	Tarrant County
Dallas County	Harris County	Waller County
Virginia		
Alexandria	Hanover County	Poquoson
Arlington County	Henrico County	Portsmouth
Charles City County	Hopewell	Prince William County
Chesapeake	James City County	Richmond
Chesterfield County	Loudoun County	Stafford County
Colonial Heights	Manassas	Suffolk
Fairfax	Manassas Park	Virginia Beach
Fairfax County	Newport News	Williamsburg
Falls Church	Norfolk	York County
Hampton		
Wisconsin		
Kenosha County	Ozaukee County	Washington County
Milwaukee County	Racine County	Waukesha County
Partial RFG Counties		
California		
El Dorado County	Riverside County	Solano County
Kern County	San Bernardino County	Sutter County
Placer County		
Connecticut		
Hartford County	Middlesex County	New London County
Litchfield County	New Haven County	Tolland County
Illinois		
Grundy County	Kendall County	
Kentucky		
Bullitt County	Oldham County	
New York		
Essex County		

Note: RFG is also sold in the District of Columbia. Reformulated gasoline is a motor gasoline specially formulated to achieve significant reductions in vehicle emissions of ozone-forming and toxic air pollutants. The Clean Air Act of 1990 mandates reformulated gasoline use in areas with ozone-air pollution problems, but some of these counties opted-in to the RFG program.

Source:

U.S. Environmental Protection Agency, RFG Areas, accessed September 15, 2017, <http://www.epa.gov/gasoline-standards/reformulated-gasoline>

Figure C.3. Counties Where Reformulated Gasoline is Sold



Note: Reformulated gasoline (RFG) is a motor gasoline specially formulated to achieve significant reductions in vehicle emissions of ozone-forming and toxic air pollutants. The Clean Air Act of 1990 mandates reformulated gasoline use in areas with ozone-air pollution problems, but some of these counties opted-in to the RFG program.

Source:

See Table C.3.

GLOSSARY

Acceleration power – Often 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.

Age – The amount of time a person or thing has existed.

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 million to \$1 billion
- Large Regionals - \$20 million to \$99 million
- Medium Regionals – Less than \$20 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."

Alcohol – The family name of a group of organic chemical compounds composed of carbon, hydrogen, and oxygen. The molecules in the series vary in chain length and are composed of a hydrocarbon plus a hydroxyl group. Alcohol includes methanol and ethanol.

Alternative fuel – For transportation applications, includes the following: methanol; denatured ethanol, and other alcohols; fuel mixtures containing 85 percent or more by volume of methanol, denatured ethanol, and other alcohols with gasoline or other fuels; natural gas; liquefied petroleum gas (propane); hydrogen; coal-derived liquid fuels; fuels (other than alcohol) derived from biological materials (biofuels such as soy diesel fuel); and electricity (including electricity from solar energy). The term "alternative fuel" does not include alcohol or other blended portions of primarily petroleum-based fuels used as oxygenates or extenders, i.e. MTBE, ETBE, other ethers, and the 10-percent ethanol portion of gasohol.

Amtrak – See Rail.

Anthropogenic – Human made. Usually used in the context of emissions that are produced as the result of human activities.

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, non-self-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 – British thermal unit. 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.

Bunker fuels – Fuel supplied to ships and aircraft, both domestic and foreign, consisting primarily of residual and distillate fuel oil for ships and kerosene-based jet fuel for aircraft.

Bus – A mode of transit service characterized by roadway vehicles powered by diesel, gasoline, battery, or alternative fuel engines contained within the vehicle.

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.

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.

Car size classifications – Size classifications of cars 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 99 cubic feet of passenger and luggage volume.

Compact – between 100 to 109 cubic feet of passenger and luggage volume.

Midsize – between 110 to 119 cubic feet of passenger and luggage volume.

Large – 120 cubic feet or more of passenger and luggage volume.

Two seater – cars designed primarily to seat only two adults.

