DOE/EIA-0464(91)
Distribution Category UC-950

Household Vehicles Energy Consumption 1991

December 1993

Energy Information Administration
Office of Energy Markets and End Use
U.S. Department of Energy
Washington, DC 20585

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As part of EIA's mission to provide meaningful data, the consumption surveys have ongoing user needs efforts to ascertain the requirements of its users. If you have any suggestions to make the data in this report more useful to your needs, please contact F. Ronald Lambrecht, RTECS Manager, at 202-586-4962 or at the address below.

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Executive Summary

This report, *Household Vehicles Energy Consumption 1991,* is based on data from the 1991 Residential Transportation Energy Consumption Survey (RTECS). Focusing on vehicle miles traveled (VMT) and energy end-use consumption and expenditures by households for personal transportation, the 1991 RTECS is the fifth in a series conducted since 1978 by the Energy Information Administration (EIA). Over 3,000 households with more than 6,000 vehicles were surveyed, providing information on their vehicle stock and annual miles traveled per vehicle. The information provided represents the characteristics and energy consumption of the 84.6 million households with vehicles nationwide. An additional 10 million households did not own or have access to a vehicle during the survey year.

Use of residential vehicles and fuels in 1991 showed little change from 1988 and was indicative of the current state of personal transportation in America. Two noticeable changes for 1991 were a small increase in the average number of miles traveled both per household[1] and per vehicle, and a slight decrease in the average consumption of motor vehicle fuel per household. An increase in the average fuel efficiency (miles per gallon-MPG), was the reason for the decreased consumption. However, vehicle fuel expenditures per household rose by 16 percent between 1988 and 1991, primarily due to a 21 percent rise in the price of vehicle fuel.

Results from the 1991 RTECS indicate that:

- Annual vehicle miles traveled per household and per vehicle were 18.9 and 10.6 thousands respectively.

- The average number of vehicles per household did not change between the 1988 and 1991 RTECS: Both surveys reported approximately 1.8 vehicles per household.

- The total number of vehicles in the U.S. stock by vehicle type remained approximately the same for 1991 and 1988. The exception has been minivans and sport-utility vehicles (listed as jeep-like vehicles in previous publications), which have almost doubled from 7 million to 12.4 million and are classified as trucks for fuel efficiency standards.

- Approximately 9 percent of the vehicle stock consisted of pre-1975 models.

- Average fuel consumption was 979 gallons per household and 548 gallons per vehicle, both down slightly from 1988, though not statistically significant.

- In 1991, the average on-road vehicle MPG was 19.3, up 5 percent from 18.3[2] in 1988. This change resulted from retiring old vehicles and purchasing newer models which are more fuel efficient. The size of the increase was limited by the increased sales of vehicles classified as trucks (i.e., minivans and sport-utility), which have lower fuel efficiency standards[3].

[1]Per household numbers are only for households with vehicles unless otherwise stated.

[2]The methodologies for calculating fuel efficiency, fuel consumption, and fuel expenditures were the same as in the 1988 RTECS. See Appendix B, "Estimation Methodologies" and Appendix C, "Quality of the Data."

[3]According to Department of Transportation statistics, there has been essentially no improvement in the overall efficiency of the new car fleet for the last 10 years. In actuality, efficiency has been declining since 1988. The availability of inexpensive fuels, desire for larger and faster vehicles, and flashy advertising are probably the main factors contributing to this phenomena.

- In 1991, households spent an average of $1,161 for vehicle fuel compared to $998 per household in 1988.

- Lower-income households appear to be paying a larger percentage of their income on vehicle fuel.

- Household vehicles consumed 10.3 quadrillion Btu of vehicle fuel, the same as in 1988. This represents approximately 31 percent of the 32.8 quadrillion Btu of all petroleum consumption in the United States and 13 percent of the total U.S. energy consumption of 81.1 quadrillion Btu.

- In 1991, combined household energy expenditures were $2,333 for both their housing unit and vehicles, with vehicle fuel purchases accounting for 50 percent. In 1988 only 47 percent of household energy expenditures were for vehicle fuel.

The 1991 RTECS provides baseline information on motor vehicle use in the residential sector. To be included in this survey one of two criteria must be met. Vehicles must be (1) owned or used by household members on a regular basis for personal transportation or (2) company vehicles, not owned by the household, but kept at home and regularly available to household members. Data from the RTECS and a companion household survey, the Residential Energy Consumption Survey, are available to the public in published reports and on public-use personal computer diskettes for the 1988 and 1991 surveys and on 9-track tapes for all years.[4]

Table ES1 summarizes selected vehicle energy-related items from the 1991 RTECS. This table allows the reader to easily discern energy information related to vehicle characteristics. The household averages in this table are based on households with vehicles.

Table ES1. Summary of Vehicle Characteristics by Census Region, 1991

Vehicle Characteristics	U.S. Total	Northeast	Midwest	South	West
Number of Households (millions)	94.6	19.3	23.4	32.3	19.6
Number of Households with Vehicles (millions)	84.6	16.0	21.1	29.5	18.0
Number of Vehicles (millions)	151.2	27.0	38.4	52.7	33.2
Vehicle Miles Traveled (billions)	1,602	295	403	571	333
Vehicle Fuel Consumption (billion gallons)	82.8	14.1	21.3	29.8	17.6
Number of Vehicles per Household	1.8	1.7	1.8	1.8	1.8
Vehicle Miles Traveled per Household (thousands)	18.9	18.5	19.1	19.3	18.5
Vehicle Miles Traveled per Vehicle (thousands)	10.6	10.9	10.5	10.8	10.0
Vehicle Fuel Efficiency (miles per gallon)	19.3	20.9	19.0	19.2	18.9

Note: Because of rounding, data may not sum to totals.

[4]See Appendix F, "Related EIA Publications on Energy Consumption," for a list of EIA publications available concerning the consumption of energy.

Source: Energy Information Administration, Office of Energy Markets and End Use, 1991 Residential Transportation Energy Consumption Survey.

1. Introduction

The purpose of this report is to provide information on the use of energy in residential vehicles in the 50 States and the District of Columbia. Included are data about: the number and type of vehicles in the residential sector, the characteristics of those vehicles, the total annual Vehicle Miles Traveled (VMT), the per household and per vehicle VMT, the vehicle fuel consumption and expenditures, and vehicle fuel efficiencies.

The Energy Information Administration (EIA) is mandated by Congress to collect, analyze, and disseminate impartial, comprehensive data about energy--how much is produced, who uses it, and the purposes for which it is used. To comply with this mandate, EIA collects energy data from a variety of sources covering a range of topics[1].

Background

The data for this report are based on the household telephone interviews from the 1991 RTECS, conducted during 1991 and early 1992. The 1991 RTECS represents 94.6 million households, of which 84.6 million own or have access to 151.2 million household motor vehicles in the 50 States and the District of Columbia.

The RTECS is a national multistage probability sample survey conducted on a triennial basis. The 1991 RTECS was the fourth RTECS covering a calendar year. Previous RTECS were conducted monthly from June 1979 to September 1981, 1983, then every 3 years beginning in 1985. The next RTECS, scheduled for 1994, will continue the 3-year cycle. The RTECS, a subsample of the Residential Energy Consumption Survey (RECS), is an integral part of a series of surveys designed by the EIA to collect data on energy use in the residential sector. The EIA also conducts energy consumption surveys in the commercial and manufacturing sectors.

Baseline information about the RTECS household and vehicle stock was collected during the RECS personal interview in the fall of 1990. In 1991, further data about the vehicle stock and vehicle miles traveled (VMT) were collected via telephone interviews. Mail questionnaires were used for households that could not be contacted by telephone. Data were collected three times during the calendar years 1991 and 1992. The beginning-of-year data collection was scheduled for January 1991, but was delayed until March because of the onset of the Persian Gulf conflict. The subsequent mid-year data collection scheduled for May and June was, therefore, delayed until July and August of 1991. The primary purpose of this data collection was to identify vehicles acquired or disposed of during the first half of the year and to obtain estimated beginning or final odometer readings on these vehicles. The end-of-year data collection took place as originally scheduled, during January and February of 1992. (See Appendix A, "How the Survey Was Conducted.")

The RTECS was designed to collect actual VMT for each vehicle in the household by obtaining the odometer reading at two points in time. The vehicle characteristic information was collected directly from the respondents and the decoded Vehicle Identification Number (VIN). Vehicle fuel consumption and expenditures were estimated using vehicle fuel efficiencies, presented in miles per gallon (MPG) from the Environmental Protection Agency, and motor

[1]EIA conducts numerous energy-related surveys. In general, the surveys can be divided into two broad groups. One group of surveys is directed to the suppliers and marketers of specific sources. These surveys--called supply surveys--measure the quantities of specific fuels produced and/or supplied to the market. The results of the supply surveys are combined and published in the *Monthly Energy Review* and other EIA publications. The second group--the consumption surveys--gathers information on the types of energy used by the end users along with the characteristics of those end users that can be associated with energy use. The RTECS belongs to the consumption group because it collects information directly from the end user--the household.

fuel prices from the Bureau of Labor Statistics. (See Appendix B, "Estimation Methodologies," for detailed information about the procedures used to estimate the MPG and the consumption and expenditures.)

The statistics published in this report are based on a sample from the population of all residential housing units in the 50 States and the District of Columbia as of November 1990. As a result, all the values are estimates rather than exact measures for the population. As described in Appendix C, "Quality of the Data," the accuracy of each estimate is indicated by its relative standard error (RSE). For tables showing household counts, no estimates were published that were based on fewer than 10 sample households. For tables showing vehicle counts, no estimates were published that were based on fewer than 18 sample vehicles. In addition, data were suppressed when the RSE for the estimate exceeded 50 percent. Each table of estimates in the section titled "Detailed Statistics" includes row and column RSE factors, to be used in calculating RSE's for individual table entries.

Unless stated otherwise, all comparisons reported in the text are statistically significant, based on a standard test made at the 0.05 significance level. No adjustments were made for simultaneous inference. See Appendix C for further details.

EIA gratefully acknowledges the cooperation of the respondents in supplying the information used to produce the estimates presented here.

Other Data Sources

This report also presents data from other sources that collect similar types of data. The two primary sources are the Federal Highway Administration's publication, *Nationwide Personal Transportation Survey (NPTS)* and the publication, *Highway Statistics 1991*. The NPTS is a survey of personal travel that is conducted about every 7 years. The *Highway Statistics 1991* is part of an annual series that is a compilation of transportation data provided by State and local governments. R. L. Polk and Company also collects data on vehicle registrations for vehicles in the 50 States and the District of Columbia.

Organization of the Report

A detailed discussion of the highlights presented in the Executive Summary follows this section. The major sections are on "Vehicle Miles Traveled," "Trends in Household Vehicle Stock," and "Vehicle Fuel Efficiency and Consumption." Tables and figures interspersed throughout the text highlight information of special interest or summarize a finer breakdown given in the detailed tables.

The detailed statistics that appear in the "Detailed Tables" section following the main text contain extensive crosstabulations of household characteristics, vehicle characteristics, and vehicle fuel consumption and expenditures. Appendix A, "How the Survey Was Conducted," contains information about how the data were collected and processed. The estimation procedures used are described in Appendix B, "Estimation Methodologies." Appendix C, "Quality of the Data," includes information on how to calculate RSE's for data in the tables.

The data for the RTECS are collected on Forms EIA-457A, EIA-457B and EIA-876A through D found in Appendix D, "Survey Forms." The Climate Zones and Census Regions and Divisions Maps are located in Appendix E. A list of related EIA publications on energy consumption is found in Appendix F. Definitions of the terms used in this report are located in the "Glossary."

1991 RTECS Survey Design

There were no major changes in the survey design and the data collection procedures between the 1988 and 1991 RTECS. In the 1985 and previous RTECS, the on-road vehicle fuel efficiencies and vehicle fuel prices were obtained by asking the respondents to maintain fuel purchase diaries for a 1-month period. The respondents were randomly assigned to a 1-month panel covering a calendar year. Fuel efficiencies, in terms of MPG, were then calculated directly using the monthly recorded vehicle fuel consumption and the recorded monthly VMT. In the 1988 and 1991 RTECS, the MPG were estimated using the Environmental Protection Agency's (EPA) certification files of test laboratory MPG estimates adjusted for on-road use. The vehicle-fuel price was estimated using the Bureau of Labor Statistics (BLS) price data. A data file from the Highway Loss Data Institute was used to decode the Vehicle Identification Number (VIN). The VIN was used to enhance the accuracy of vehicle characteristics that were used for matching the RTECS vehicles to EPA's certification files. (See Appendix A, "How the Survey was Conducted," for a detailed discussion of the changes in the survey design and Appendix B, "Estimation Methodologies," for a discussion of the procedures used for calculating the fuel efficiencies, adjusting the MPG for on-road efficiency shortfall, and the motor fuel consumption and expenditures data.)

2. Trends in Household Vehicle Stock

The 1991 RTECS counted more than 150 million vehicles in use by U.S. households. This chapter examines recent trends in the vehicle stock, as measured by the RTECS and other reputable vehicle surveys. It also provides some details on the type and model year of the household vehicle stock, and identifies regional differences in vehicle stock. Because vehicles are continuously being bought and sold, this chapter also reports findings relating to turnover of the vehicle stock in 1991. Finally, it examines the average vehicle stock in 1991 (which takes into account the acquisition and disposal of household vehicles over the course of the year) and identifies variations in the average number of household vehicles based on differences in household characteristics.

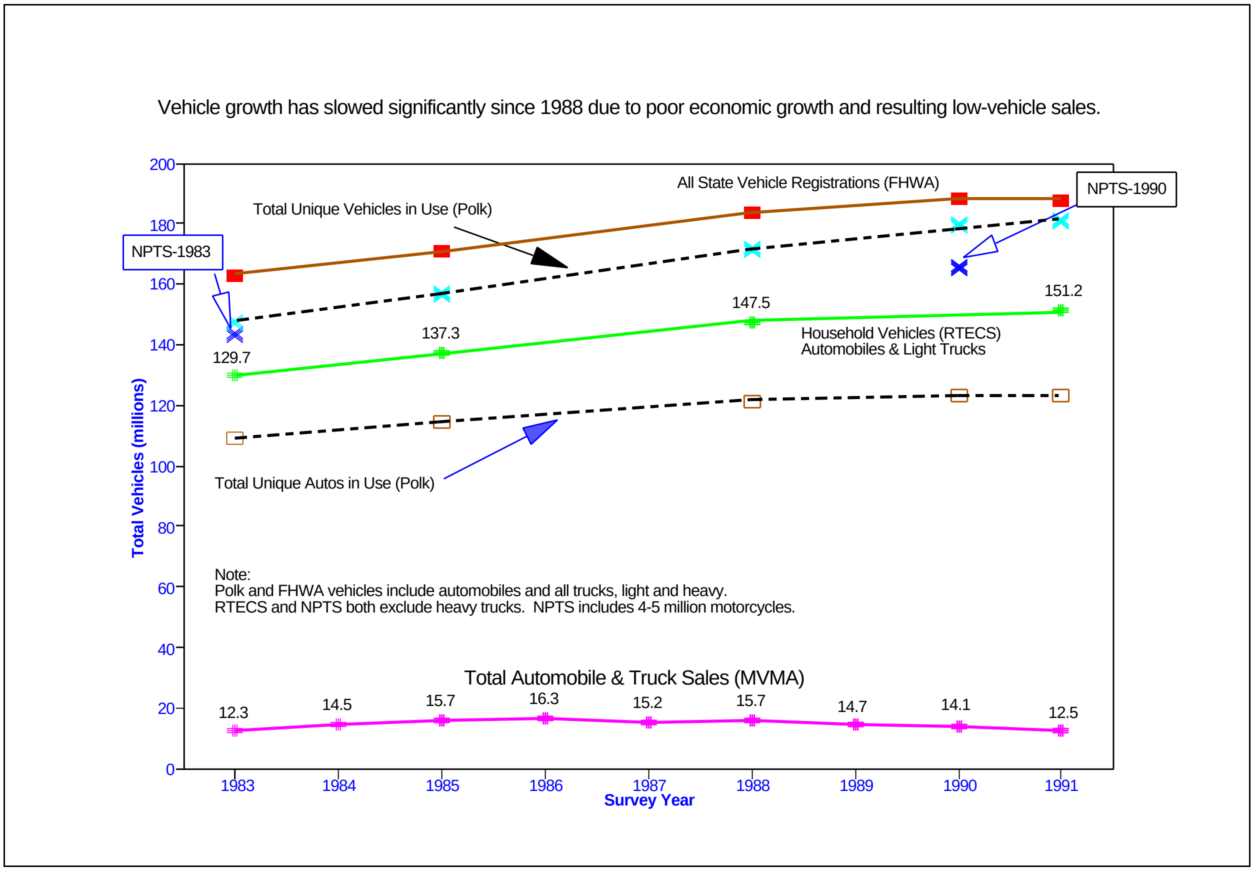
Number of Household Vehicles

Over the past 8 years, the stock of household vehicles has increased at about the same pace as the number of households with vehicles (17 percent). Recently, the increase in vehicle stock slowed considerably, increasing by only 3.7 million vehicles (about 2.5 percent) between 1988 and 1991 according to RTECS counts. This increase represents the net gain from the excess of vehicle sales over vehicle retirements, and is consistent with the decline in total sales of new vehicles due to slow economic growth (Figure 1).

Figure 1. RTECS and Other Estimates of Households and Total Vehicles

Sources: Federal Highway Administration, *Highway Statistics 1991*, Table MV-1, October 1992; Department of Energy, *Transportation Energy Data Book*, March 1993, R. L. Polk and Company data (data not to be further reproduced); Motor Vehicle Manufacturers Association, 1992.

Between 1983 and 1991, the total number of vehicles in use (based on the Polk data) increased by 23 percent, from 147 million to 181 million vehicles, while the number of vehicles used strictly for household purposes (based on the RTECS data) increased by 17 percent (from about 130 million to over 150 million vehicles). Nevertheless, household vehicles continue to represent the largest share of all vehicles on the road. The remaining vehicles included in total vehicles are either commercial fleet automobiles or commercial trucks (See Table 1).



