Light-Duty Automotive Technology and Fuel Economy Trends: 1975 Through 2008

Executive Summary

United States
Environmental Protection
Agency

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Compliance and Innovative Strategies Division
and
Transportation and Climate Division

Office of Transportation and Air Quality
U.S. Environmental Protection Agency

NOTICE

This technical report does not necessarily represent final EPA decisions or positions. It is intended to present technical analysis of issues using data that are currently available. The purpose in the release of such reports is to facilitate the exchange of technical information and to inform the public of technical developments.

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I. Executive Summary

Introduction

This report summarizes key trends in fuel economy and technology usage related to model year (MY) 1975 through 2008 light-duty vehicles sold in the United States. Light-duty vehicles are those vehicles that EPA classifies as cars or light-duty trucks (sport utility vehicles or SUVs, vans, and pickup trucks with less than 8500 pounds gross vehicle weight ratings). The data in this report supersede the data in previous reports in this series.

Since 1975, overall new light-duty vehicle fuel economy has moved through four phases:

1. a rapid increase from 1975 through the early 1980s,
2. a slower increase until reaching its peak in 1987,
3. a gradual decline until 2004, and
4. an increase beginning in 2005.

The projected fleetwide average MY2008 light-duty vehicle fuel economy is 20.8 miles per gallon (mpg). The fleetwide average MY2007 value is 20.6 mpg. There is greater confidence in the MY2007 value as the database for 2007 includes formal sales data for about 80% of the MY2007 fleet, while the projected MY2008 value is based on pre-model year sales projections provided by automakers. The 20.8 mpg value for model year 2008 represents a 1.5 mpg, or 8%, increase over the 19.3 mpg value for 2004, which was the lowest fuel economy value since 1980.

More so than in any other recent report, EPA believes that the pre-model year 2008 sales projections provided by automakers to EPA do not accurately reflect the actual light-duty vehicle market in MY2008. Automakers submitted MY2008 sales projections to EPA in the spring and summer of 2007 when average nationwide gasoline prices were in the $2.50 to $3.00 per gallon range. Actual gasoline prices have averaged about $3.50 per gallon during MY2008, or $0.50 to $1.00 per gallon higher than at the time automakers provided sales projections to EPA. Based on publicly available sales data, which are not part of the formal EPA database, it appears that higher gasoline prices have led to a 10 to 15 percent decrease in overall light-duty vehicle sales relative to automaker projections. Further, the sales data suggest that subcompact, compact, and midsize cars have been the only vehicle classes to have met or exceeded sales projections by automakers, while sales of midsize SUVs, large SUVs, and large pickup trucks are 15 to 25 percent lower than automaker projections. It also appears that 4-cylinder engines have gained market share from 6-cylinder and 8-cylinder engines. Accordingly, it is extremely likely that the projected fleetwide average MY2008 fuel economy value of 20.8 mpg is too low. EPA will provide a more accurate value for MY2008 in the 2009 report, based on formal end-of-year submissions to EPA by automakers.

The fuel economy values in this report are either *adjusted* (ADJ) EPA "real-world" estimates provided to consumers, or unadjusted EPA *laboratory* (LAB) values. Most of the data is presented in adjusted values. Either adjusted or laboratory fuel economy may be reported as city, highway, or, most commonly, as *composite* (combined city/highway, or COMP). In 2006, EPA revised the methodology by which EPA estimates adjusted fuel economy to better reflect changes in driving habits and other factors that affect fuel economy such as higher highway speeds, more aggressive driving, and greater use of air conditioning. This is the second report in this series to reflect this new real-world fuel economy methodology, and every adjusted fuel economy value in this report for 1986 and later model years is lower than values in pre-2007

reports in this series. To reflect that these changes did not occur overnight, these new downward adjustments are phased in, gradually, beginning in 1986, and for 2005 and later model years the new adjusted composite values are, on average, about 6% lower than under the methodology used by EPA in older reports. See Appendix A for more details.

Because the underlying methodology for generating unadjusted laboratory fuel economy values has not changed since this series began in the mid-1970s, they provide an excellent basis for comparing long-term fuel economy trends from the perspective of vehicle design, apart from the factors that affect real-world fuel economy that are reflected in the adjusted fuel economy values. Laboratory composite values represent a harmonic average of 55 percent city fuel economy and 45 percent highway fuel economy, or "55/45." For 2005 and later model years, unadjusted laboratory composite fuel economy values are, on average, about 25% greater than adjusted composite fuel economy values. The projected fleetwide average 26.0 mpg unadjusted laboratory composite fuel economy value for MY2008 is an all-time high.