Small station wagon – less than 130 cubic feet of passenger and luggage volume.

Mid-size station wagon – between 130 to 159 cubic feet of passenger and luggage volume.

Large station wagon – 160 or more cubic feet of passenger and luggage volume.

Carbon dioxide (CO₂) – 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 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*.

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 – An energy-consuming sector that consists of service-providing facilities of: businesses; Federal, State, and local governments; and other private and public organizations, such as religious, social or fraternal groups. Includes institutional living quarters.

Commuter rail – A mode of transit service (also called metropolitan rail, regional rail, or suburban rail) characterized by an electric or diesel propelled railway for urban passenger train service consisting of local short distance travel operating between a central city and adjacent suburbs.

Compact car – See *car size classifications*.

Compression ignition – The form of ignition that initiates combustion in a diesel engine. The rapid compression of air within the cylinders generates the heat required to ignite the fuel as it is injected.

Constant dollars – A time series of monetary figures is expressed in constant dollars when the effect of change over time 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) – A measure of the average change over time in the prices paid by urban consumers for a market basket of consumer goods and services.

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.

Conventional Refueling Station – An establishment for refueling motor vehicles with traditional transportation fuels, such as gasoline and diesel fuel.

Corporate Average Fuel Economy (CAFE) Standards – CAFE standards were originally established by Congress for new cars, 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, car 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.

Criteria pollutant – A pollutant determined to be hazardous to human health and regulated under EPA's National Ambient Air Quality Standards. The 1970 amendments to the Clean Air Act require EPA to describe the health and welfare impacts of a pollutant as the "criteria" for inclusion in the regulatory regime.

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 production is measured at the wellhead and includes lease condensate.

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.

Curb weight – The weight of a vehicle including all standard equipment, spare tire and wheel, all fluids and lubricants to capacity, full tank of fuel, and the weight of major optional accessories normally found on the vehicle.

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." See also constant dollars.

Demand Response – A transit mode that includes passenger cars, vans, and small buses operating in response to calls from passengers to the transit operator who dispatches the vehicles. The vehicles do not operate over a fixed route on a fixed schedule. Can also be known as paratransit or dial-a-ride.

Diesel fuel – See *Distillate fuel oil*.

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*.

E85 – 85% ethanol and 15% gasoline.

E95 – 95% ethanol and 5% gasoline.

Electric utilities sector – Consists of privately and publicly owned establishments which generate electricity primarily for resale.

Emission standards – Limits or ranges established for pollution levels emitted by vehicles as well as stationary sources. The first standards were established under the 1963 Clean Air Act.

End-use sector – See *Sector*.

Energy capacity – Often measured in kilowatt hours. The energy delivered by the battery up to termination of discharge specified by the battery manufacturer.

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 from that process; for example, gallons of fuel per passenger-mile or Btu per ton-mile.

Ethanol (C₂H₅OH) – Otherwise known as ethyl alcohol, alcohol, or grain-spirit. A clear, colorless, flammable oxygenated hydrocarbon with a boiling point of 78.5 degrees Celsius in the anhydrous state. In transportation, ethanol is used as a vehicle fuel by itself (E100 – 100% ethanol by volume), blended with gasoline (E85 – 85% ethanol by volume), or as a gasoline octane enhancer and oxygenate (10% by volume).

Excise tax – Paid when purchases are made on a specific good, such as gasoline. Excise taxes are often included in the price of the product. There are also excise taxes on activities, such as highway usage by trucks.

Ferry boat – A transit mode comprising vessels carrying passengers and in some cases vehicles over a body of water, and that are generally steam or diesel-powered.

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, 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. American Samoa, Guam, North Mariana Islands and U.S. Outlying Islands) and foreign countries is excluded. Traffic to or from the Panama Canal Zone is included, but traffic with U.S. origin and U.S. destination traveling through the Panama Canal is not.

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; 7.5% anhydrous ethanol and 92.5% gasoline by volume; or 5.5% anhydrous ethanol and 94.5% 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.