The 1991 RTECS count includes vehicles that were owned or used on a regular basis by 84.6 million households (about 89 percent of the total 94.6 million households). The number of households without vehicles (households that do not own or use a vehicle on a regular basis as defined by RTECS) has remained nearly constant at 10 million households since 1983. As a percentage of total households in the RTECS, however, households without vehicles have declined from 14 percent of all RTECS households in 1983 to 12 percent in 1991. In 1991, households without vehicles were principally one- or two-person white households with no children, living in urban neighborhoods in the Northeast or Midwest and earning below $15,000 (per household).

Table 1. Comparison of Household and Total Vehicle Stock
(Million Vehicles)

Vehicle Comparison	1983	1985	1988	1990	1991
Automobiles, FHWA	126.4	131.9	141.3	143.5	143.0
Trucks, FHWA	36.7	39.2	42.5	44.7	44.8
Total, FHWA	163.2	171.1	183.8	188.2	187.7
Household Vehicles RTECS	129.7	137.3	147.5	NS	151.2
Household Vehicles NPTS	143.7	NS	NS	165.2	NS
Autos in Use, Polk	109.0	114.7	121.5	123.3	123.3

Vehicle Counts

In addition to the RTECS survey, other sources of information on vehicle stock include the Nationwide Personal Transportation Survey (NPTS), Federal Highway Administration (FHWA) estimates of total registered vehicles, and an estimate of actual "vehicles in use" from R.L. Polk & Company. The range of estimates (Figure 1) make data comparisons among these sources difficult: (1) Only the RTECS and NPTS estimates represent actual household vehicle stock; (2) The FHWA estimated total vehicle registrations (automobile plus light and heavy trucks) includes duplicate registrations of some vehicles in different states; and (3) The proprietary data from R.L. Polk & Company eliminates these duplicate registrations, but counts only those vehicles in use on a particular date.

Because the FHWA and Polk estimates do not distinguish between household and other vehicles, the only direct estimates of the household vehicle stock are from the RTECS and the NPTS. The RTECS survey:

- Includes automobiles, station wagons, passenger and cargo vans, motor homes, pickup trucks, and sport-utility vehicles used for personal transportation on a regular basis by members of a household.

- Includes vehicles that are owned by the household, vehicles that are rented or leased by the household for a period of 1 month or longer, and company cars and other business vehicles that are not owned by the household but are available regularly for the personal use of household members.

- Excludes motorcycles, bicycles, all-terrain vehicles (ATV's), and other related vehicles.

The NPTS estimates of household vehicles are systematically higher than the RTECS estimates (see Chapter 3) because they include motorcycles and more commercial fleet vehicles used by households.

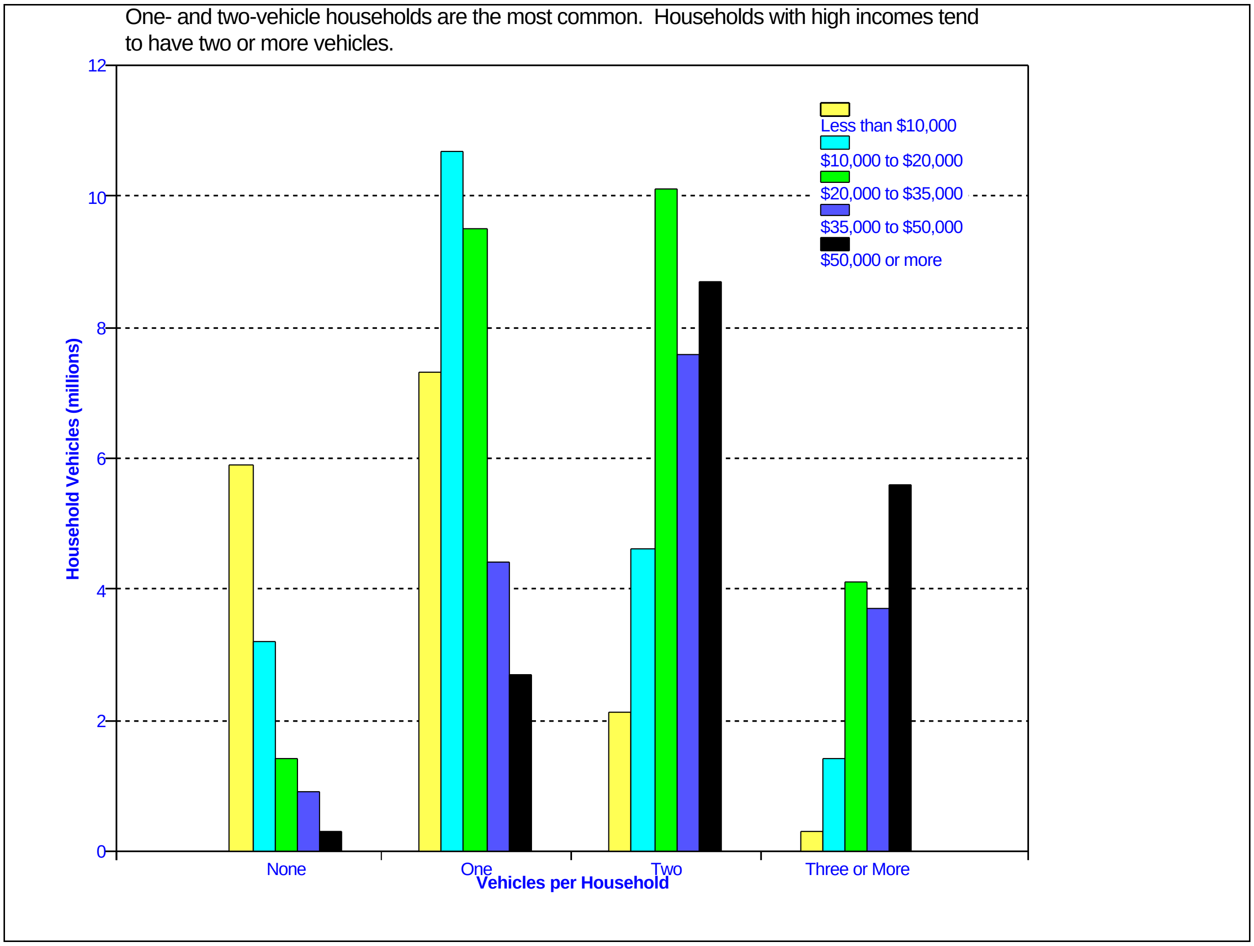
The vehicle count for the RTECS and the Polk estimates is taken at a single point in time (July 1 of each survey year), as opposed to the FHWA and NPTS estimates, which are based on a cumulative count over the year. The FHWA count of all types of vehicles has risen at about the same rate as the count of RTECS vehicles used for personal transportation, even though the aggregate FHWA estimates include some double counting.

Trucks in Use, Polk	38.1	42.4	50.2	56.0	58.2
Total in Use, Polk	147.1	157.0	171.7	179.3	181.4
Auto Sales MVMA	9.2	11.0	10.5	9.3	8.3
Truck Sales MVMA	2.6	4.7	5.1	4.8	4.1
Total Sales	11.7	15.7	15.7	14.1	12.5

NS = No survey that year.
Note: Because of rounding, data may not sum to totals.
Sources: Federal Highway Administration, *Highway Statistics 1991*, Table MV-1, October 1992; Department of Energy, *Transportation Energy Data Book*, March 1993, R. L. Polk and Company data (data not to be further reproduced); Motor Vehicle Manufacturers Association, 1992.

In July 1991, most RTECS households had either one or two vehicles. About 37 percent owned or used only one vehicle, 35 percent had two vehicles, 16 percent had three or more vehicles, and 12 percent did not own or use a vehicle on a regular basis (Figure 2). The number of vehicles in RTECS households varied substantially by the level of family income. Of the 15.6 million households with annual family incomes below $10,000, 38 percent did not own or have regular use of a vehicle, and 47 percent had only one vehicle. In contrast, about one-third of the 17.3 million households earning at least $50,000 per year had three or more vehicles (Table 2). Only 2 percent of the higher income group did not have any vehicles, and 16 percent had only one vehicle.

Figure 2. Total Household Vehicle Ownership, and Ownership by Income



Source: Energy Information Administration, Office of Energy Markets and End Use, 1991 Residential Transportation Energy Consumption Survey.

Table 2. Households by Number of Vehicles and 1990 Family Income, July 1991

1990 Annual Family Income	Total Households (million)	Number of Vehicles			
		None	One	Two	Three or More
Total	94.6	11.7	34.6	33.1	15.1
Less than $5,000	5.2	2.6	1.9	0.6	0.1
$5,000 to $9,999	10.4	3.3	5.4	1.5	0.2
$10,000 to $19,999	19.8	3.2	10.7	4.6	1.4
$20,000 to $34,999	25.1	1.4	9.5	10.1	4.1
$35,000 to $49,999	16.7	0.9	4.4	7.6	3.7
$50,000 or More	17.3	0.3	2.7	8.7	5.6

Note: Because of rounding, data may not sum to totals.

Source: Energy Information Administration, Office of Energy Markets and End Use, 1991 Residential Transportation Energy Consumption Survey.

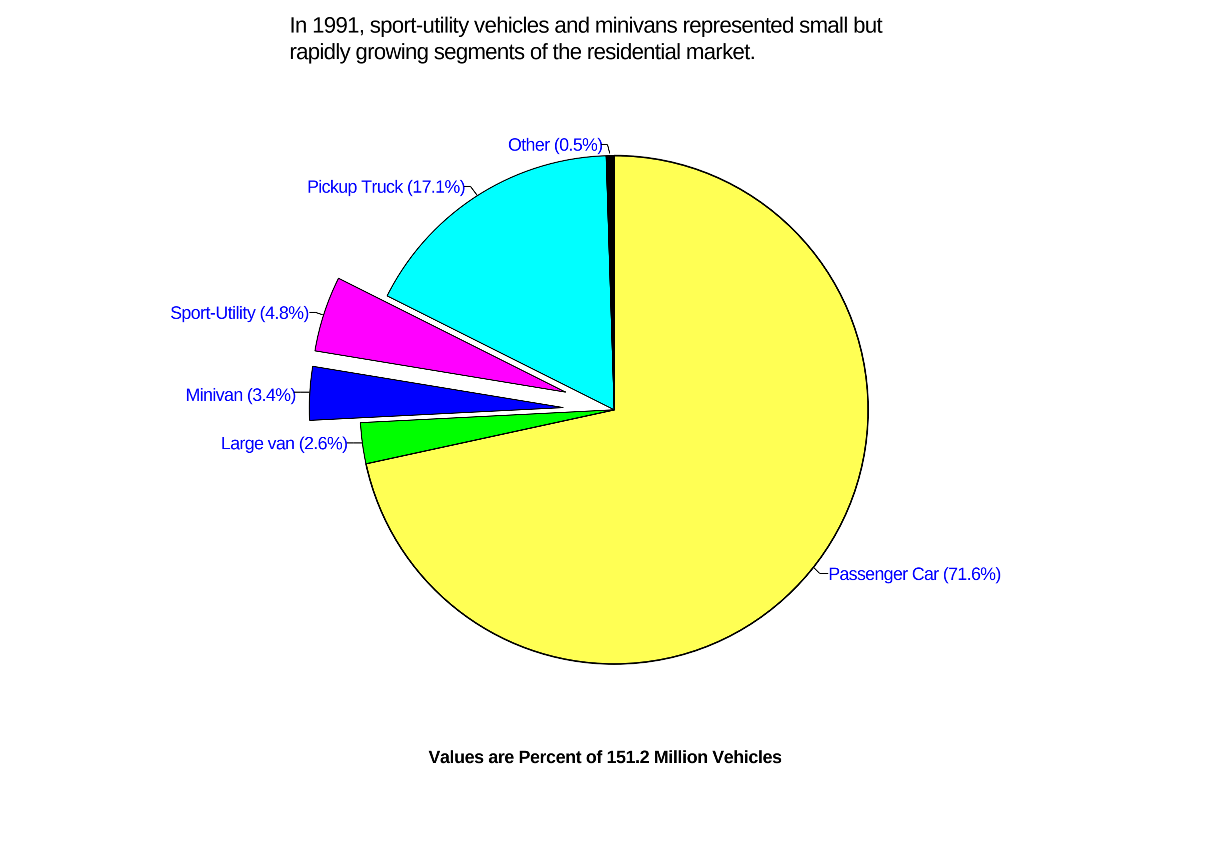
Vehicle Stock Composition

Vehicle Type

Despite low overall sales of vehicles, minivans and sport-utility vehicles continued to make large gains in their market share of the U.S. fleet in the 1988 to 1991 period. Minivans and sport-utility vehicles increased their share of the household vehicle stock from 4.7 percent in 1988 to 8.2 percent in 1991. The total number of these vehicles reached 12.4 million in 1991, an increase of 77 percent since 1988, compared with an the overall increase of only 2.5 percent for all residential vehicles (Figure 3).

Meanwhile, the total number of passenger cars, including station wagons, changed from 109.3 million in 1988 to 108.3 million in 1991; the number of pickup trucks remained the same. Both, however, decreased as a percentage of the total residential fleet. Large vans continued their decline in both absolute numbers (from 4.7 million in 1988 to 3.9 million in 1991) and percentage of the total fleet.

Figure 3. Household Vehicle Composition, 1991



Source: Energy Information Administration, Office of Energy Markets and End Use, 1991 Residential Transportation Energy Consumption Survey.

Vehicle Model Year

In 1991, the newest vehicles (model years 1989-1992) made up about 19 percent of the total household vehicle stock while the oldest vehicles (pre-1977 models) made up 12 percent. Nearly half (46 percent) of all vehicles were from model years 1983-1988. The remaining 23 percent of the household vehicles were from model years 1977-1982.

About one-third of the oldest vehicles (pre-1977 models) were in the West (Table 3 and Figure 4). Pre-1977 vehicles accounted for a larger share of vehicles in the West than in any other region (about 18 percent compared to only 6 percent in the Northeast).

Table 3. Number of Vehicles by Model Year and Census Region, 1991

Vehicle Model	U.S. Total	Northeast	Midwest	South	West
Total Vehicles (million)	151.2	27.0	38.4	52.7	33.2
1991 to 1992	5.5	1.0	1.3	2.0	1.2
1990	10.5	2.3	2.7	3.6	1.9
1989	12.5	2.8	3.0	4.4	2.3
1986 to 1988	39.0	8.8	9.6	12.7	7.8
1983 to 1985	31.1	5.8	8.2	11.0	6.1
1980 to 1982	17.5	3.0	4.3	6.5	3.8
1977 to 1979	16.7	1.8	4.8	6.2	3.9
1976 or Earlier	18.4	1.5	4.4	6.3	6.1

Note: Because of rounding, data may not sum to totals.
Source: Energy Information Administration, Office of Energy Markets and End Use, 1991 Residential Transportation Energy Consumption Survey.

Change in Vehicle Stock

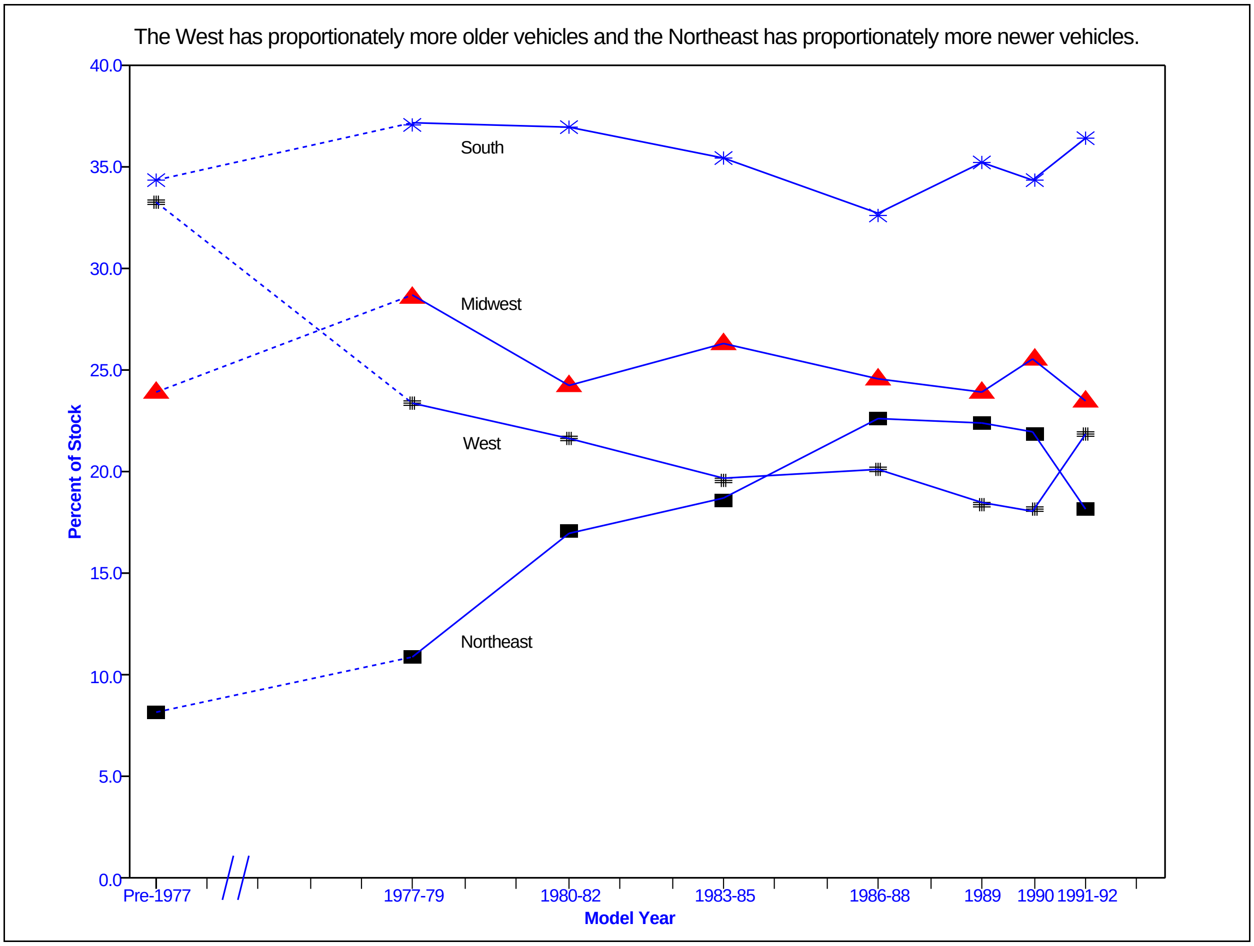
In 1991, about one-third of all RTECS households (31 million households) made some type of change in their vehicle stock (Table 4). Of the households that made a change in vehicle stock during 1991:

- 20 percent acquired one or more vehicles without disposing of any.
- 35 percent disposed of one or more vehicles without acquiring any.
- 45 percent acquired and disposed of at least one vehicle.