The Department of Transportation's National Highway Traffic Safety Administration (NHTSA) has the overall responsibility for the Corporate Average Fuel Economy (CAFE) program. For 2008, the CAFE standards are 27.5 mpg for cars and 22.5 mpg for light trucks (for light trucks, individual manufacturers can choose between the fixed, unreformed 22.5 mpg standard and a reformed vehicle footprint-based standard which yields different compliance levels for each manufacturer). EPA provides laboratory composite fuel economy data, along with alternative fuel vehicle credits and test procedure adjustments, to NHTSA for CAFE enforcement. Accordingly, current NHTSA CAFE values are a minimum of 25% higher than EPA adjusted fuel economy value.

Importance of Fuel Economy

Fuel economy continues to be a major area of public and policy interest for several reasons, including:

1. Fuel economy is directly related to energy security because light-duty vehicles account for approximately 40 percent of all U.S. oil consumption, and much of this oil is imported.

2. Fuel economy is directly related to the cost of fueling a vehicle and is of great interest when crude oil and gasoline prices rise.

3. Fuel economy is directly related to emissions of greenhouse gases (i.e., carbon dioxide). Light-duty vehicles contribute about 20 percent of all U.S. carbon dioxide emissions.

Characteristics of Light Duty Vehicles for Four Model Years

	1975	1987	1998	2008
Adjusted Fuel Economy (mpg)	13.1	22.0	20.1	20.8
Weight (lbs.)	4060	3220	3744	4117
Horsepower	137	118	171	222
0 to 60 Time (sec.)	14.1	13.1	10.9	9.6
Percent Truck Sales	19%	28%	45%	48%
Percent Front-Wheel Drive	5%	58%	56%	53%
Percent Four-Wheel Drive	3%	10%	20%	28%
Percent Multi-Valve Engine	-	-	40%	77%
Percent Variable Valve Timing	-	-	-	58%
Percent Cylinder Deactivation	-	-	-	7%
Percent Gasoline Direct Injection	-	-	-	2.3%
Percent Turbocharger	-	-	1.4%	2.5%
Percent Manual Trans	23%	29%	13%	7%
Percent Continuously Variable Trans	-	-	-	8%
Percent Hybrid	-	-	-	2.5%
Percent Diesel	0.2%	0.2%	0.1%	0.1%

Highlight #1: Fuel Economy Increases Beginning in 2005 Reverse the Long-Term Trend of Declining Fuel Economy From 1987 through 2004.

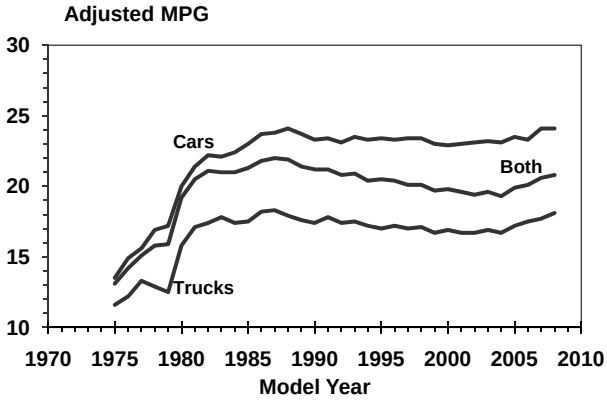
Overall average fuel economy is projected to increase by 1.5 mpg, or 8%, from 19.3 mpg in MY2004 to 20.8 mpg in MY2008. The actual fuel economy performance for MY2008 will likely exceed 20.8 mpg as this value is based on pre-model year sales projections made by automakers at a time when gasoline prices were considerably lower. The fuel economy increases beginning in MY2005 reverse a long trend of slowly declining fuel economy since 1987. The projected MY2008 unadjusted laboratory fuel economy value of 26.0 mpg, which does not account for real world fuel economy performance, represents an all-time high.

Since 1975, the fuel economy of the combined car and light truck fleet has moved through several phases: (1) a rapid increase from 1975 to the early 1980s, (2) a slow increase to the fuel economy peak of 22.0 mpg in 1987, (3) a gradual decline from the peak to 19.3 mpg in 2004, and (4) consecutive annual increases beginning in 2005, growing to 20.8 mpg in 2008.