Global warming potential (GWP) – An index used to compare the relative radiative forcing of different gases without directly calculating the changes in atmospheric concentrations. GWPs are calculated as the ratio of the radiative forcing that would result from the emission of one kilogram of a greenhouse gas to that from the emission of one kilogram of carbon dioxide over a fixed period of time, such as 100 years.

Greenhouse gases – Those gases, such as water vapor, carbon dioxide, nitrous oxide, methane, hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulfur hexafluoride, that are transparent to solar (short-wave) radiation but opaque to long-wave (infrared) radiation, thus preventing long-wave radiant energy from leaving Earth's atmosphere. The net effect is a trapping of absorbed radiation and a tendency to warm the planet's surface.

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 truck plus the maximum anticipated load weight, including passengers, fluids, and cargo.

Gross vehicle weight rating (gvwr) – The gross vehicle weight which is assigned to each new truck by the manufacturer. This rating may be different for trucks of the same model because of certain features, such as heavy-duty suspension. Passenger cars are not assigned gross vehicle weight ratings.

Heavy-heavy truck – See *Truck size classifications*.

Heavy rail – A mode of transit service (also called metro, subway, rapid transit, or rapid rail) operating on an electric railway with the capacity for a heavy volume of traffic. Characterized by high speed and rapid acceleration of passenger rail cars.

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.

Hybrid-electric vehicles – Combines the benefits of gasoline engines and electric motors and can be configured to obtain different objectives, such as improved fuel economy, increased power, or additional auxiliary power for electronic devices and power tools.

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.

Inertia weight – The curb weight of a vehicle plus 300 pounds.

Intercity bus – See *Bus*.

Intermodal – Transportation activities involving more than one mode of transportation, including transportation connections and coordination of various modes.

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 to 261 degrees Celsius. 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 Celsius 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 *Car size classifications*.

Lease Condensate – A liquid recovered from natural gas at the well or at small gas/oil separators in the field. Consists primarily of pentanes and heavier hydrocarbons (also called field condensate).

Light duty vehicles – Cars 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*.

Light rail – Mode of transit service (also called streetcar, tramway or trolley) operating passenger rail cars singly (or in short, usually two-car or three-car trains) on fixed rails in right-of-way that is often separated from other traffic for part or much of the way.

Liquefied 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 – Total passenger miles divided by total vehicle miles.

Low emission vehicle – Any vehicle certified to the low emission standards which are set by the Federal government and/or the state of California.

M85 – 85% methanol and 15% gasoline.

M100 – 100% methanol.

Medium truck – See *Truck size classifications*.

Methanol (CH₃OH) – A colorless highly toxic liquid with essentially no odor and very little taste. It is the simplest alcohol and boils at 64.7 degrees Celsius. In transportation, methanol is used as a vehicle fuel by itself (M100), or blended with gasoline (M85).

Midsized car – See *Car size classifications*.

Minicompact car – See *Car 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 Celsius 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.

Regular gasoline: Gasoline having an antiknock index, i.e., octane rating, greater than or equal to 85 and less than 88. Note: Octane requirements may vary by altitude.

Midgrade gasoline: Gasoline having an antiknock index, i.e., octane rating, greater than or equal to 88 and less than or equal to 90. Note: Octane requirements may vary by altitude.

Premium gasoline: Gasoline having an antiknock index, i.e., octane rating, greater than 90. Note: Octane requirements may vary by altitude.

Reformulated gasoline: Finished motor gasoline formulated for use in motor vehicles, the composition and properties of which meet the requirements of the reformulated gasoline regulations promulgated by the U.S. Environmental Protection Agency under Section 211(k) of the Clean Air Act. For more details on this clean fuel program see <http://www.epa.gov/otaq/fuels/gasolinefuels/rfg/index.htm>. Note: This category includes oxygenated fuels program reformulated gasoline (OPRG) but excludes reformulated gasoline blendstock for oxygenate blending (RBOB).