Some of the acquisitions and disposals reported in the first two categories may actually be part of a two-step vehicle replacement transaction, but were not reported in the third category because the corresponding transaction did not occur during the time period covered by the RTECS.

The households most likely to make a change were those households with the greater number of vehicles. The 63.6 million households that did not change their vehicle stock in 1991 included the 10 million households that did not own or have available a vehicle in 1991. Forty percent had one vehicle and 44 percent had two or more vehicles.

Figure 4. Vehicle Stock Composition



Source: Energy Information Administration, Office of Energy Markets and End Use, 1991 Residential Transportation Energy Consumption Survey.

Table 4. Changes in Vehicle Stock by Selected Household Characteristics, 1991

Household Characteristics	Households not Changing Vehicles		Households Changing Vehicles	
	(million)	(percent)	(million)	(percent)
Household Composition	63.6	100.0	31.0	100.0
With Children	21.7	34.1	14.1	45.5
Without Children	41.8	65.7	16.9	54.5
Number of Drivers	63.6	100.0	31.0	100.0
None	8.1	12.7	.5	1.6
One	23.7	37.3	7.4	23.9
Two	27.1	42.6	17.1	55.2
Three or More	4.7	7.4	6.1	19.7
Household Size	63.6	100.0	31.0	100.0
One	19.9	31.3	3.9	12.6
Two	20.0	31.4	10.4	33.5
Three or More	23.7	37.3	16.7	53.9

Note: Because of rounding, data may not sum to totals.
Source: Energy Information Administration, Office of Energy Markets and End Use, 1991 Residential Transportation Energy Consumption Survey.

Average Number of Vehicles

In 1991, RTECS households with vehicles averaged 1.8 vehicles each. This has not changed since the 1988 RTECS (and is only slightly higher than in the 1983 and 1985 RTECS), because the increase in the number of households has kept pace with the increase in the number of household vehicles (Figure 5). The number of vehicles per household varies, however, depending on differences in household characteristics such as household income and household size.

Average Number of Vehicles

In contrast to the vehicle count (which is based on the number of vehicles on July 1), the average number of vehicles is measured over a period of time to account for the significant turnover in vehicle ownership. It represents the effective number of vehicles owned or used by a household on a regular basis for a full year. For example, a household that had two vehicles--one each for 6 months during the year--would be considered to have had one vehicle on average for the entire year. A household that had two vehicles--one for the full year and one for 6 months--would be considered to have had 1.5 vehicles on average for the entire year. Estimates of the average number of vehicles by selected household and vehicle characteristics are provided in "Detailed Tables." (See "Glossary" for the definition of Vehicle and Vehicle Stock.) Unless otherwise stated, all statistics such as vehicle miles traveled and vehicle fuel consumption and expenditures are based on the average number of vehicles, rather than at one preferred point-in-time.

A plausible relationship exists among household income, the number of drivers, and the number of vehicles in the household. Households may acquire vehicles partly for materialistic reasons (such as a perceived boost in their social status). In such a case, higher income households would acquire more vehicles independent of the number of drivers in the households. Alternatively, households may acquire vehicles primarily for practical reasons (as a means of personal transportation). In this case, both household income and the number of drivers would be related to the number of vehicles in the household. Particularly, if a household member requires a vehicle to get to work, ownership of a vehicle would add to the total income of the household (since the household member would be unemployed without the vehicle). Likewise the more workers in a household, the more likelihood of more drivers and vehicles to journey to work and a higher family income.

Family Income

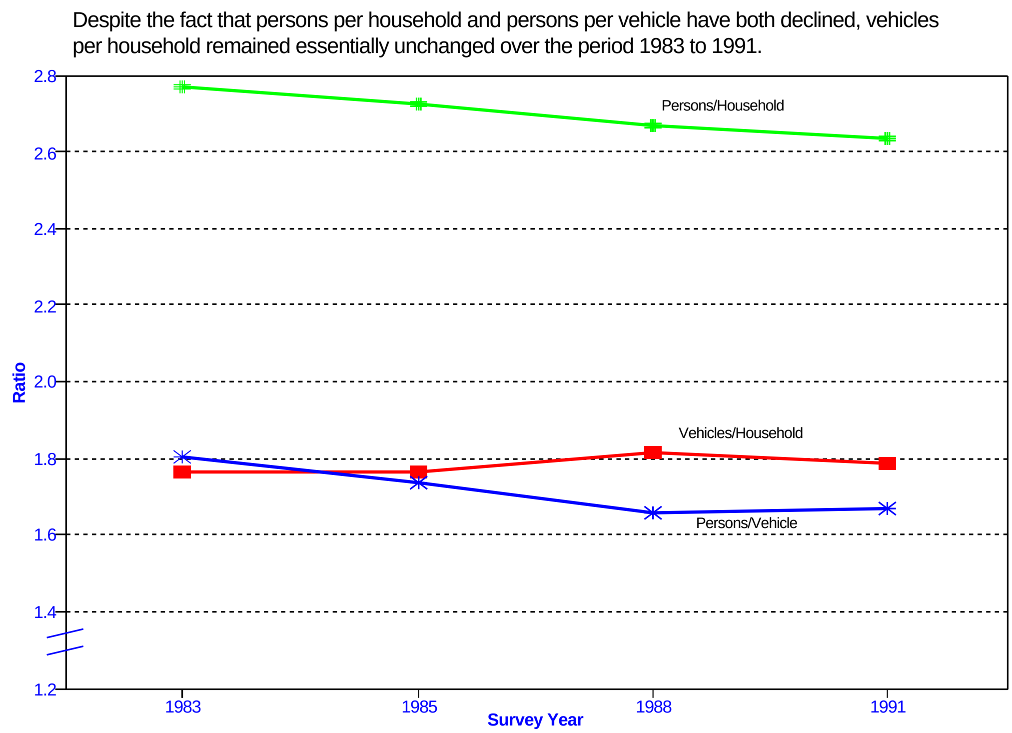
As family income increases, the average number of vehicles in the household increases. Households with annual family incomes of less than $10,000 had the fewest vehicles on average (1.3 vehicles per household). The average number of vehicles rises with each progressively higher income category, from 1.6 vehicles in households earning $10,000-$35,000 per year to 2.1 vehicles in households earning more than $35,000. Not surprisingly, households with the highest family incomes ($75,000 or more) have the largest number of vehicles on average (2.4 vehicles).

Number of Drivers

As the number of drivers in the household increases, the average number of vehicles in the household also increases. Households with only two drivers had 2.0 vehicles per household, compared with 3.1 vehicles in households with four or more drivers. In 1991, about 3 percent of RTECS households had four or more drivers, down from 5 percent in 1988.

Figure 5. Trends in Vehicles and Population Ratios

Source: Energy Information Administration, Office of Energy Markets and End Use, 1991 Residential Transportation Energy Consumption Survey.



Household Composition

The presence of children and the age of the primary driver play a significant role in the number of vehicles per household:

- Households with children old enough to drive (16 or 17 years old) had the most vehicles on average, 2.4 per household. In a traditional nuclear family where both parents drive, such households would usually have a total of three or more drivers.

- Households with children who are not old enough to drive (all under 15 years old) tend to have fewer vehicles than average (1.8 to 1.9 vehicles per household).

- Two-adult households without children, where the householder was between 35 and 59 years old, had 2.2 vehicles per household.

- Householders over 60 years of age and living alone had the least number of vehicles per household.

3. Vehicle Miles Traveled

This chapter presents information on household vehicle usage, as measured by the number of vehicle miles traveled (VMT). VMT is one of the two most important components used in estimating household vehicle fuel consumption. (The other, fuel efficiency, is discussed in Chapter 4). In addition, this chapter examines differences in driving behavior based on the characteristics of the household and the type of vehicle driven. Trends in household driving patterns are also examined using additional information from the Department of Transportation's Nationwide Personal Transportation Survey (NPTS).

Household VMT is a measure of the demand for personal transportation. Demand for transportation may be viewed from either an economic or a social perspective. From the economic point-of-view, the use of a household vehicle represents the consumption of one consumer good to secure other goods or services: household members drive to work, to shop, for recreation, or to socialize. The social perspective takes into account the makeup of the household and the motivation for each vehicle trip.

Total and Average Vehicle Miles Traveled

In 1991, household vehicles traveled a total of just over 1.6 trillion miles, up by 91 billion miles (6.0 percent) since 1988 (Table 5). This represents an annual increase of only 2.0 percent, which is substantially slower than in the early 1980's (between 1983 and 1988, annual growth averaged about 4.5 percent). The total increase since 1983 (32 percent) corresponds to an average annual increase of 3.5 percent per year.

Table 5. Annual Percent Change in Vehicles and Vehicle Miles Traveled, 1983, 1985, 1988, 1991

	Survey Year				Survey-to-Survey Annual Percent Change			Overall
	1983	1985	1988	1991	1983 to 1985	1985 to 1988	1988 to 1991	1983 to 1991
Number of Households (million)	84.4	87.3	91.6	94.6	1.7	1.6	1.1	1.4
Number of Households with Vehicles (million)	72.2	77.7	81.3	84.6	3.7	1.5	1.3	2.0
Real Disposable Personal Income (billion $1987)	2894	3162	3404	3535	4.5	2.5	1.0	2.4
Number of Household Vehicles (million)	129.3	137.3	147.5	151.2	3.0	2.4	0.8	2.0
Vehicles Miles Traveled (billion)	1215	1353	1511	1602	5.5	3.8	2.0	3.5
Vehicle Miles Traveled per Household with Vehicles (Thousand)	16.8	17.4	18.6	18.9	1.7	2.2	0.6	1.5

Vehicle Miles Traveled per Vehicle (Thousand)	9.4	9.9	10.2	10.6	2.4	1.3	1.3	1.5

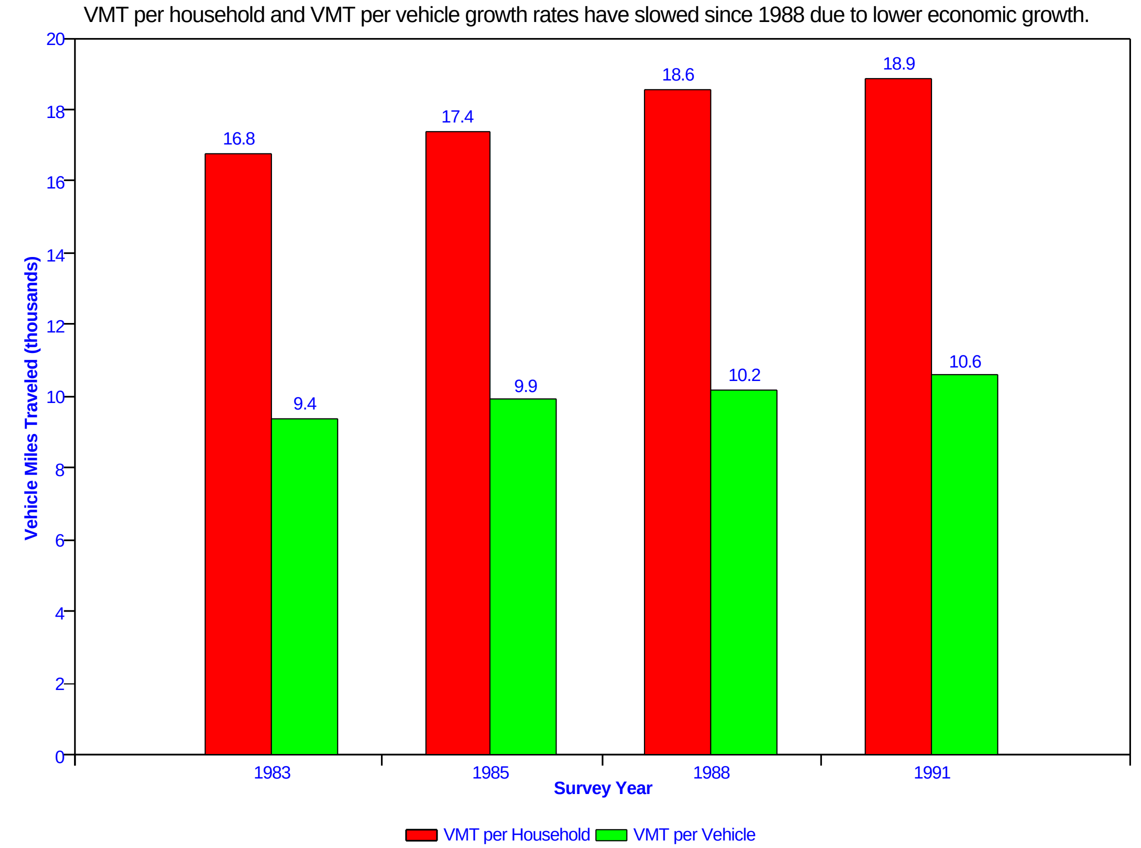
Sources: Energy Information Administration, Office of Energy Markets and End Use, 1983, 1985, 1988, and 1991 Residential Transportation Energy Consumption Surveys; U.S. Bureau of Economic Analysis, *Survey of Current Business Population*, March 1992.

The relatively slower growth since 1988 can be traced to both the downturn in the economy and underlying longer-term social changes that have affected households and their members. The growth in household vehicle miles traveled typically averages about 1 percentage point above the growth in real disposable personal income (personal income adjusted for inflation). The 3.5 percent overall annual growth in VMT between 1983 and 1991 compares to 2.4 percent growth in disposable personal income over the same time period. The 2.0 percent growth in VMT between 1988 and 1991 compares to a 1.0 percent growth rate for personal income (Table 5).

In 1991, there were more than 150 million household vehicles in nearly 85 million U.S. households (about 90 percent of all households). U.S. households with vehicles drove, on average, about 10,600 miles per vehicle and 18,900 miles per household (Figure 6). Two key factors affecting how much individual households drive are the number of drivers and the presence of children in the household. The following sections examine the effect of these and other factors (such as the number of drivers and household income) on household VMT.

Figure 6. Household and Vehicle Miles Traveled by Survey Year

Source: Energy Information Administration, Office of Energy Markets and End Use, 1991 Residential Transportation Energy Consumption Survey.



Measurement of Vehicle Miles Traveled (VMT)

The annual VMT for each vehicle in the RTECS was either (1) calculated using two odometer readings or (2) imputed using a regression estimate. For each vehicle in the sample, the RTECS collects a beginning-of-year and an end-of-year odometer reading. VMT equals the difference between the two readings, adjusted to reflect a 365-day year. For vehicles that were in the household less than a full year, the mileage was adjusted to reflect the amount of time the household was in possession of the vehicle. For vehicles that were missing one or both odometer readings, a regression estimate was used to estimate the annual mileage. For a vehicle that was not used by the household for the full year, the regression estimate was adjusted downward to reflect the amount of time the vehicle was in the household. The total VMT, representing the number of miles traveled nationally for all residential vehicles, is equal to the weighted sum of the individual VMT for each vehicle. (See Appendix B, "Estimation Methodologies," and Appendix C, "Quality of the Data," for further discussion about the annual VMT.)

The Effect of Household Composition

Average household driving varies extensively depending on the makeup of the household:

- Households with children drove 22,800 miles on average, compared with 16,500 miles in households with no children.

- Households with 16- or 17-year-old children drove more than any other major group (28,000 miles), about 7,000-8,000 miles more than households with younger children.

- In households without children, VMT ranged from 10,600 miles in single adult households to 19,700 miles in households with two or more adults.

- In single-driver households without children, VMT ranged from a low of 7,300 miles for drivers at least 60 years old to 14,200 miles for drivers under 35 years old.

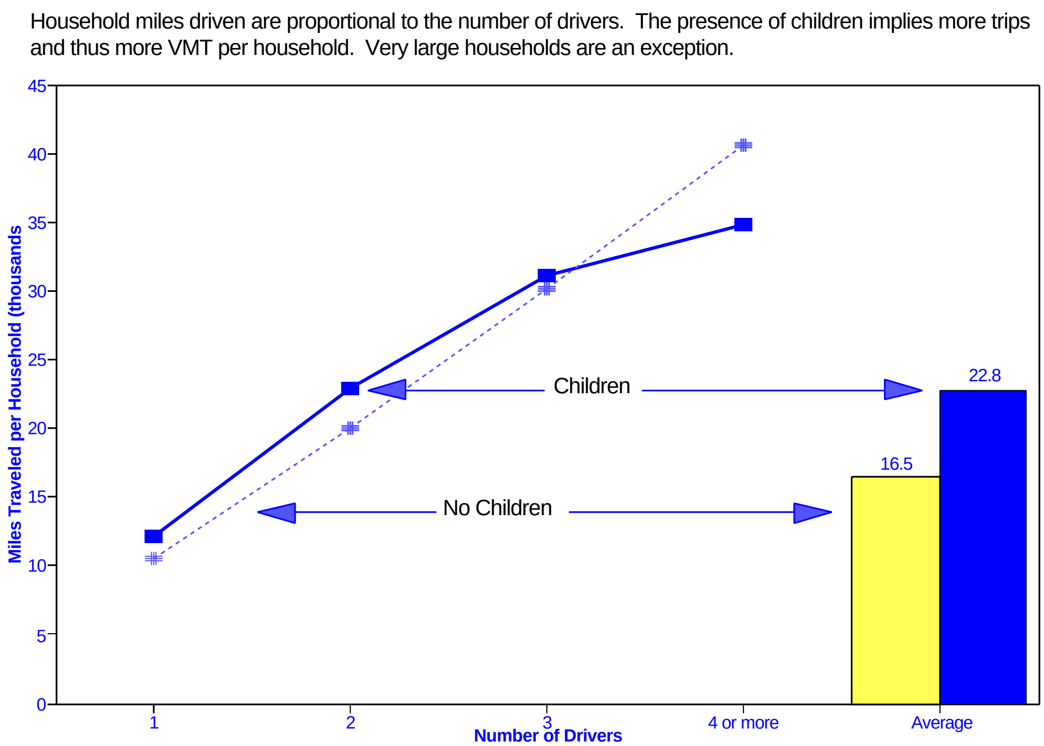
- Excluding households with 16- or 17-year old children, the remaining households with children still averaged 21,700 miles, about 5,000 miles more than households without children; the difference being the presence of adults over 60 years of age[2]. If they are excluded, then households with young children drive less than households with at least two adults and no children. In other words, the households that do the most driving are those with two adults, no children and a head of household younger than 60 years of age.