The 20.8 mpg value for model year 2008 is 1.2 mpg below the peak of 22.0 mpg in MY1987. But it is important to note that this difference is due to the new methodology for calculating adjusted fuel economy values that is gradually phased in over the 1986 to 2005 timeframe. Based on the laboratory composite fuel economy values, which are not affected by the new methodology for calculating adjusted fuel economy values, the projected MY2008 value of 26.0 mpg is 0.1 mpg higher than the previous peak of 25.9 mpg in 1987.

MY2008 cars are projected to average 24.1 mpg and MY2008 light trucks are estimated to average 18.1 mpg. Since 2004, light truck fuel economy has increased by 1.4 mpg, while car fuel economy has increased by 1.0 mpg (car market share has also increased). The recent increase in truck fuel economy is due, in part, to higher truck CAFE standards, which have risen from 20.7 mpg in 2004 to 22.5 mpg in 2008.

Adjusted Fuel Economy by Model Year
(Annual Data)



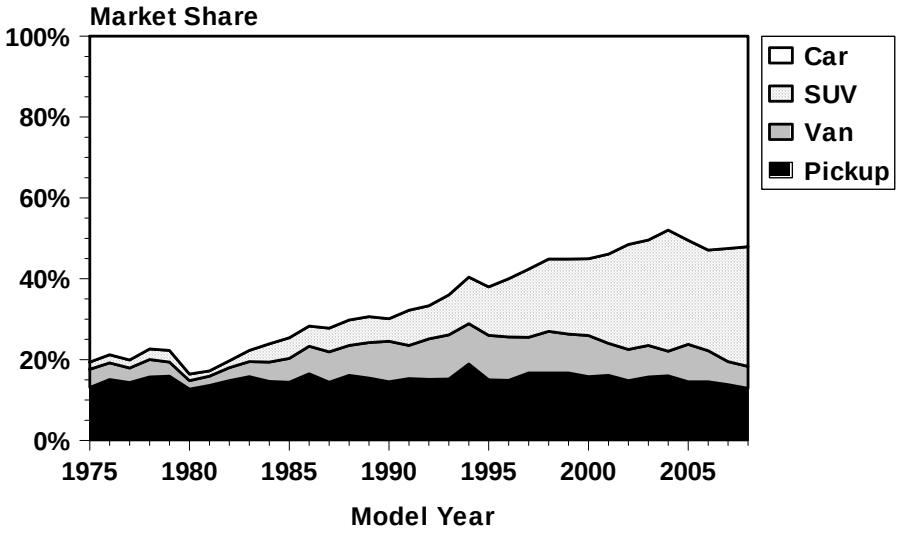
Highlight #2: Trucks Continue To Represent About Half of New Vehicle Sales.

Sales of light trucks, which include SUVs, vans, and pickup trucks, have accounted for about 50 percent of the U.S. light-duty vehicle market since MY2002. After two decades of constant growth, light truck market share has been relatively stable from 2002 through 2007. While projected MY2008 truck market share is relatively stable, it is likely that actual truck market share in MY2008 will be less than the projected value, which is based on pre-model year sales projections, given higher gasoline prices.

Historically, growth in the light truck market was primarily driven by the explosive increase in the market share of SUVs (EPA does not have a separate category for crossover vehicles and classifies many crossover vehicles as SUVs). The SUV market share increased from less than 10 percent of the overall new light-duty vehicle market in MY1990 to about 30 percent of vehicles built each year since 2003. By comparison, market shares for both vans and pickup trucks have declined slightly since 1990. The increased overall market share of light trucks, which in recent years have averaged 5-7 mpg lower than cars, accounted for much of the decline in fuel economy of the overall new light-duty vehicle fleet from MY1987 through MY2004.

The MY2008 light truck market share is projected to be 48 percent, based on pre-model year sales projections by automakers. It is likely that actual light truck market share will be less than 48 percent, due to the impact of high gasoline prices on consumers.