MTBE – Methyl Tertiary Butyl Ether—a colorless, flammable, liquid oxygenated hydrocarbon containing 18.15 percent oxygen.

Naphtha-type jet fuel – See *Jet fuel*.

National income – See *Income*.

Nationwide Personal Transportation Survey (NPTS) – A nationwide 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, 1990, and 1995 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.

Natural gas, dry: Natural gas which remains after: 1) the liquefiable hydrocarbon portion has been removed from the gas stream; and 2) any volumes of nonhydrocarbon gases have been removed where they occur in sufficient quantity to render the gas unmarketable. Dry natural gas is also known as consumer-grade natural gas. The parameters for measurement are cubic feet at 60 degrees Fahrenheit and 14.73 pounds per square inch absolute.

Natural gas, wet: The volume of natural gas remaining after removal of lease condensate in lease and/or field separation facilities, if any, and after exclusion of nonhydrocarbon gases where they occur in sufficient quantity to render the gas unmarketable. Natural gas liquids may be recovered from volumes of natural gas, wet after lease separation, at natural gas processing plants.

Natural gas plant liquids: Natural gas liquids recovered from natural gas in processing plants and from natural gas field facilities and fractionators. Products obtained include ethane, propane, normal butane, isobutane, pentanes plus, and other products from natural gas processing plants.

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.

Nonattainment area – Any area that does not meet the national primary or secondary ambient air quality standard established by the Environmental Protection Agency for designated pollutants, such as carbon monoxide and ozone.

Oil Stocks – Oil stocks include crude oil (including strategic reserves), unfinished oils, natural gas plant liquids, and refined petroleum products.

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 Economic Cooperation and Development (OECD) – Consists of Australia, Austria, Belgium, Canada, Chile, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, Luxembourg, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Slovenia, South Korea, Spain, Sweden, Switzerland, Turkey, United Kingdom, and United States. Total

OECD includes the United States Territories (Guam, Puerto Rico, and the U.S. Virgin Islands). Total OECD excludes data for Czech Republic, Hungary, Mexico, Poland, and South Korea which are not yet available.

OECD Europe: Consists of Austria, Belgium, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Poland, Portugal, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Turkey, and United Kingdom. OECD Europe excludes data for Czech Republic, Hungary, and Poland which are not yet available.

OECD Pacific: Consists of Australia, Japan, South Korea, and New Zealand.

Organization for Petroleum Exporting Countries (OPEC) – Includes Algeria, Angola, Ecuador, Iran, Iraq, Kuwait, Libya, Nigeria, Qatar, Saudi Arabia, United Arab Emirates, and Venezuela.

Arab OPEC – Consists of Algeria, Bahrain, Egypt, Iraq, Kuwait, Libya, Qatar, Saudi Arabia, Syria, Tunisia, and the United Arab Emirates.

Other single-unit truck – See *Single-unit truck*.

Oxygenate – A substance which, when added to gasoline, increases the amount of oxygen in that gasoline blend. Includes fuel ethanol, methanol, and methyl tertiary butyl ether (MTBE).

Paratransit – Mode of transit service (also called demand response or dial-a-ride) characterized by the use of passenger cars, vans or small buses operating in response to calls from passengers or their agents to the transit operator, who then dispatches a vehicle to pick up the passengers and transport them to their destinations.

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*".

Persian Gulf countries – Consists of Bahrain, Iran, Iraq, Kuwait, Qatar, Saudi Arabia, and the United Emirates.

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 known 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.

Plug-in hybrid-electric vehicles (PHEVs) — Hybrid-electric vehicles with high capacity batteries that can be charged by plugging them into an electrical outlet or charging station. There are two basic PHEV configurations:

Parallel or Blended PHEV: Both the engine and electric motor are mechanically connected to the wheels, and both propel the vehicle under most driving conditions. Electric-only operation usually occurs only at low speeds.