[2]Households in which the head of household was at least 60 years old. All household ages refer to the head of household, as stated in the RECS.

The Effect of the Number of Drivers

In 1991, VMT averaged 10,000 miles per driver in households with no children, and 1,000 to 2,000 miles higher in households with children, depending on the age of the children (Figure 7). These averages apply to households with up to three drivers. In households with four or more drivers, the presence of children (regardless of their age) implied fewer miles per driver. There are two likely explanations. One is that these households included one or more younger or older adult drivers, who tend to drive less than average. A second, and related consequence of the first, is that the number of vehicles does not keep pace with the number of drivers. The data also indicates that it is equally likely that households with three drivers have two or three vehicles; and those with four drivers are only slightly less likely to have three rather than four vehicles. Thus VMT cannot keep pace with drivers in larger households with more than three drivers.

Figure 7. Average Household Vehicle Miles Traveled and the Number of Drivers



Source: Energy Information Administration, Office of Energy Markets and End Use, 1991 Residential Transportation Energy Consumption Survey.

The Effect of Household Income

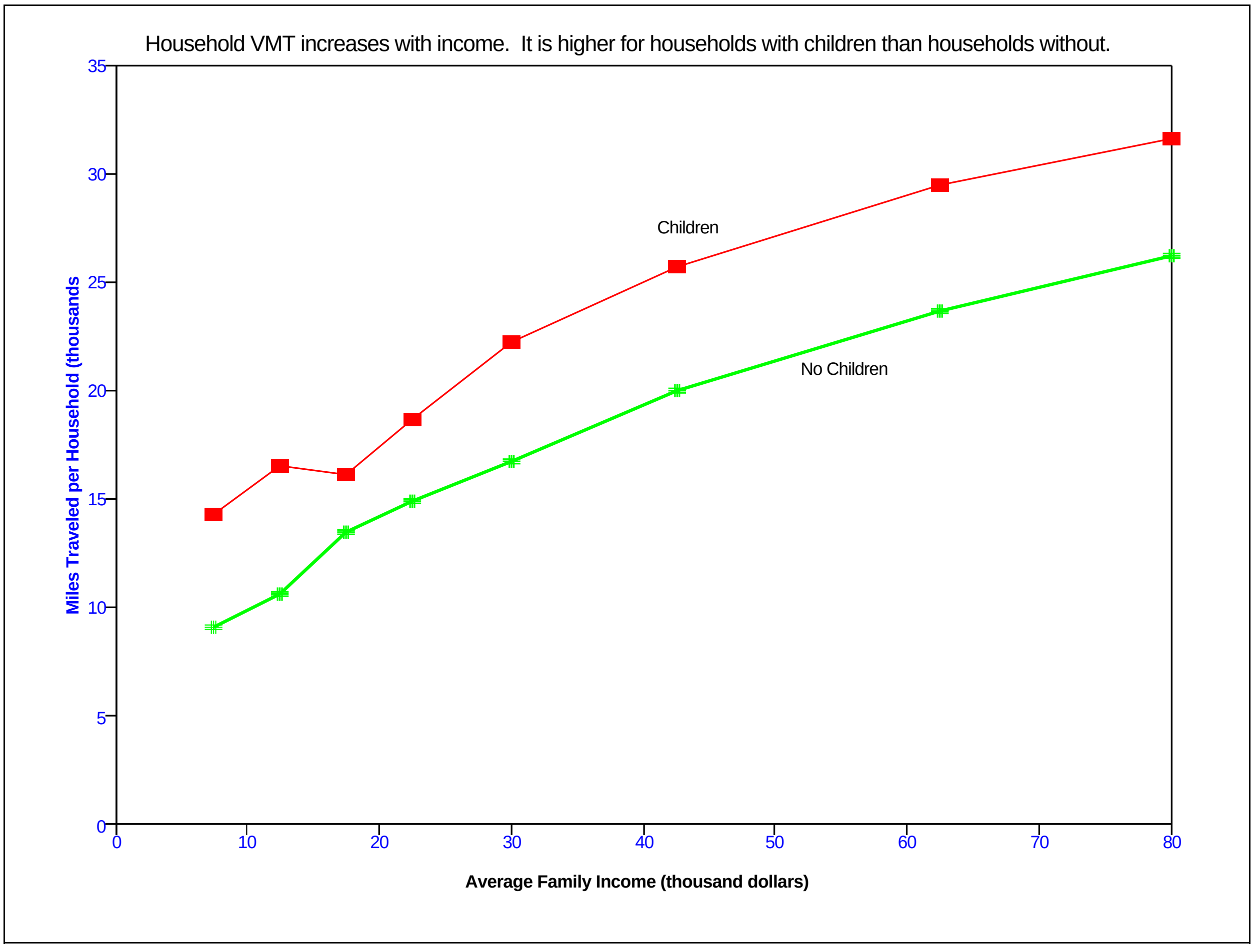
VMT per household increases with household income (Figure 8).

- For every additional $10,000 of income, vehicle miles traveled increased by approximately 3,000 miles. Within each income category, the presence of children added 3,000 to 5,000 miles per household.

- Households with annual incomes of $35,000 or more drove about twice as many miles per household as those earning less than $15,000.

Household income is more likely to increase with household size, so also is the number of drivers. Thus it is plausible that income and drivers are correlated. For example, more drivers would imply more household members in the work place and consequently a higher household income.

Figure 8. Average Household Vehicle Miles Traveled and Income



Source: Energy Information Administration, Office of Energy Markets and End Use, 1991 Residential Transportation Energy Consumption Survey.

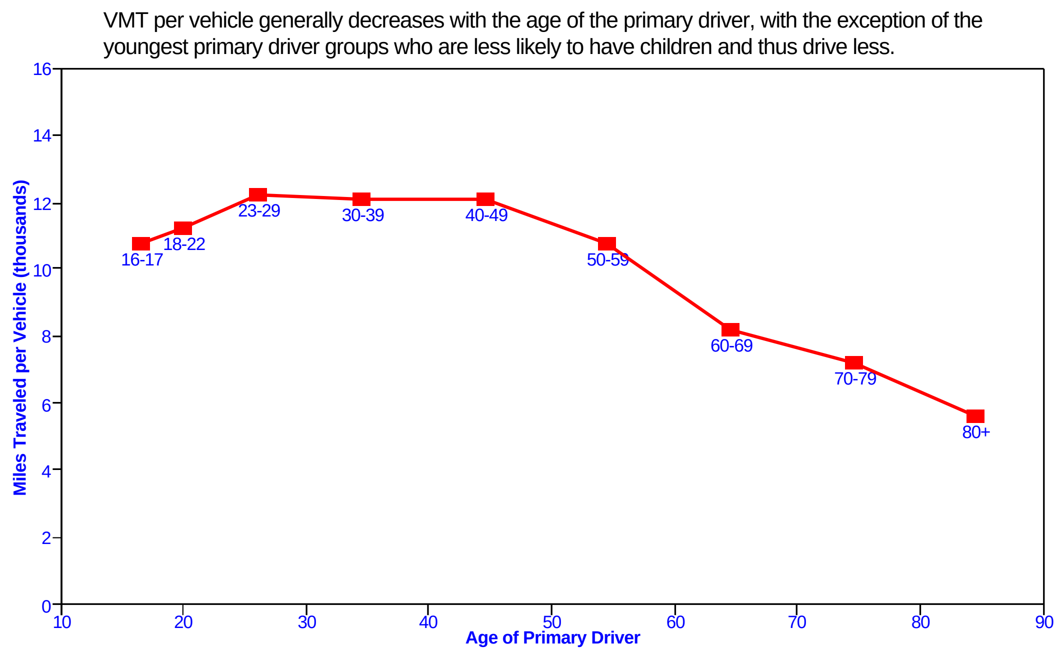
The Effect of Driver Age

VMT per vehicle is also related to the age of the driver in the household (Figure 9).

- VMT per vehicle increases with age of the primary driver into the 30's, averages more than 12,000 miles per year through the 40's, then declines. The youngest primary drivers probably drive less because they are less likely to have children (which adds to driving distances in other age categories), and are also less likely to have to go to work.

- Primary drivers in their 80's drive the least (an average of less than 6,000 miles).

Figure 9. Average Vehicle Miles Traveled per Vehicle and Age of Primary Driver



Source: Energy Information Administration, Office of Energy Markets and End Use, 1991 Residential Transportation Energy Consumption Survey.

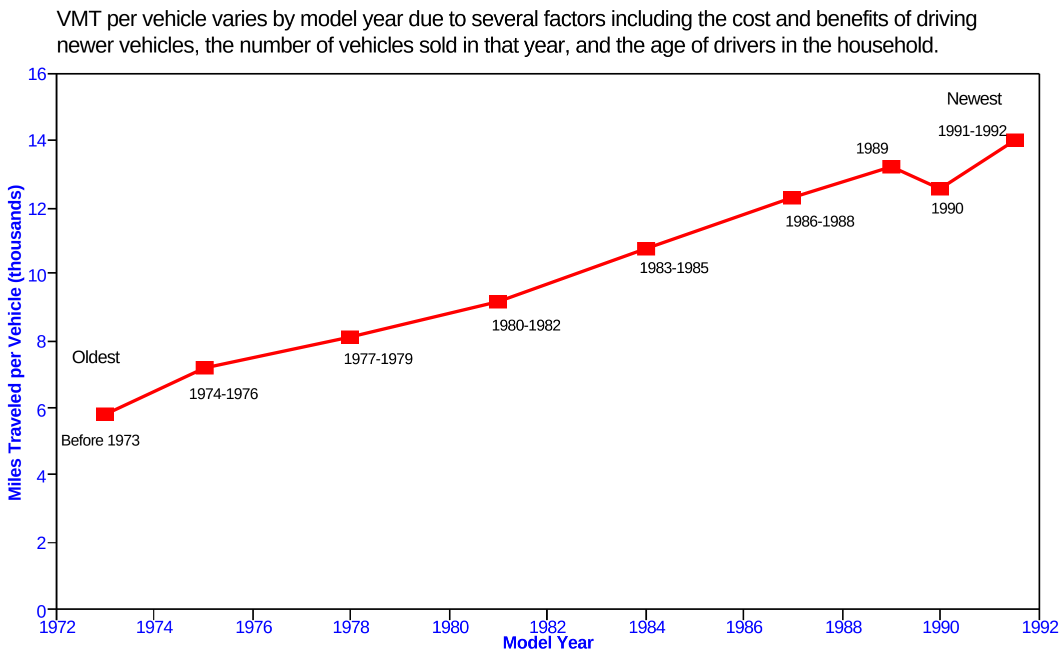
The Effect of Vehicle Age

The number of miles driven in a vehicle appears to be inversely proportional to the age of the vehicle (Figure 10). The newest vehicles in the survey (model years 1991 and 1992) were driven twice the number of miles per vehicle as the oldest vehicles (the pre-1977 models). This is not surprising, as new vehicles are typically cheaper to run, more comfortable, and more reliable than older vehicles.

Approximately 85 percent of the oldest vehicles (pre-1977 model year) were in households with more than one vehicle. In such a household, an older vehicle typically is not the household's primary vehicle, and is therefore driven less than the primary (probably newer) vehicle.

Another factor may be that older households tend to hold on to their vehicles longer and older households drive less than younger households. Thus older vehicles are in part associated with the age of the primary household member.

Figure 10. Average Vehicle Miles Traveled and Vehicle Age



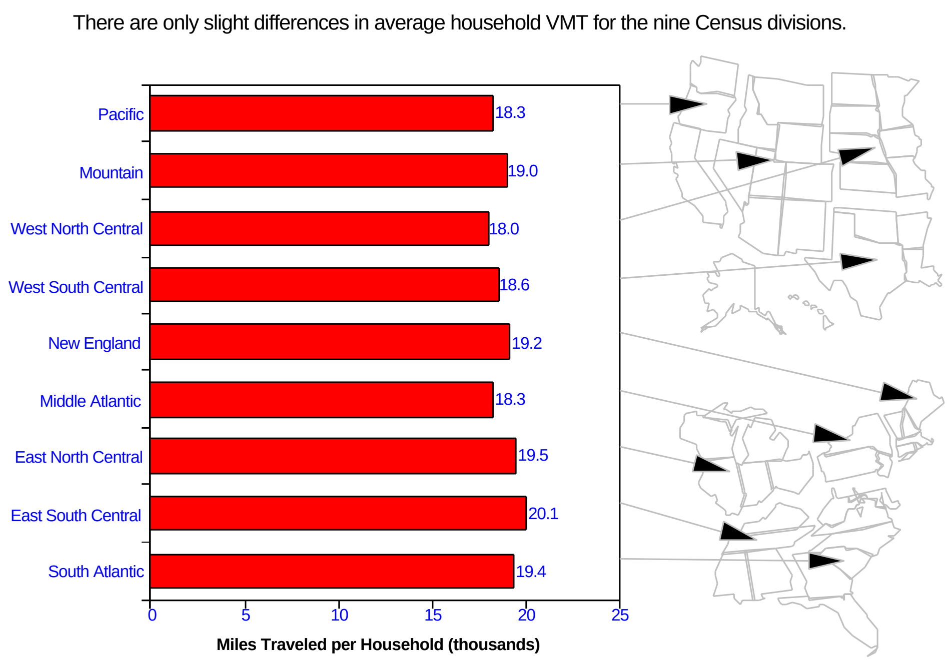
Source: Energy Information Administration, Office of Energy Markets and End Use, 1991 Residential Transportation Energy Consumption Survey.

The Effect of Region

Regional differences in VMT are of particular interest when considering gasoline tax issues. The debate over the proposed increase in the gasoline tax in the fiscal year 1994 budget suggested that households in the South and West Regions (where cities are fewer and more widely separated) drive further distances than in other regions. Although the 1991 RTECS identified some differences among regions, none of the variation was statistically significant. Figure 11 shows the average per household VMT by Census region. Of greater interest is the wide variation within each region, as indicated by the standard errors associated with the RTECS data. On average, metropolitan households drive about 900 miles more each year than nonmetropolitan (generally rural) households (20,400 miles per household compared with 19,500 miles in rural areas). As would be expected, central city households drive the least on average (only 15,900 miles).

Rural refers to all nonmetropolitan areas in the United States, for example, those not in a Metropolitan Statistical Area, and it is not meant to imply farm or ranch types exclusively. However, there are limited data in the survey from respondents that could be classified as "farm operations," those that were more than one acre in size and had $1,000 or more in sales in the year. Because of the wide variation in this limited number of cases, their average household VMT of 29,000 is not statistically different from the smaller average of 19,500 for all rural households. It is likely, however, that these farm operations have a higher annual VMT than nonfarm households at the national level.

Figure 11. Average Household Vehicle Miles Traveled and Census Regions



Source: Energy Information Administration, Office of Energy Markets and End Use, 1991 Residential Transportation Energy Consumption Survey.

The Effect of Vehicle Type

Minivans were driven more on average than any other type of household vehicle in 1991 (12,700 miles), followed by sport-utility vehicles (11,800 miles), passenger cars (10,400 miles), large vans (9,800 miles), and pickup trucks (9,400 miles).

Vehicle preferences reflect the household's stage of life (singles with no children, households with young children, households with teenagers or older parents, etc.). For example, households with children own 76 percent of the minivans and 58 percent of the sport-utility vehicles (the two highest mileage categories). The presence of children not only influences the preference for minivans and sport-utility vehicles but is also associated with higher VMT (as discussed above).

Another reason for the relatively greater use of minivans and sport-utility vehicles is their relative newness in the vehicle fleet. These alternatives to the more traditional station wagon or family sedan have only been on the market since the last half of the 1980's. They, therefore, have not had enough time to penetrate uniformly into older households, and they are still too new to be relegated from their status of primary household vehicle. If these vehicles were distributed more uniformly by age across the vehicle population, their usage would more likely resemble usage patterns for other types of vehicles.

Insights from the Nationwide Personal Transportation Survey (NPTS)

Changes in demand for transportation by households, as detailed above, reflect the substantial changes in economic and social factors over the past decade. The U.S. Department of Transportation's Nationwide Personal Transportation Survey (NPTS)[3] provides some insights into these changes, which are not directly addressed in the RTECS itself. In particular, the NPTS provides insights on the household demographics and economic changes responsible for increases in the number of household trips and VMT.