Sales Fraction by Vehicle Type
(Annual Data)



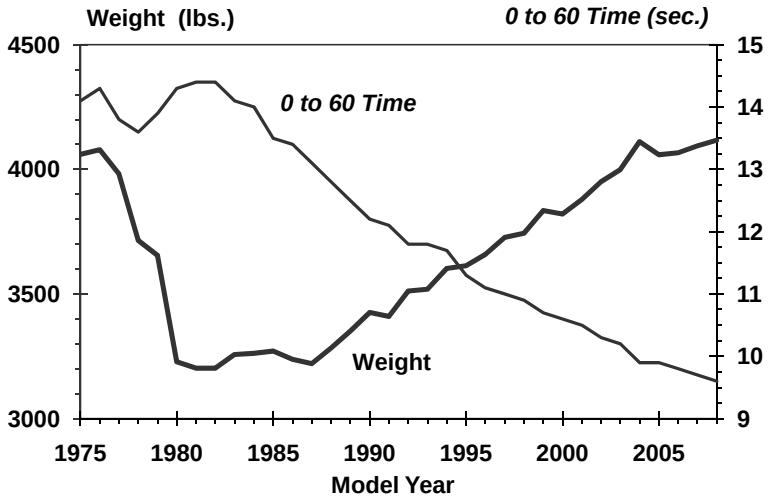
Highlight #3: Technological Innovation Since 2005 Is Being Used for Higher Fuel Economy and Performance.

Automotive engineers are constantly developing more advanced and efficient vehicle technologies. From 1987 through 2004, on a fleetwide basis, this technology innovation was utilized exclusively to support market-driven attributes other than fuel economy, such as vehicle weight (which supports vehicle content and features), performance, and utility. Beginning in MY2005, technology has been used to increase both fuel economy and performance, while keeping vehicle weight relatively constant.

Vehicle weight and performance are two of the most important engineering parameters that help determine a vehicle's fuel economy. All other factors being equal, higher vehicle weight (which supports new options and features) and faster acceleration performance (e.g., lower 0-to-60 mile-per-hour acceleration time), both decrease a vehicle's fuel economy. Average vehicle weight and performance had increased steadily from the mid-1980s through 2004.

Average light-duty vehicle weight has been fairly constant since 2004, with a small increase in weight of cars offset by a small decrease in truck market share. Average fleetwide performance has improved slightly in MY2006 and MY2007. The projection for MY2008 is for a small increase in both vehicle performance and weight, but it is likely that weight, and possibly performance as well, will be lower in MY2008 once we get final sales data.

Weight and Performance
(Annual Data)