Series PHEVs, also called Extended Range Electric Vehicles (EREVs): Only the electric motor turns the wheels; the gasoline engine is only used to generate electricity. Series PHEVs can run solely on electricity until the battery needs to be recharged. The gasoline engine will then generate the electricity needed to power the electric motor. For shorter trips, these vehicles might use no gasoline at all.

Processing Gain – The amount by which the total volume of refinery output is greater than the volume of input for given period of time. The processing gain arises when crude oil and

other hydrocarbons are processed into products that are, on average, less dense than the input.

Processing Loss – The amount by which the total volume of refinery output is less than the volume of input for given period of time. The processing loss arises when crude oil and other hydrocarbons are processed into products that are, on average, denser than the input.

Proved Reserves of Crude Oil – The estimated quantities of all liquids defined as crude oil, which geological and engineering data demonstrate with reasonable certainty to be recoverable in future years from known reservoirs under existing economic and operating conditions.

Quad – Quadrillion, 10^{15} . In this publication, a Quad refers to Quadrillion Btu.

Rail –

Amtrak (American Railroad Tracks): Operated by the National Railroad Passenger Corporation of Washington, DC. This rail system was created by President Nixon in 1970, and was given the responsibility for the operation of intercity, as distinct from suburban, passenger trains between points designated by the Secretary of Transportation.

Class I freight railroad: Defined by the Interstate Commerce Commission each year based on annual operating revenue. A railroad is dropped from the Class I list if it fails to meet the annual earnings threshold for three consecutive years.

Commuter railroad: Those portions of mainline railroad (not electric railway) transportation operations which encompass urban passenger train service for local travel between a central city and adjacent suburbs. Commuter railroad service—using both locomotive-hauled and self-propelled railroad passenger cars—is characterized by multi-trip tickets, specific station-to-station fares, and usually only one or two stations in the central business district. Also known as suburban railroad.

Transit railroad: Includes "heavy" and "light" transit rail. **Heavy transit rail** is characterized by exclusive rights-of-way, multi-car trains, high speed rapid acceleration, sophisticated signaling, and high platform loading. Also known as subway, elevated railway, or metropolitan railway (metro). **Light transit rail** may be on exclusive or shared rights-of-way, high or low platform loading, multi-car trains or single cars, automated or manually operated. In generic usage, light rail includes streetcars, trolley cars, and tramways.

Refiner sales price – Sales from the refinery made directly to ultimate consumers, including bulk consumers (such as agriculture, industry, and electric utilities) and residential and commercial consumers.

Reformulated gasoline (RFG) – See *Motor gasoline*.

RFG area – An ozone nonattainment area designated by the Environmental Protection Agency which requires the use of reformulated gasoline.

Residential sector – An energy consuming sector that consists of living quarters for private households. Excludes institutional living quarters.

Residential Transportation Energy Consumption Survey (RTECS) – This survey was designed by the Energy Information Administration of the Department of Energy to provide information on how energy is used by households for personal vehicles. It has been conducted five times since 1979, the most recent being 1991.

Residual fuel oil – The heavier oils that remain after the distillate fuel oils and lighter hydrocarbons are boiled off in refinery operations. Included are products known 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 period – October 1 of the previous year to September 30 of the given year. Approximately the same as a model year.

Sales-weighted miles per gallon (mpg) – Calculation of a composite vehicle fuel economy based on the distribution of vehicle sales.

Scrapage 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*.

Sector – A group of major energy-consuming components of U.S. society developed to measure and analyze energy use. The sectors most commonly referred to are: residential, commercial, industrial, transportation, and electric power.

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.

Spark ignition engine – An internal combustion engine in which the charge is ignited electrically (e.g., with a spark plug).

Special fuels – Consist primarily of diesel fuel with small amount of liquefied 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 *Car size classifications*.

Supplemental air carrier – See *Air carrier*.

Survival 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 will be in use at the end of a given year.