In contrast to the RTECS' focus on vehicles, the NPTS focuses on all types of trips--who makes trips in household vehicles and why they chose household vehicles over other modes of transportation such as walking, biking or mass transit. Despite the differences in what is measured by the NPTS and the RTECS, the coverage is similar enough in the aggregate to justify using NPTS findings about travel behavior to explain the driving trends identified in the RTECS. For instance, the NPTS estimates personal miles traveled (PMT) by any mode and examines the role of personal vehicles in capturing an increasing fraction of PMT. The total VMT of 1,613 billion miles[4] measured by the NPT's in 1990 is very similar to the 1,602 billion miles reported in the 1991 RTECS. The findings reported below are based on the results of the 1983 and 1990 NPTS.

Growth in Personal Miles Traveled

Personal miles traveled increased by about 19 percent between 1983 and 1990. The NPTS attributes this increase to three factors: population growth (4.3 percent), more trips per capita (7 percent), and longer trips on average (6.9 percent).

[3]*Travel Behavior Issues in the 90's: Nationwide Personal Transportation Survey*, U.S. Department of Transportation, Federal Highway Administration, July 1992.

[4]Includes travel-day and travel-period trips as explained in the box that follows on the NPTS.

- Although **population growth** is the smallest component explaining these changes, substantial regional shifts in population can account for rapid growth in some areas - in particular the South and West Regions.

- The number of **trips per capita** represents the number of trips an average person undertakes for any reason, by any mode of transportation. Women led the trend in the increasing number of trips per capita, largely due to an increase in personal business trips. This trend is consistent with the increasing representation of women in the work force since 1983.

- The **average trip length** increased because of the increasing emphasis on travel to work. In particular, the progressive shift of the population from urban centers to more suburban areas (and also out of the city) increased the average length of the trip to work.

The Nationwide Personal Transportation Survey (NPTS)

The Department of Transportation's NPTS used a random-digit-dialing telephone survey to interview approximately 22,000 households about their driving patterns and estimated mileage. This information supplements the RTECS information on vehicle consumption, mileage (both vehicle and personal), and expenditures collected via two-stage personal interviews with over 3,000 households. RTECS data from respondents' odometer readings (more than 6,000 vehicles) are used to estimate the mileage traveled by the vehicle-owning households nationwide.

In many respects, the two surveys complement each other and allow a better understanding of trends in personal-travel behavior and energy consumption.

- NPTS. The NPTS collects three types of information: (1) a "personal travel day" measure which includes all trips for any reason over a 24-hour period, (2) a "travel period" measure which includes long trips of over 75 miles one-way made in a 14-day period, and (3) a "commercial" travel measure which includes travel by household members who drive as an essential part of their work. Surveys are made throughout the year to account for seasonal variations. The NPTS covers all travel by any mode of transportation including walking, bicycling, and motorcycles.

- RTECS. The RTECS measures VMT using odometer readings taken at the beginning and end of the year. This method captures all travel by household members in all vehicles that they either own or use substantially.

- Data Comparisons. The vehicle miles recorded for the RTECS include the vehicle mileage portions of the "personal travel day" and the "travel period" measures reported in the NPTS, and some of the "commercial" mileage. RTECS considers "commercial" travel as personal travel if the household has access to that vehicle for personal use for more than a month of the year. RTECS, however, does not include travel by walking, bicycling, and motorcycling, which are included in the NPTS.

Another trend noted in the NPTS is the substantial increase in the percentage of the population who drive, particularly among women. Personal miles driven by women increased by 49 percent between 1983 and 1990 (91 percent for women in the 16-to-19-year-old range). Personal miles driven by men also increased, but by a more modest 18 percent, mainly in the 16-to-34-year-old range. Men continue to account for approximately 70 percent of the total personal miles driven.

Growth in Vehicle Miles Traveled

Vehicle miles traveled are a result of: (1) the number of vehicle trips and (2) the average vehicle-trip length. The increasing number of vehicle trips and vehicle miles of travel, as measured in the NPTS was much higher than would be expected on the basis of the growth in personal trips and personal miles of travel. In addition to making more frequent and longer trips, an increasing number of household members appear to be switching to using personal vehicles for their trips and cutting back in their use of alternatives such as public transportation.

Although increasing trip length and frequency are the dominant forces behind the increase in VMT, other factors also contribute to this trend. These include a decline in vehicle occupancy; a decline in use of public transportation and walking as alternatives to vehicle travel; and increasing travel distances for commuting to work, for work-related trips, and for trips to school and church (Figure 12). The following is based on the 1983 and 1990 NPTS.

- The NPTS estimated that travel in **personally operated vehicles** increased from 82 percent of all travel in 1983 to 87 percent in 1990. This 5-percentage-point increase was accounted for by the increased number of trips; the decline in the use of public transit and walking; and a net decline in those working at home (due to a shift from rural to urban employment).

- **Average vehicle occupancy**, a measure of the number of persons in a vehicle per vehicle trip, declined from 1.7 in 1983 to 1.6 in 1990. One factor contributing to this decline is the increase in working singles (male and female) with vehicles. The decline in average vehicle occupancy means that 6 percent more trips were required for the same set of riders to achieve the same person miles traveled[5].

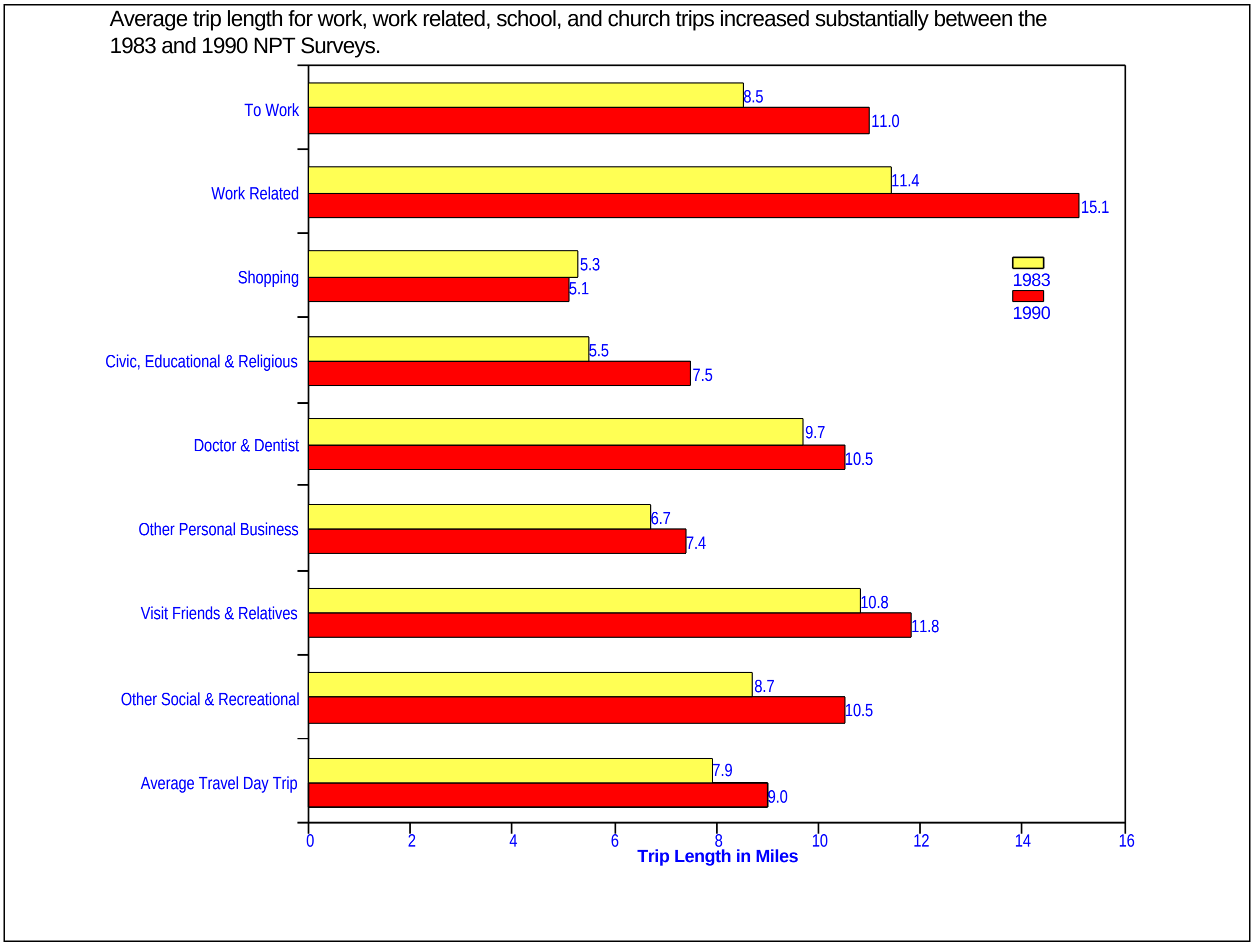
- **Average vehicle-trip length** grew by 13.9 percent from 1983 to 1990. The family and personal business grouping of trips for shopping, to doctors and dentists, and other family and personal business had the largest increase in share of VMT. Social and recreational trips appeared to have declined as a fraction of VMT.

- **Personal trip length** grew by 9 percent. The average trip length for work and work-related business, and school and church increased the most. Their fraction of VMT hardly changed over the 1983 to 1990 interval.

Household VMT, as recorded in RTECS, have grown for reasons more diverse than the simple compounding of the growth of households and number of vehicles. These reasons include increases in the locational changes of households and work, aging of the population, number of women holding driving licenses, and increases in vehicle ownership. The aging of the population has led to more people in the 25- to 45-year old group, the years of peak driving. Increase in female labor-force participation have led to more women holding driving licenses and more driving for work, family, and personal business purposes. The locational changes of households and work have led to longer trip lengths for work and work-related purposes. It could be argued that more and smaller households have also led to fewer occupants in the average vehicle and more resulting trips. More recent Census-based data suggest that some of these social and demographic measures may have slowed, perhaps to be overtaken by others.

[5]100 average trips of 1 mile with 1.7 persons per vehicle is equivalent to 170 person miles. If the vehicle occupancy falls to 1.6, then 170/1.6 trips are required for the same person miles: a 6-percent increase.

Figure 12. Trends in Vehicle-Trip Length, 1983 and 1990



Sources: Department of Transportation, *1983 and 1990 Nationwide Personal Transportation Surveys*.

4. Vehicle Fuel Efficiency and Consumption

Fuel consumption is estimated from RTECS data on the vehicle stock (Chapter 2) and miles traveled (Chapter 3), in combination with vehicle fuel efficiency ratings, adjusted to account for individual driving circumstances. The first two sections of this chapter present estimates of household vehicle fuel efficiency and household fuel consumption calculated from these fuel efficiency estimates. These sections also discuss variations in fuel efficiency and consumption based on differences in household and vehicle characteristics. The third section presents EIA estimates of the potential savings from replacing the oldest (and least fuel-efficient) household vehicles with new (and more fuel-efficient) vehicles. The final section of this chapter focuses on households receiving (or eligible to receive) supplemental income under government programs, in particular programs targeted at low-income households.

Vehicle Fuel Efficiency

The fuel efficiency of household vehicles averaged 19.3 miles per gallon (MPG) in 1991. This represents an increase of 1 MPG (5.5 percent) since the 1988 RTECS, when household vehicles averaged 18.3 MPG. Fuel efficiency varies by the age and type of vehicle. Newer cars are more fuel efficient than older cars, averaging 20.6 to 22.0 MPG for model year 1983 or later compared with 12.2 MPG for model year 1973 or earlier. On average, passenger cars are the most fuel efficient (21.1 MPG) and full-size vans the least efficient (13.7 MPG).

Calculation of Vehicle Fuel Efficiency

The vehicle fuel efficiencies presented in this report were calculated using the Environmental Protection Agency (EPA) laboratory test results, adjusted for on-road driving. Information on vehicle characteristics, obtained from the Vehicle Identification Number (VIN) and from the respondent, enhanced the matching of vehicles to the EPA certification files. Earlier RTECS (prior to 1988) calculated fuel efficiencies using information recorded by respondents in vehicle fuel-purchase diaries.

A sequential adjustment procedure was used to adjust the EPA test data for each RTECS sample vehicle. First, the EPA test data were adjusted to account for an MPG shortfall between the test data and the actual, on-road fuel efficiency for a combination of both city and highway driving conditions. The resulting composite, or on-road MPG, is the "sticker" MPG reported on new vehicles and published in the DOE/EPA *Gas Mileage Guide*. Next, the data were adjusted to account for individual driving circumstances, in particular the effect of urban versus rural driving conditions and seasonal effects. For each vehicle in the RTECS sample, the on-road MPG was adjusted based on the average number of miles driven per day and whether the vehicle was driven in the North or the South. These adjustments provided specific in-use MPG values for each vehicle in the RTECS sample. See Appendix B for additional details.

Two factors that also contribute to vehicle fuel efficiency--individual driving behavior and aging of vehicles--cannot be determined because the RTECS fuel efficiency data were not measured from actual driving. This is important to keep in mind when considering the information presented in this report, as driver behavior and vehicle aging have an additional but unknown effect on the MPG of individual vehicles.

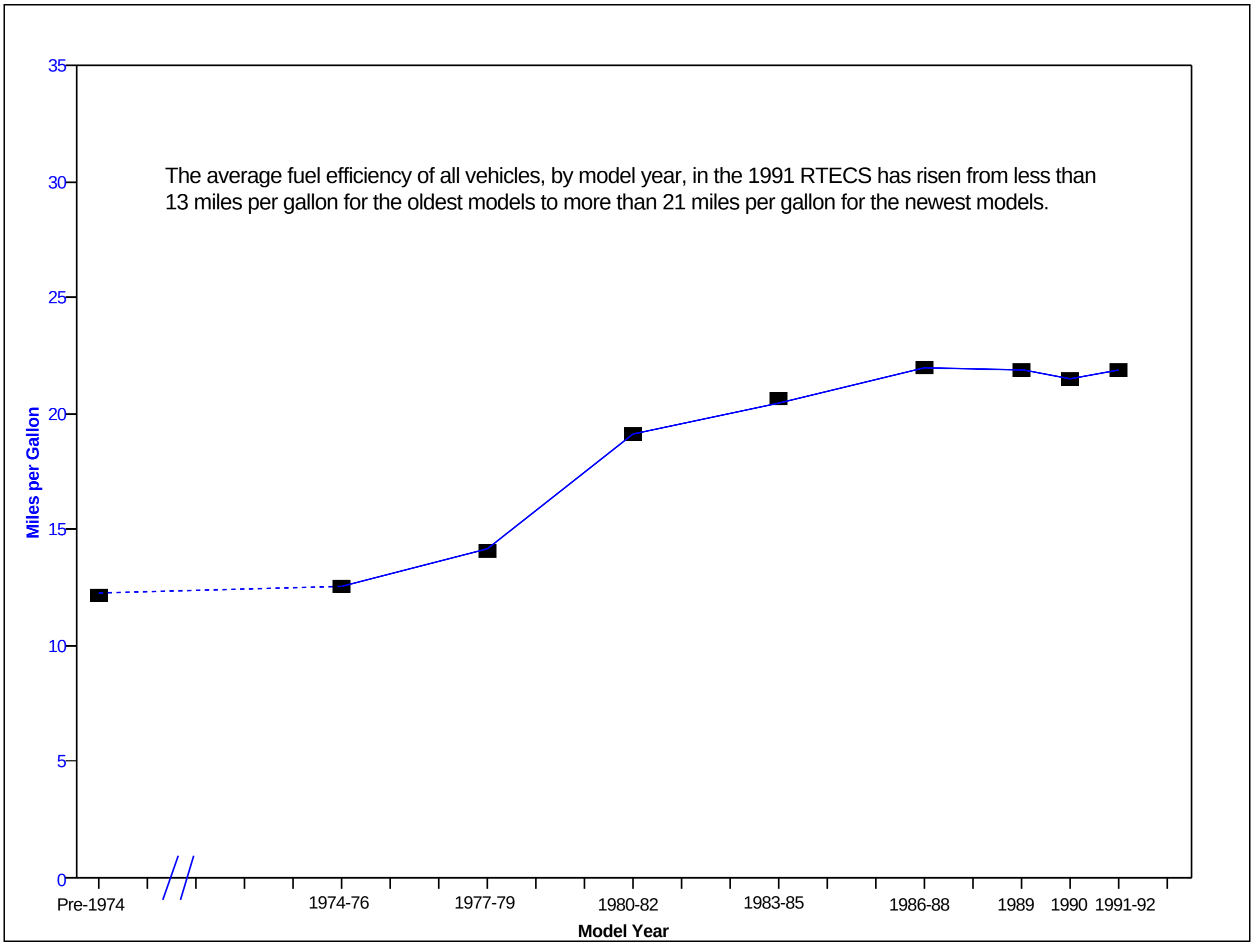
Of the vehicle characteristics measured in the 1991 RTECS, the two most important ones affecting fuel efficiency are the model year and the type of vehicle. The 1991 RTECS also identified differences in average vehicle fuel efficiency based on household location, composition, and income.

Model Year

The fuel efficiency of household vehicles has increased significantly over the past 14 years. For 1979 and earlier models, the average is 14.1 MPG or less. Since 1983, the average has risen above 20 MPG and has leveled out at close to 22 MPG (Figure 13). The increase is largely due to a combination of the sharp increase in gasoline prices in the 1970's, which stimulated demand for more fuel-efficient vehicles, and the implementation of Corporate Average Fuel Economy (CAFE)[6] standards.