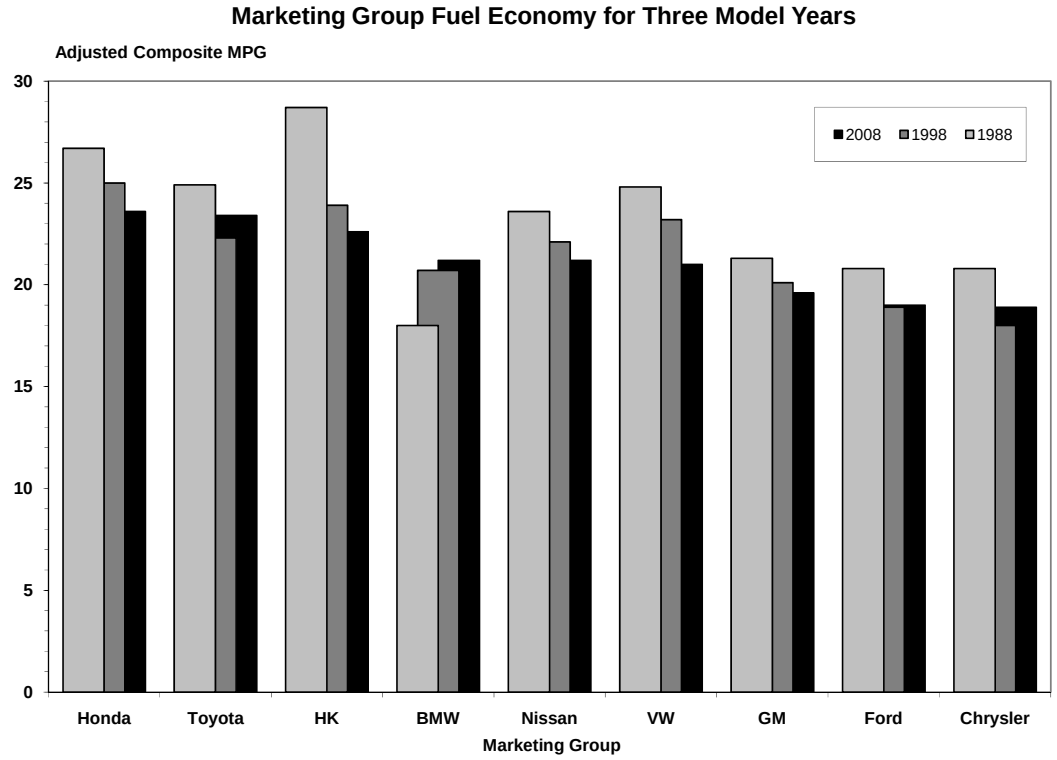


Highlight #4: Differences between Marketing Group Fuel Economies Are Narrowing.

In 1987, when industry-wide fuel economy peaked, some major marketing groups had average fuel economies 6 to 8 mpg higher than other top marketing groups. The typical difference between higher and lower fuel economy marketing groups is now 3 to 4 mpg. Most, if not all, of these marketing groups will likely have higher MY2008 fuel economy values when final sales data is reported, due to higher gasoline prices.

For MY2008, the nine highest-selling marketing groups (that account for over 95 percent of all sales) fall into three fuel economy groupings: Honda, Toyota, and Hyundai-Kia (HK) have estimated fuel economies of 22.6 to 23.6 mpg; BMW, Nissan, and Volkswagen have projected fuel economies of 21.0 to 21.2 mpg; and General Motors, Ford, and DaimlerChrysler have estimated fuel economies of 18.9 to 19.6 mpg. Note that these adjusted fuel economy values for marketing groups can not be directly compared to those in reports in this series prior to 2007, since this year's report uses the new methodology where adjusted fuel economy values since 2005 are, on average, about 6% lower than in previous reports.

Each of these marketing groups has lower average fuel economy today than in 1988, with the exception of BMW. Since then, the differences between marketing group fuel economies have narrowed considerably, with some of the higher mpg marketing groups in 1988 showing larger fuel economy decreases since 1988. Three of the marketing groups show a slight increase in average fuel economy since 1998: Toyota, BMW, and Chrysler. For MY2008, Volkswagen and BMW are the only two of the nine highest-selling marketing groups to have a projected truck market share of less than 39 percent.



Important Notes with Respect to the Data Used in This Report

Most of the fuel economy values in this report are a single *adjusted* composite (combined city/highway) fuel economy value, based on the real-world estimates for city and highway fuel economy provided to consumers on new vehicle labels, in the EPA/DOE *Fuel Economy Guide*, and in EPA's *Green Vehicle Guide*.

This 2008 report supersedes all previous reports in this series, which date back to the early 1970s. In general, users of this report should rely exclusively on data in this 2008 report, which covers the years 1975 through 2008, and not try to make comparisons to data in previous reports in this series. There are at least two reasons for this.

One, EPA revised the methodology for estimating real-world fuel economy values in December 2006. This is the second report in this series to reflect this new real-world fuel economy methodology, and every adjusted (ADJ) fuel economy value in this report for 1986 and later model years is lower than given in reports in this series prior to the 2007 report. Accordingly, adjusted fuel economy values for 1986 and later model years should not be compared with the corresponding values from pre-2007 reports. These new downward adjustments are phased in, linearly, beginning in 1986, and for 2005 and later model years the new adjusted composite (combined city/highway) values are, on average, about 6% lower than under the methodology previously used by EPA. See Appendix A for more in-depth discussion of this new methodology and how it affects both the adjusted fuel economy values for individual models and the historical fuel economy trends database.

Two, when EPA changes a marketing group definition to reflect a change in the industry's financial arrangements, EPA makes the same adjustment in marketing group composition in the historical database as well. This maintains a consistent marketing group definition over time, which allows the identification of trends over time. On the other hand, it means that the database does not necessarily reflect actual past financial arrangements. For example, the 2008 database no longer reflects the fact that Chrysler was combined with Daimler for several years.

In some tables and figures in this report, a single *laboratory* composite (combined city/highway) value is also shown. Because the underlying methodology for generating and reporting laboratory fuel economy values has not changed since this series began in the mid-1970s, these laboratory fuel economy values provide an excellent basis for comparing long-term fuel economy trends from the perspective of vehicle design, apart from the factors that affect real-world fuel economy that are reflected in the adjusted fuel economy values. For 2005 and later model years, laboratory composite fuel economy values are, on average, about 25% greater than adjusted composite fuel economy values.