Tax incentives – In general, a means of employing the tax code to stimulate investment in or development of a socially desirable economic objective without direct expenditure from the budget of a given unit of government. Such incentives can take the form of tax exemptions or credits.

Test weight – The weight setting at which a vehicle is tested on a dynamometer by the U.S. Environmental Protection Agency (EPA). This weight is determined by the EPA using the inertia weight of the vehicle.

Ton-mile – The movement of one ton of freight the distance of one mile. Ton-miles are computed by multiplying the weight in tons of each shipment transported by the distance hauled.

Transmission types –

- A3 – Automatic three speed
- A4 – Automatic four speed
- A5 – Automatic five speed
- L4 – Automatic lockup four speed
- M5 – Manual five speed

Transit bus – See *Bus*.

Transit railroad – See *Rail*.

Transportation sector – Consists of both private and public passenger and freight transportation, as well as government transportation, including military operations.

Truck Inventory and Use Survey (TIUS) – Survey designed to collect data on the characteristics and operational use of the nation's truck population. It is conducted every five years by the U.S. Bureau of the Census. Surveys were conducted in 1963, 1967, 1972, 1977, 1982, 1987, and 1992. For the 1997 survey, it was renamed the Vehicle Inventory and Use Survey in anticipation of including additional vehicle types. However, no additional vehicle types were added to the 1997 survey.

Trolleybus – Mode of transit service (also called transit coach) using vehicles propelled by a motor drawing current from overhead wires via connecting poles called a trolley pole, from a central power source not onboard the vehicle.

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 gvwt
 Light-heavy – 20,001 to 26,000 pounds gvwt
 Heavy-heavy – 26,001 pounds gvwt or more.

Two-axle, four-tire truck – See *Single-unit truck*.

Two seater car – See *Car size classifications*.

Ultra-low emission vehicle – Any vehicle certified to the ultra-low emission standards which are set by the Federal government and/or the state of California.

Urban – Usually refers to areas with population of 5,000 or greater.

Vanpool: A ridesharing prearrangement using vans or small buses providing round-trip transportation between the participant's prearranged boarding points and a common and regular destination.

Variable operating cost – See *Operating cost*.

Vehicle Inventory and Use Survey – Last conducted in 2002. See *Truck Inventory and Use Survey*.

Vehicle-miles traveled (vmt) – One vehicle traveling the distance of one mile. Total vehicle miles, thus, is the total mileage traveled by all vehicles.

Volatile organic compounds (VOCs) – Organic compounds that participate in atmospheric photochemical reactions.

Waterborne Commerce –

Coastwise: Domestic traffic receiving a carriage over the ocean, or the Gulf of Mexico. Traffic between Great Lakes ports and seacoast ports, when having a carriage over the ocean, is also termed Coastwise.

Domestic: Includes coastwise, lakewise, and internal waterborne movements.

Foreign: Waterborne import, export, and in-transit traffic between the United States, Puerto Rico and the Virgin Islands and any foreign country.

Internal: Vessel movements (origin and destination) which take place solely on inland waterways. An inland waterway is one geographically located within the boundaries of the contiguous 48 states or within the boundaries of the State of Alaska.

Lakewise: Waterborne traffic between the United States ports on the Great Lakes System. The Great Lakes System is treated as a separate waterway system rather than as a part of the inland waterway system. In comparing historical data for the Great Lakes System, one should note that prior to calendar year 1990, marine products, sand and gravel being moved

from the Great Lakes to Great Lake destinations were classified as local traffic. From 1990-on, these activities are classified as lakewise traffic.

Well-to-wheel – A life cycle analysis used in transportation to consider the entire energy cycle for a given mode, rather than just tailpipe emissions. The analysis starts at the primary energy source and ends with the turning wheels of the vehicle.

Zero-emission vehicle – Any vehicle certified to the zero emission standards which are set by the Federal government and/or the state of California. These standards apply to the vehicle emissions only.