Figure 13. Average Fuel Efficiency of All Vehicles, by Model Year

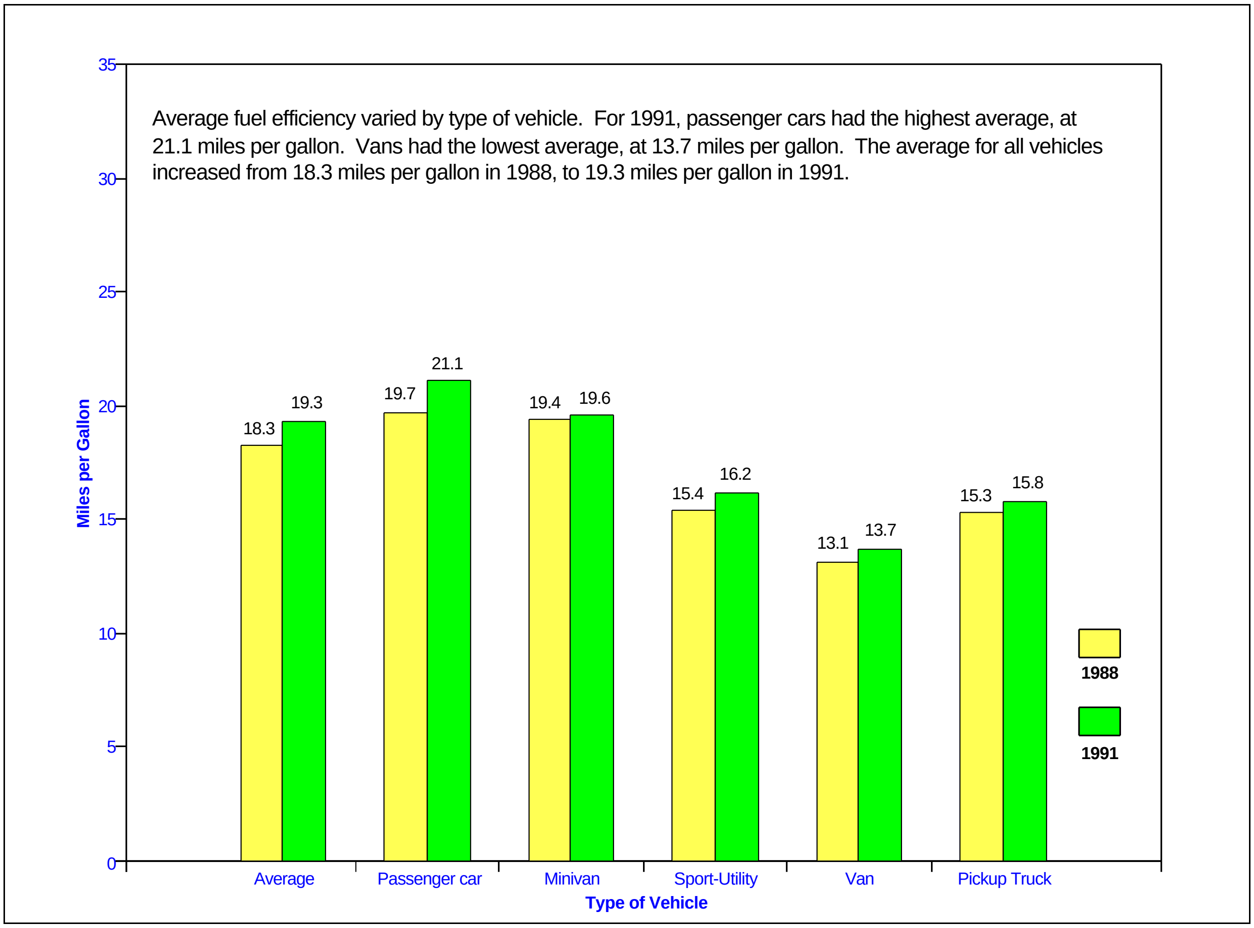
[6]Corporate Average Fuel Economy (CAFE) standards were established by the Energy Policy and Conservation Act of 1975. The standards took effect in 1978.



Source: Energy Information Administration, Office of Energy Markets and End Use, 1991 Residential Transportation Energy Consumption Survey.

Even though the average fuel efficiency of new vehicles has stabilized over the past several years, the average for the entire stock is still increasing as older, less fuel-efficient vehicles are replaced by newer vehicles that are more fuel efficient. Between 1988 and 1991,[7] average fuel efficiency increased for all vehicles and for passenger cars in particular (Figure 14). The fuel economy of the total stock is expected to improve further as older, less efficient vehicles continue to be replaced; however, the rate of improvement will slow as the percentage of pre-1979 vehicles being replaced declines. Eventually, the fuel efficiency of new vehicles will need to be improved further in order to boost the average fuel economy.

Figure 14. Average Fuel Efficiency of All Vehicles, by Type of Vehicle



Source: Energy Information Administration, Office of Energy Markets and End Use, 1991 Residential Transportation Energy Consumption Survey.

[7]Fuel-efficiency data from the 1983 and 1985 RTECS cannot be directly compared to the 1988 or 1991 RTECS because of the change in the RTECS fuel-efficiency methodology.

Type of Vehicle

Another factor affecting average fuel efficiency is the composition of the vehicle stock. There is a fairly large variation in fuel efficiency between different vehicle types, which are subject to different CAFE standards.[8] For example, minivans, large vans, and pickup trucks are less fuel efficient and have lower CAFE standards than passenger cars. These types of vehicles have increased in popularity in recent years, reducing the proportion of more fuel-efficient passenger cars in the residential fleet--from about 75 percent of the new vehicle stock (1988-1989 models) in 1988 to only 66 percent of the new vehicle stock (1991-1992 models) in 1991. Because of the increasing proportion of minivans, large vans, and pickup trucks, the new vehicle fleet is less fuel efficient on average than it would have been if the mix of passenger cars and other vehicles had not changed.

Between 1988 and 1991, vehicles with three types of characteristics showed significant improvements in fuel efficiencies: passenger cars (from 19.7 MPG in 1988 to 21.1 MPG in 1991), vehicles equipped with automatic transmissions (from 17.1 MPG to 18.4 MPG), and vehicles with engines 4.5 liters or larger (from 11.8 MPG to 14.0 MPG). Differences between the 1988 and 1991 surveys for other vehicle characteristics are not statistically significant.

Location of Household

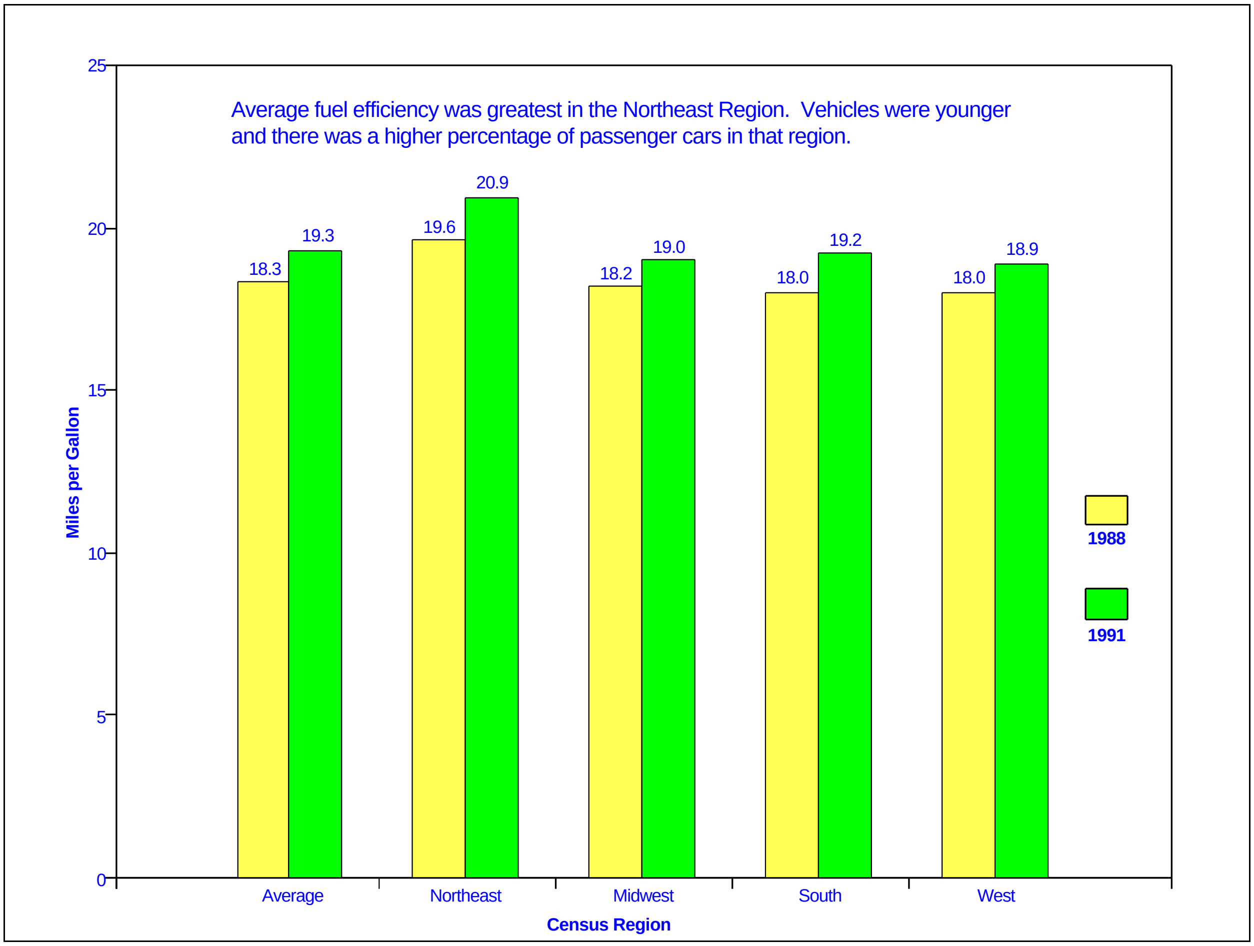
As in the 1988 RTECS, vehicles in households located in the Northeast were, on average, more fuel efficient in 1991 than those in other regions (Figure 15). Vehicles in the Northeast averaged nearly 21 MPG while those in the Midwest, South, and West averaged closer to 19 MPG. The apparent reason for this finding is that, on average, vehicles in the Northeast were newer and more likely to be passenger cars--two of the key factors that contribute to higher average fuel efficiency (Figures 13 and 14). Newer vehicles are defined as model years 1983 and later, and older models as 1979 or earlier. In the Northeast, about 12 percent of the vehicles were older (compared with 24 to 30 percent in the other three regions) and about 77 percent were newer (compared with 58 to 65 percent in the other regions). The Northeast also had a higher proportion of passenger cars in its vehicle mix (80 percent compared with 67 to 71 percent in the other three regions).

On average, vehicles in the central city and suburbs were more fuel efficient than vehicles used in rural[9] areas (close to 20 MPG for central cities and suburbs compared with 18 MPG for nonmetropolitan areas). The two primary factors contributing to the lower fuel efficiency in rural areas are the relatively older age of the vehicle and the relatively smaller percentage of passenger cars in the vehicle stock. In rural areas, 31 percent of the vehicles were older vehicles and 56 percent were newer vehicles. This compares with 20 percent older/70 percent newer in suburban areas and 22 percent older/65 percent newer in central cities. In addition, only 60 percent of all vehicles in rural areas were classified as passenger cars (the rest were primarily pickup trucks and sport-utility vehicles) compared with 74 percent in suburban areas and 78 percent in central cities.

[8]Since 1983, CAFE standards for new model passenger cars have been set in the 26.0 to 27.5 MPG range (27.5 for 1990 and newer models). Standards for light trucks, which include mini-vans and sport-utility vehicles, have been in the 19.0 to 20.5 range since 1983 (20.2 MPG in 1991). For a manufacturer to meet the passenger car or light-truck standard, the models in the fleet that fall below the standard must be offset by models that exceed the standard, such that a sales-weighted fleet average MPG meets the CAFE standards.

[9]When the term "rural" is used, it refers to all nonmetropolitan areas in the United States. These are areas that are not located in a Metropolitan Statistical Area. (See the Glossary for definition.)

Figure 15. Average Fuel Efficiency of All Vehicles, by Census Region



Source: Energy Information Administration, Office of Energy Markets and End Use, 1991 Residential Transportation Energy Consumption Survey.

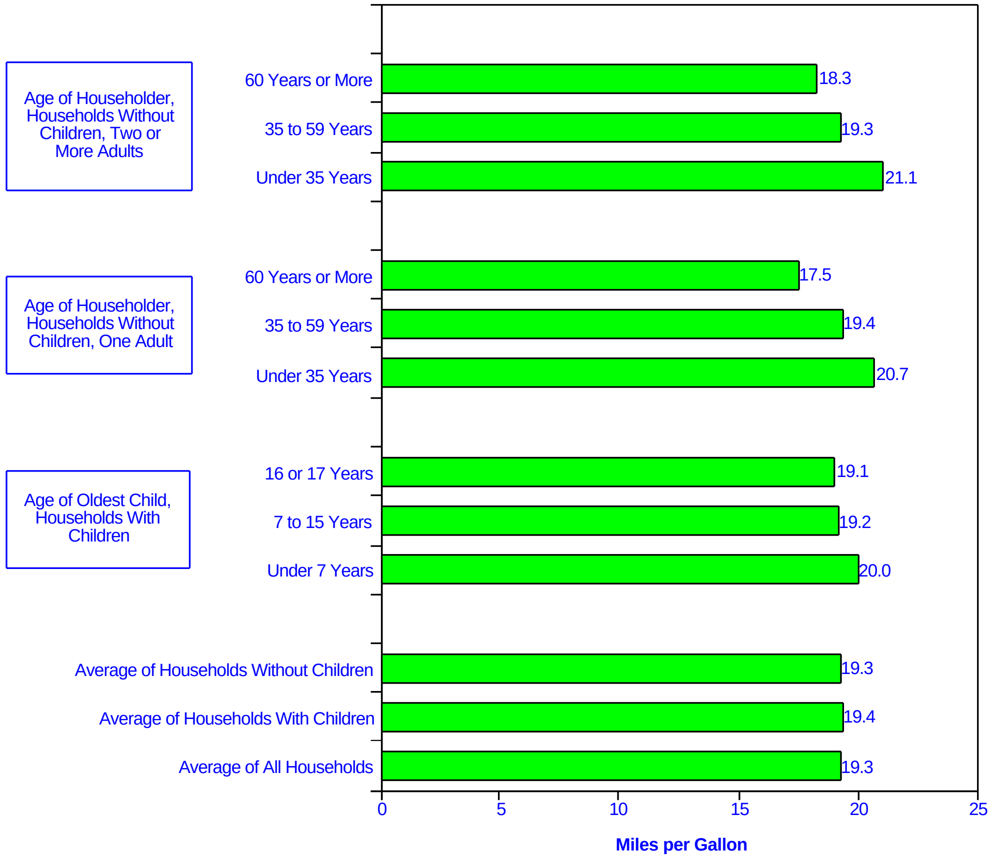
Composition of Household

No significant differences in fuel efficiency were found between households with children and households without children. Vehicles in households with children averaged 19.4 MPG, compared with 19.3 MPG for vehicles in households without children.

In households without children, average fuel efficiencies varied based on the age of the oldest household member (Figure 16). Vehicles in households in which the oldest adult was under 35 years old were more fuel efficient than those with older drivers. This difference can be attributed to the fact that older drivers, on average, had older vehicles which are, on average, less fuel efficient.

Figure 16. Average Fuel Efficiency of All Vehicles, by Household Composition

Households with and without children had similar average fuel efficiencies. Households without children and householders 60 or more years old had the lowest average fuel efficiencies.

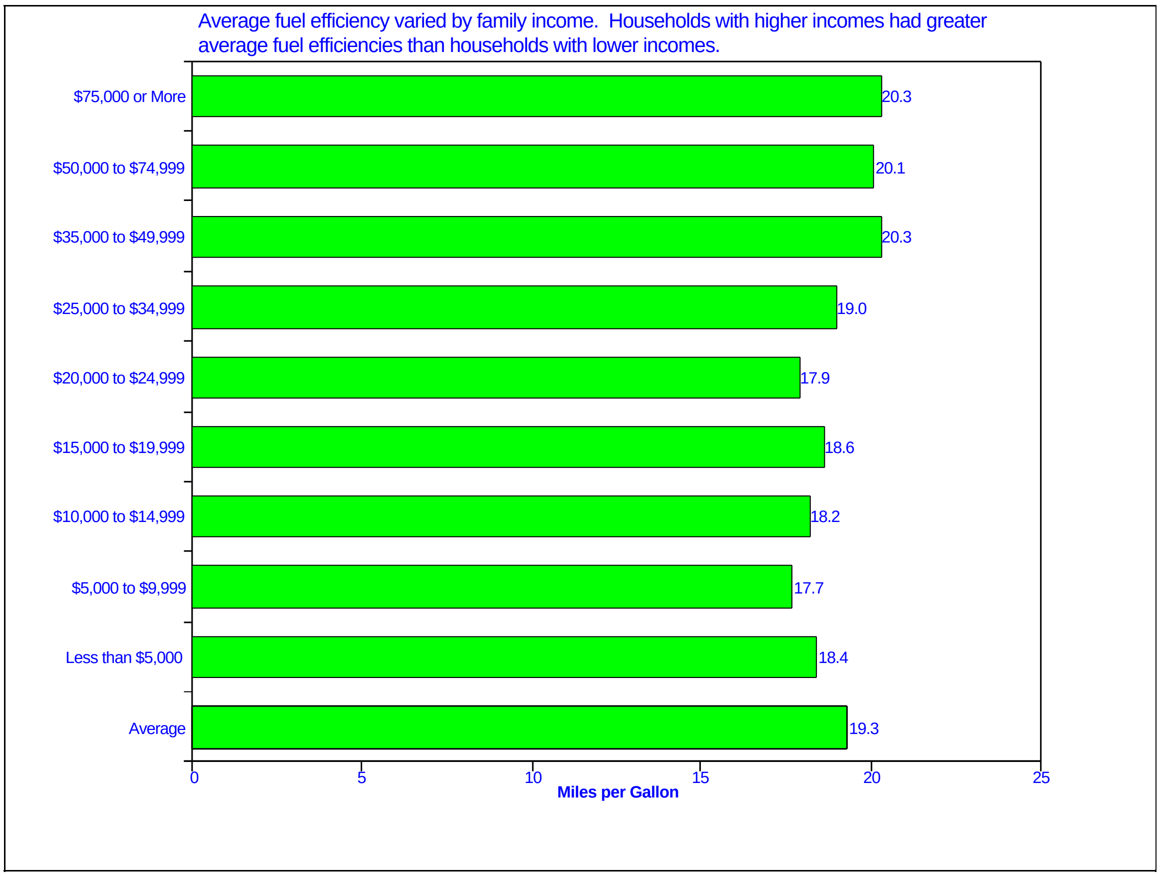


Source: Energy Information Administration, Office of Energy Markets and End Use, 1991 Residential Transportation Energy Consumption Survey.