Formal Corporate Average Fuel Economy (CAFE) compliance data as reported by the Department of Transportation's National Highway Traffic Safety Administration (NHTSA) do not correlate precisely with either the adjusted or laboratory fuel economy values in this report. While EPA's laboratory composite fuel economy data form the cornerstone of the CAFE compliance database, NHTSA must also include credits for alternative fuel vehicles and test procedure adjustments (for cars only) in the official CAFE calculations. Accordingly, NHTSA CAFE values are at least 25% higher than EPA adjusted fuel economy values for model years 2005 through 2008.

In general, car/truck classifications in this database parallel classifications made by NHTSA for CAFE purposes and EPA for vehicle emissions standards. However, this report

relies on engineering judgment, and typically there are a few cases each model year where the methodology used for classifying vehicles for this report results in differences in the determination of whether a given vehicle is classified as a car or a light truck. See Appendix A for a list of these exceptions.

The data presented in this report were tabulated on a model year basis, but many of the figures in this report use three-year moving averages that effectively smooth the trends, and these three-year moving averages are tabulated at the midpoint. For example, the midpoint for model years 2006, 2007, and 2008 is MY2007. Figures are based on annual data unless otherwise noted.

All of the data in this report are from vehicles certified to operate on gasoline or diesel fuel. There are no data from the very small number of vehicles that are certified to operate only on alternative fuels. The data from ethanol flexible fuel vehicles, which can operate on both an 85 percent ethanol/15 percent gasoline blend or gasoline, are from gasoline operation.

All average fuel economy values were calculated using harmonic rather than arithmetical averaging, in order to maintain mathematical integrity. See Appendix A.

The EPA fuel economy database used to generate the fuel economy trends database in this report was frozen in January 2008, yielding additional data beyond that used in last year's report for model years beginning in 2005, although additional data for MY2007 was added in April 2008.

Through MY2006, the fuel economy, vehicle characteristics, and sales data used for this report were from the formal end-of-year submissions from automakers obtained from EPA's fuel economy database that is used for CAFE compliance purposes. Accordingly, values for all model years up to 2006 can be considered final.

For MY2007, the data used in this report are based on a database where about 80 percent of the total sales are from formal end-of-year CAFE submissions by automakers, and about 20 percent are from confidential pre-model year sales projections submitted to the Agency by the automakers, with these latter projections updated based on actual 2007 sales data reported in trade publications. EPA has a high level of confidence in the data for MY2007, given that 80 percent of the 2007 data is based on actual CAFE reports. It is noteworthy that the 20.6 mpg adjusted fuel economy value for MY2007 in this report is 0.4 mpg higher than the projected 20.2 mpg adjusted fuel economy value for MY2007 in the 2007 report. This suggests that higher gasoline prices have led to actual 2007 sales that differ from the projected 2007 sales provided to EPA by automakers in 2006.

For MY2008, EPA has exclusively used confidential pre-model year sales projections. Accordingly, MY2008 projections are much more uncertain, particularly given the changes in the automotive marketplace driven by higher fuel prices. For model years 1998 through 2005, the final laboratory fuel economy values for a given model year have varied from 0.4 mpg lower to 0.4 mpg higher compared to original estimates for the same model year that were based exclusively on projected sales.

For More Information

Light-Duty Automotive Technology and Fuel Economy Trends: 1975 through 2008 (EPA420-R-08-015) is available on the Office of Transportation and Air Quality's (OTAQ) Web site at:

www.epa.gov/otaq/fetrends.htm

Printed copies are available from the OTAQ library at:

U.S. Environmental Protection Agency
Office of Transportation and Air Quality Library
2000 Traverwood Drive
Ann Arbor, MI 48105
(734) 214-4311

A copy of the *Fuel Economy Guide* giving city and highway fuel economy data for individual models is available at:

www.fueleconomy.gov

or by calling the U.S. Department of Energy at (800) 423-1363.

EPA's *Green Vehicle Guide* providing information about the air pollution emissions and fuel economy performance of individual models is available on EPA's web site at:

www.epa.gov/greenvehicles

For information about the Department of Transportation (DOT) Corporate Average Fuel Economy (CAFE) program, including a program overview, related rulemaking activities, and summaries of the fuel economy performance of individual manufacturers since 1978, see:

www.nhtsa.dot.gov and click on "Fuel Economy"