Family Income

Vehicles in households with higher incomes had higher average fuel efficiencies than those in households with lower incomes (Figure 17). Households in the income categories starting at $35,000/year averaged at least 20 MPG, while those in income groups below $35,000/year averaged 19 MPG or less. This could be explained by the consistent increase in the percentage of newer models (1983 and later) with each higher income category. Partially offsetting the effect of vehicle age is the distribution of vehicle type as a function of income. Households in income categories below $20,000/year had a higher percentage of passenger cars than households in the next higher income categories up to $75,000/year (75-83 percent versus 67-70 percent). For households in the highest income categories (over $75,000/year), the percentage of passenger cars was similar to the lowest income categories (79 percent).

Figure 17. Average Fuel Efficiency of All Vehicles, by 1990 Family Income



Source: Energy Information Administration, Office of Energy Markets and End Use, 1991 Residential Transportation Energy Consumption Survey.

Vehicle Fuel Consumption

Household vehicles consumed a total of 82.8 billion gallons of fuel in 1991 (compared to 82.4 billion gallons in

1988). This equates to 548 gallons per vehicle (559 gallons in 1988) and 979 gallons per household (1,014 gallons in 1988). The 1991 RTECS identified differences in average household and vehicle fuel consumption based on household characteristics (location and composition) and vehicle characteristics (type and model year).

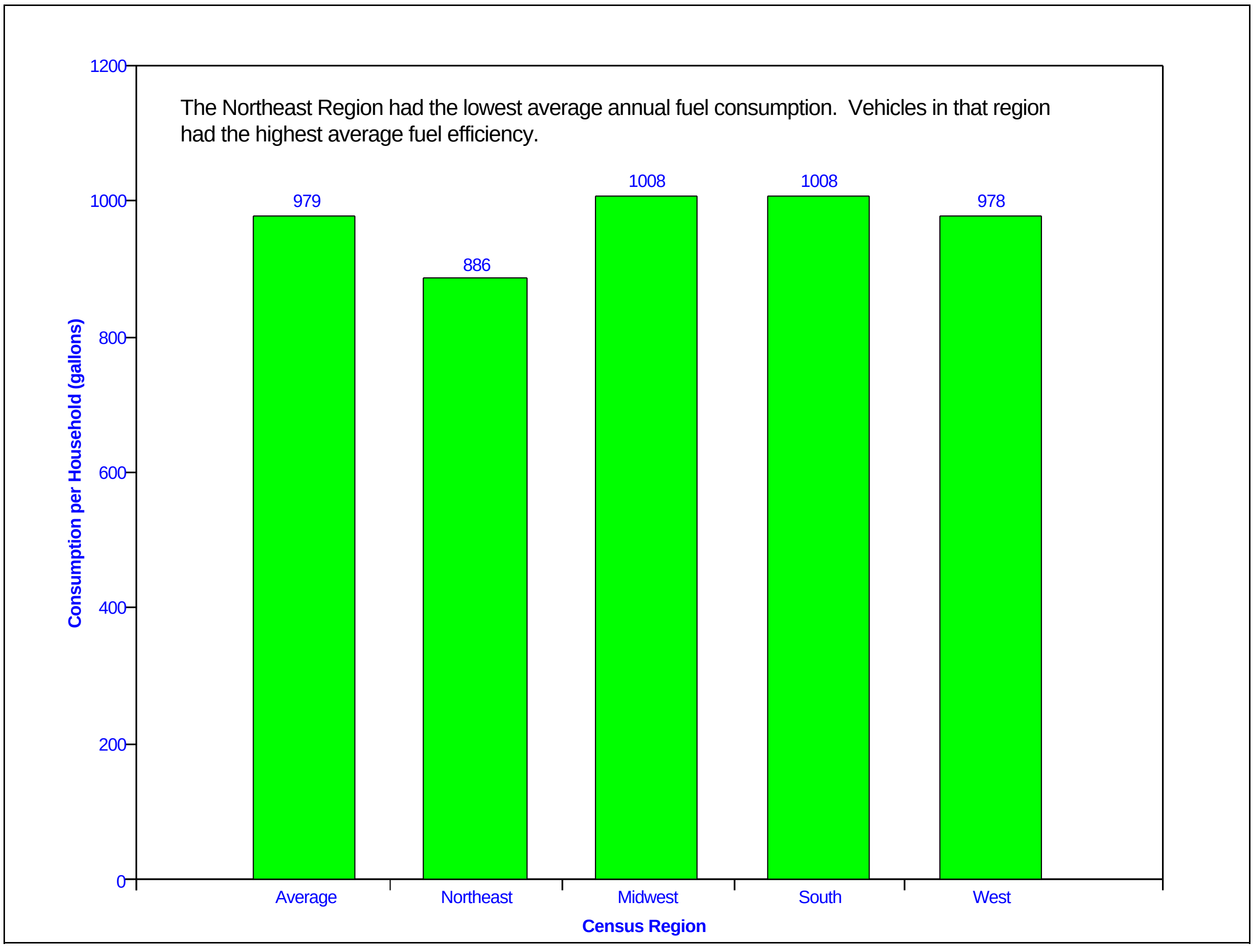
Location of Household

Average annual vehicle fuel consumption was lower in the Northeast than in any other Census region (Figures 18 and 19). Households in the Northeast consumed a total of 886 gallons per household, compared with an average range of 978 to 1,008 gallons per household in the other three regions. Households in the Northeast also consumed

Calculation of Vehicle Fuel Consumption

Total vehicle fuel consumption is a function of fuel efficiency and the number of miles traveled. The 1991 RTECS calculated annual vehicle fuel consumption by dividing the annual vehicle miles traveled (VMT) by the annual fuel efficiency. These fuel efficiencies were derived based on EPA test data rather than on actual fuel purchases (see Calculation of Vehicle Fuel Efficiency). Because the RTECS did not directly measure fuel consumption, this report does not consider the effects of driving behavior and vehicle aging on energy consumption.

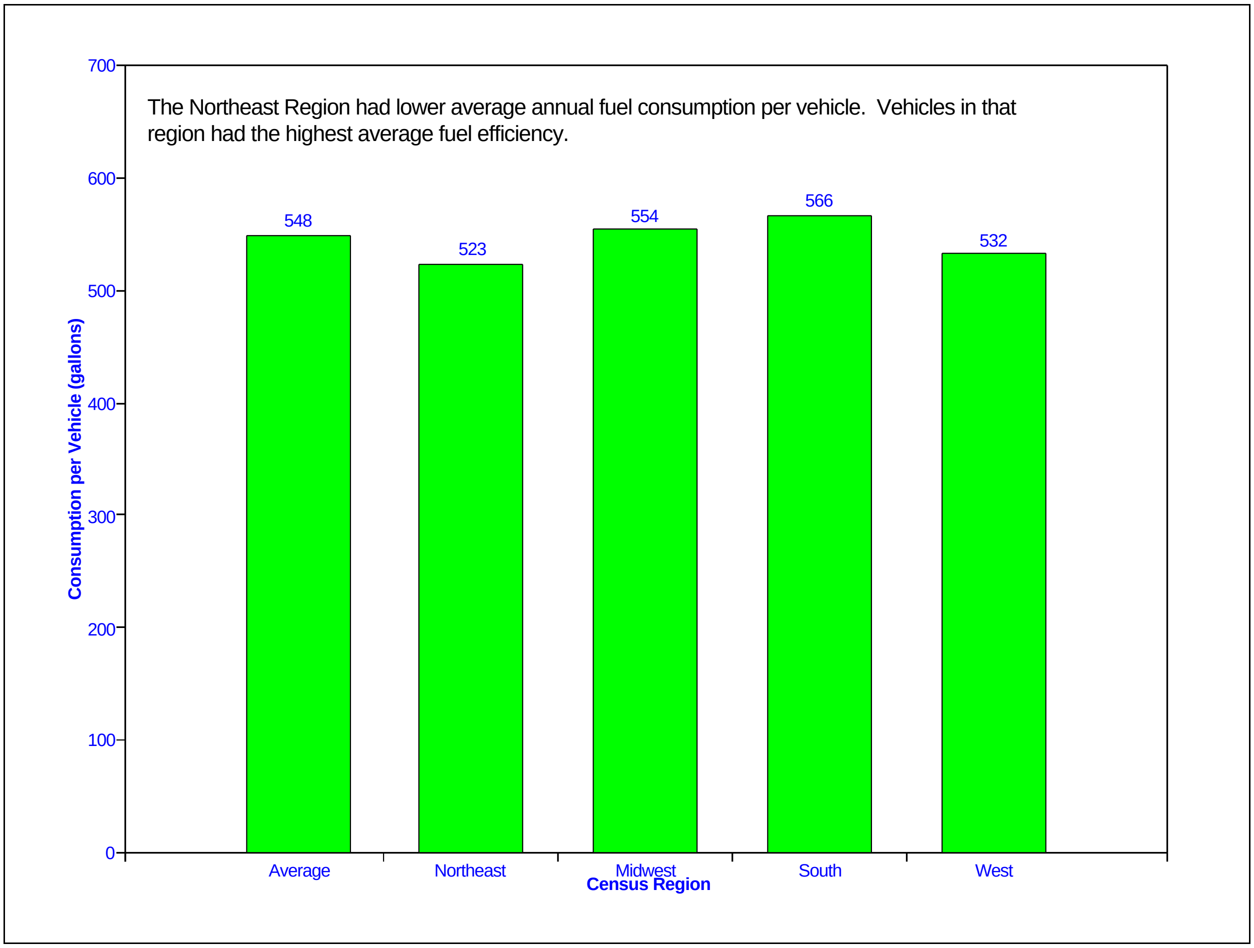
Figure 18. Average Annual Household Fuel Consumption, by Census Region



Source: Energy Information Administration, Office of Energy Markets and End Use, 1991 Residential Transportation Energy Consumption Survey.

less on average per vehicle than the South (523 gallons versus 566 gallons), but not significantly less than the other two regions. The lower average consumption for the Northeast was largely due to the higher fuel efficiency of vehicles in the region. Vehicle miles traveled (VMT), per household as well as per vehicle, were similar for all four regions.

Figure 19. Average Annual Vehicle Fuel Consumption, by Census Region



Source: Energy Information Administration, Office of Energy Markets and End Use, 1991 Residential Transportation Energy Consumption Survey.

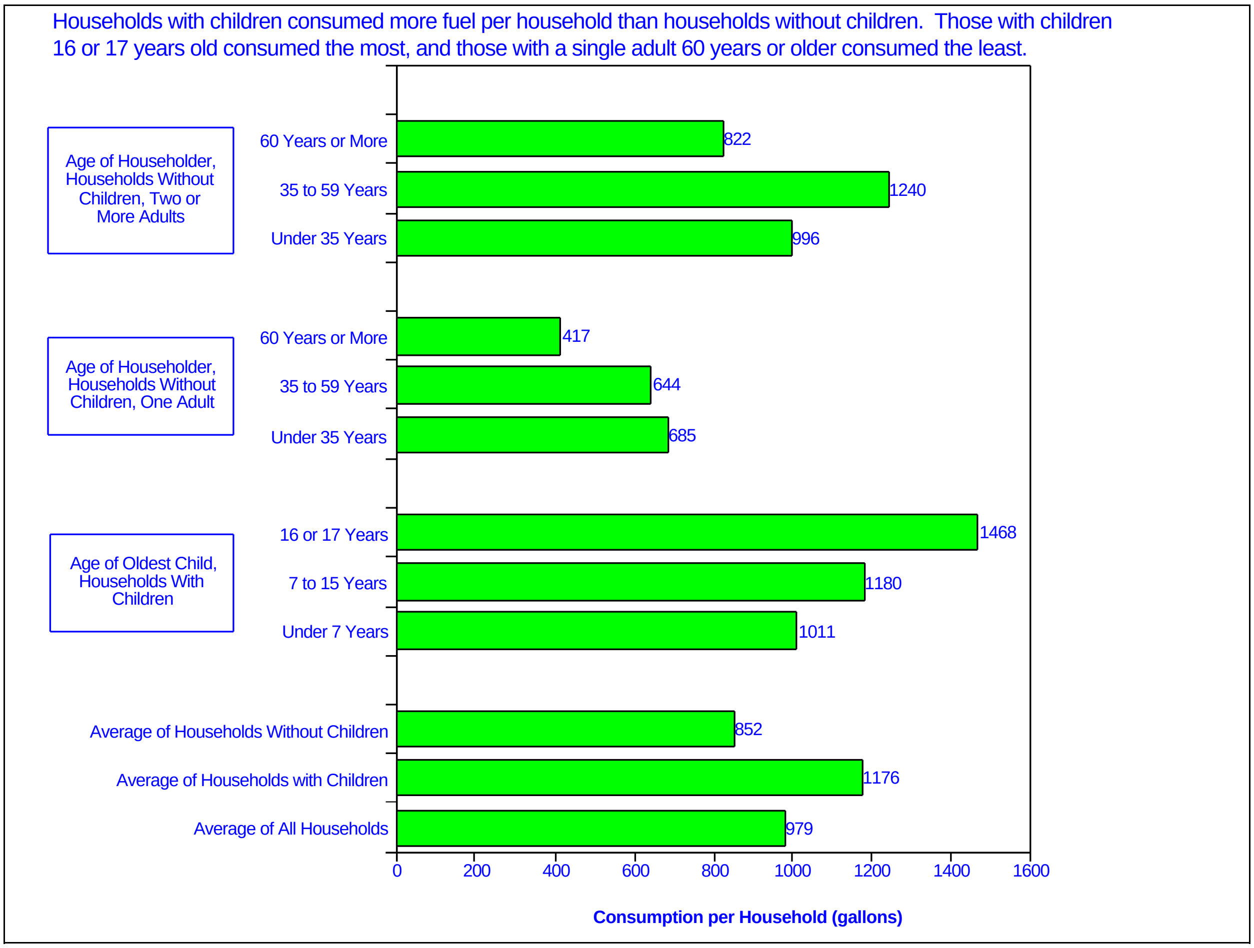
Households in rural areas used more fuel per household and per vehicle than central city households (34 percent greater per household and 13 percent greater per vehicle) or suburban households (26 percent greater per household and 9 percent greater per vehicle). These differences can be explained by the lower fuel efficiency in rural areas (which accounted for greater average consumption) and the lower VMT per household in central city areas (which reduced average household and vehicle consumption).

Composition of Household

Trends in average household fuel consumption parallel trends in VMT per household. The variation in consumption among different household categories was largely controlled by VMT per household and less by other factors.

Households without children consumed more fuel in total than households with children (44.0 billion gallons compared with 38.9 billion gallons). However, households with children consumed more fuel on average (1,176 gallons per year compared with 852 gallons in households without children--Figure 20). Those whose oldest child was 16 or 17 years old consumed more fuel than any other group (1,468 gallons). Not surprisingly, households with no children and only one adult consumed the least fuel (556 gallons per year). These observations are consistent with the finding that lower VMT correlated with lower fuel consumption (see Chapter 3).

Figure 20. Average Annual Household Fuel Consumption, by Household Composition



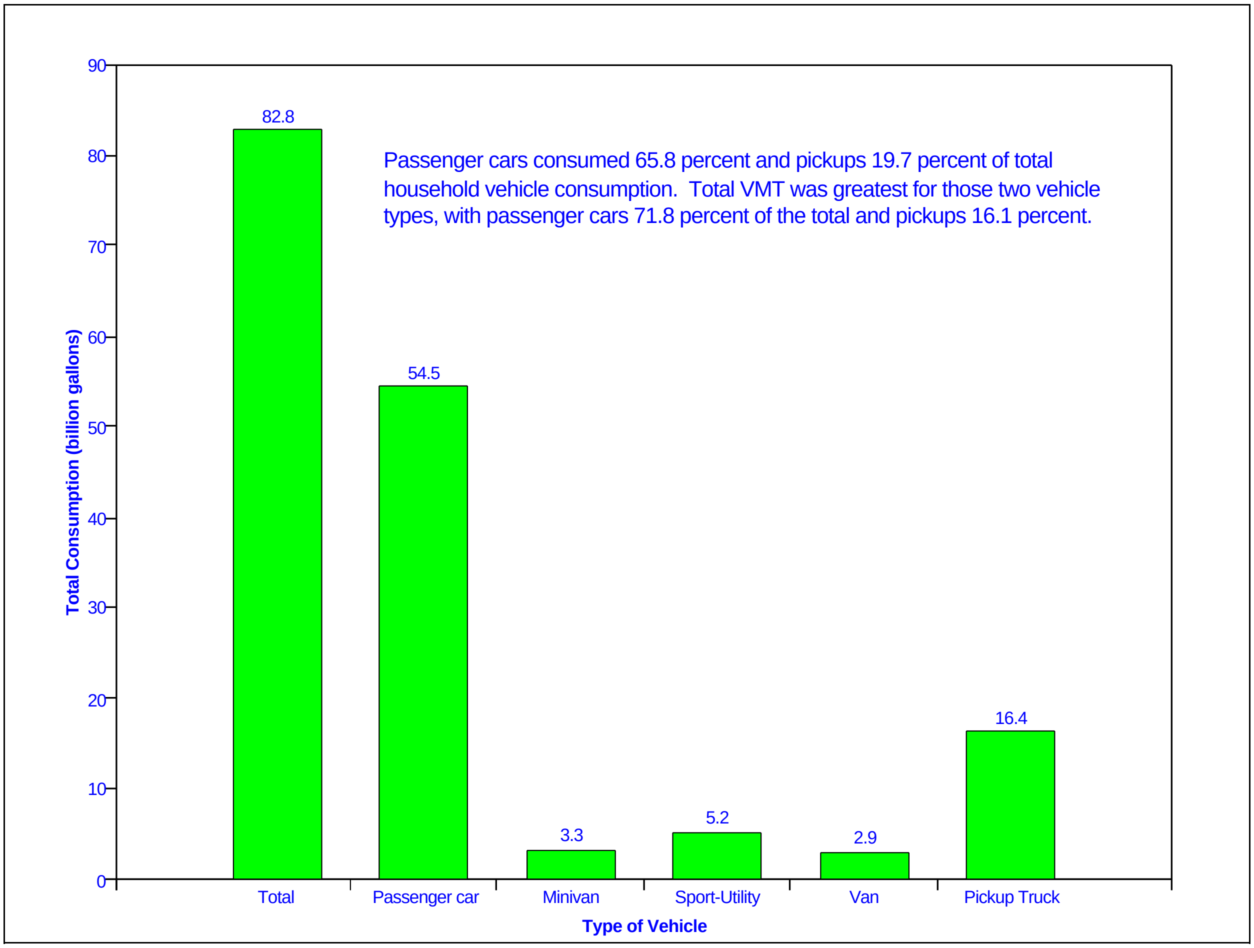
Source: Energy Information Administration, Office of Energy Markets and End Use, 1991 Residential Transportation Energy Consumption Survey.

Average annual fuel consumption per vehicle did not vary much by household composition. All but one of the household subcategory groups consumed in the range of 466-613 gallons/year, on average. Households with a single adult 60 years or older and no children, however, consumed significantly less fuel per vehicle (347 gallons) primarily because their VMT per vehicle was lower than for any other group.

Type of Vehicle

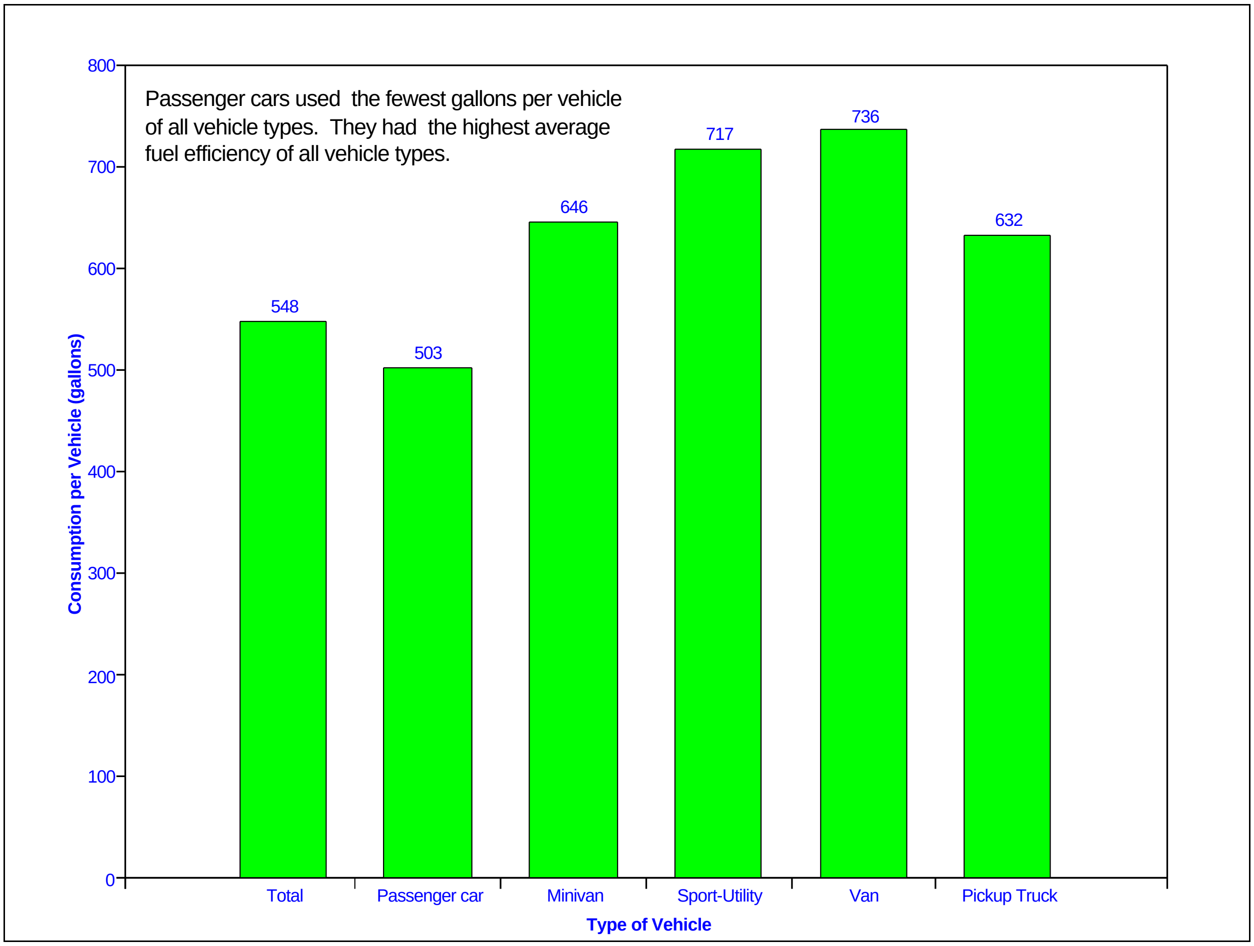
The 1991 RTECS data by type of vehicle reveal different patterns for total and average annual vehicle fuel consumption (Figures 21 and 22). For example, passenger cars consumed the most fuel in total (54.5 billion gallons) but the least fuel per vehicle (503 gallons). Total consumption for the different types of vehicles is the product of average fuel efficiency and total VMT. For passenger cars, the high consumption was mainly the result of the high total VMT, which is a function of the greater number of these vehicles.

Figure 21. Total Annual Vehicle Fuel Consumption, by Vehicle Type



Source: Energy Information Administration, Office of Energy Markets and End Use, 1991 Residential Transportation Energy Consumption Survey.

Figure 22. Average Annual Vehicle Fuel Consumption, by Vehicle Type



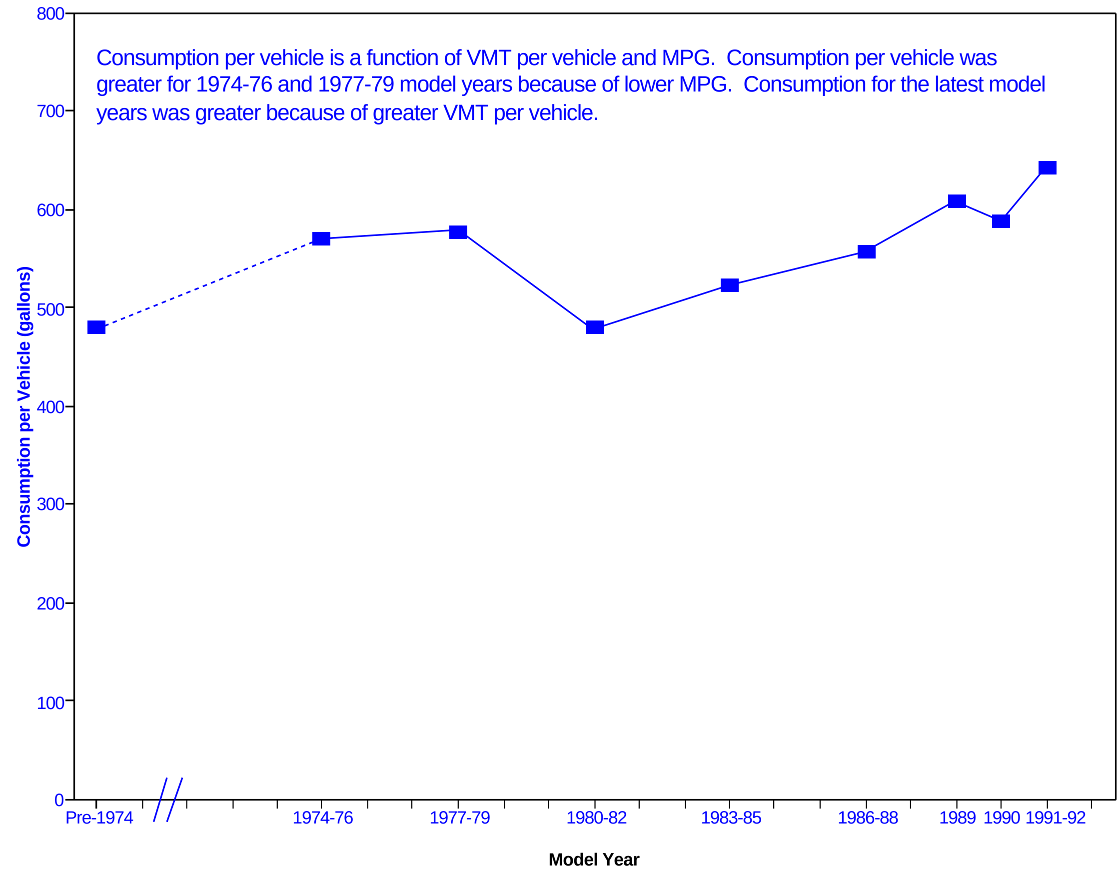
Source: Energy Information Administration, Office of Energy Markets and End Use, 1991 Residential Transportation Energy Consumption Survey.

One trend which may affect future consumption patterns is the increasing popularity of minivans, which increased their market share from 1.5 percent of vehicles in 1988 to 3.4 percent in 1991. Minivans (which are classified as light trucks for CAFE purposes) are less fuel efficient on average than passenger cars. The percentage of new model passenger cars has already declined from 75 percent in the 1988 RTECS to 66 percent in 1991. If the recent trend continues, minivans will increasingly replace passenger cars in the vehicle stock. This change in vehicle mix will raise the overall average fuel consumption per vehicle above the comparable level if passenger cars had been purchased instead of minivans.

Model Year

Based on the 1991 RTECS, consumption per vehicle increased from pre-1974 models through 1979 models, then declined for the 1980-1982 model year category. The increase for the models of the 1970 decade reflects the higher VMT per vehicle for those models and relatively little increase in fuel efficiency. The decreases for the 1980-1982 models are due to major improvements in fuel efficiency (Figure 23). In the early 1980's, there was no significant change in VMT per vehicle. Since the 1982 model year, continuing increases in VMT per vehicle more than offset fuel savings due to improvements in fuel efficiency, increasing consumption per vehicle.

Figure 23. Average Annual Vehicle Fuel Consumption, by Vehicle Model Year



Source: Energy Information Administration, Office of Energy Markets and End Use, 1991 Residential Transportation Energy Consumption Survey.

Potential Fuel Savings from Replacing Old Vehicles

Using the RTECS data, it is possible to estimate energy savings that could occur if a portion of the existing vehicle stock were replaced with more fuel-efficient vehicles[10]. However, it is difficult to accurately estimate these savings because the new, replacement vehicles may be used differently. RTECS data indicate that newer vehicles are driven more on average, and the acquisition of a newer vehicle may cause households with more than one vehicle to alter the pattern of vehicle usage in ways that are difficult to characterize. Even though it is likely that the replacement vehicles will be driven more than the older vehicles they replace, a particular household may acquire a newer vehicle for a specific purpose that precludes it from becoming the household's primary, or high VMT, vehicle.

[10]A similar analysis was performed for household appliances and equipment in "Potential Efficiency Gains and Energy Savings from Replacing 1990 Stock with 1990 New Appliance Units," *Household Energy Consumption and Expenditures 1990*, DOE/EIA-0321(90), pp. 30-35. That analysis showed that significant savings are possible if older, less efficient household equipment is replaced with new energy-efficient equipment.

Given these difficulties, a simple, hypothetical example may better illustrate possible fuel savings. By starting with the simplifying assumption that the replacement vehicle is driven the same number of miles as the older vehicle it replaces, the required calculation can be made easily with the RTECS data.

First, assume all vehicles that are older than the 1980 model year are replaced with new (1991-92) models. By targeting only pre-1980 vehicles for replacement, it is possible to estimate the impact of replacing the least efficient model years in the stock with the most efficient. According to the RTECS, 35.1 million vehicles from the pre-1980 model year consumed a total of 19.1 billion gallons of fuel in 1991 (23 percent of all fuel consumed by household vehicles). These older vehicles traveled a total of 253 billion miles (16 percent of total VMT in 1991), for an average VMT per vehicle of 7,200 miles. Assuming the new model replacement vehicles also averaged 7,200 miles each, and their average fuel efficiency was 21.8 MPG (the average of the new 1991 vehicles), the replacement vehicles would use only 11.6 billion gallons of fuel--a fuel savings of 7.5 billion gallons. This is equivalent to 9.1 percent of the total 1991 fuel consumption.[11]

Even greater savings could be realized if the replacement vehicles were more fuel efficient than the average of new 1991 vehicles. For example, the fuel savings would increase to 10.7 billion gallons (13 percent of total fuel consumption in 1991) if the replacement vehicles averaged 30 MPG; 12.8 billion gallons (15 percent) for 40 MPG; and 14.0 billion gallons (17 percent) for 50 MPG.

Although these results are significant, the energy savings are not as impressive as those estimated in a similar analysis for replacement of older household appliances. The potential energy savings from the replacement of old household appliances are relatively larger because inefficient household appliances represent a relatively larger proportion of the household appliance stock. Fuel savings due to retirement of "gas guzzlers" are relatively smaller because a substantial number of these vehicles (i.e., pre-1980 vehicles) already have been taken off the road.

Fuel Consumption in Households Participating in Income Supplement Programs

The 1991 RTECS included data on vehicle use, fuel consumption, and fuel expenditures for households that participate in several income supplement programs (Table 6), ranging from Social Security and pension programs to food stamps and Aid to Families with Dependent Children (AFDC). Households may qualify for more than one program. With the exception of Social Security, pension programs, and unemployment benefits, these programs are targeted at low-income households.

On average, households in income supplement programs traveled fewer miles, consumed less fuel, and spent less money for motor fuels than the population of all households with vehicles. These findings were consistent with observations, noted earlier, for households with older drivers (such as retired persons) and for lower income households.

[11]The Office of Technology Assessment (OTA) estimated the impact of a program that would allow automobile companies to purchase and retire pre-1975 cars for the purpose of removing inefficient, polluting vehicles from the road. In return, the companies would be awarded credits toward meeting their CAFE standards. OTA estimated that 370-520 gallons per vehicle per year could be saved. The total savings would depend upon the number of vehicles scrapped. The 1991 RTECS estimated that there are approximately 13.5 million pre-1975 vehicles in the stock. If all were replaced, and the OTA estimate of savings per vehicle is used, between 5 and 7 billion gallons of fuel would be saved. Although OTA used a different set of assumptions and a different methodology, the range of savings is very close to the fuel savings of 7.5 billion gallons estimated here. U.S. Congress, Office of Technology Assessment, *Retiring Old Cars: Programs To Save Gasoline and Reduce Emissions*, OTA-E-536, July 1992.

Table 6. U.S. per Household Vehicle Miles Traveled, Vehicle Fuel Consumption and Expenditures for Income Supplement Programs, 1991

Income Supplement Program	Number of Households with Vehicles (million)	Average per Household			
		Number of Vehicles	Vehicle Miles Traveled (thousand)	Consumption (gallons)	Expenditures (dollars)
Total U.S.	84.6	1.8	18.9	979	1,161
Social Security[a]	21.4	1.6	12.9	718	852
Pension Funds[b]	15.3	1.7	14.1	756	898
Unemployment Benefits	2.7	1.9	21.1	1,087	1,292
Food Stamps	3.4	1.3	12.2	710	828
AFDC Income[c]	2.2	1.4	13.4	769	898
SSI Income[d]	1.7	1.4	11.3	649	758
Other Aid	1.5	1.4	11.2	644	753

[a]Includes social security and railroad retirement pension income.
[b]Pension income other than social security and railroad retirement.
[c]AFDC--Aid to Families with Dependent Children.
[d]Supplemental security income administered by the Social Security Administration.
Source: Energy Information Administration, Office of Energy Markets and End Use, 1991 Residential Transportation Energy Consumption Survey.

The only exception is households that received unemployment benefits. These households had more vehicles, traveled more miles, consumed more fuel, and spent more on motor fuels than the other groups that received income supplements. Inclusion in this category required only that at least one household member received unemployment benefits sometime during the year. These households were at or near national household averages for family income, numbers of drivers and numbers of vehicles, i.e., they were more typical of the national average than the other income supplement households.

The 1991 RTECS collected more detailed information from a small number of households that received, or were eligible to receive, public assistance such as food stamps, AFDC, and LIHEAP[12] (Table 7). Because the total number of cases in the RTECS sample with these characteristics was small, the relative standard errors were fairly large. As a result, some data in this table were withheld.

Low-income households receiving public assistance spent a larger proportion of their incomes to fuel their vehicles--typically twice as much as higher income households. For example, Midwest households receiving food stamps spent 13.1 percent of their income on motor fuel, compared with only 5.4 percent for all households in the Midwest Census region. Because of the large percentage of income spent on fuel, low-income households were affected relatively more than other households by any change in the price of fuel.

Low-income households receiving public assistance also had a greater percentage of older vehicles than average (Table 7). The average age of their vehicles was typically two or more years older than higher income households, so they did not benefit as much from the greater fuel efficiency of newer vehicles. In addition, many of the older vehicles required more expensive, higher grades of gasoline, which added to fuel expenditures.

[12]Low-Income Home Energy Assistance Program. Established by the Low-Income Home Energy Assistance Act of 1981, LIHEAP provides Federal funds to States to assist eligible low-income households with heating and cooling bills.

Within each vehicle vintage category, however, the vehicles belonging to low-income groups had similar to slightly better fuel efficiency than the overall average for each category. The lower fuel efficiency of vehicles belonging to low-income groups was therefore a reflection of the age of the vehicles, not the type of vehicle. Although low-income groups on average had older vehicles, the vehicle type in itself was not less efficient than higher income groups.

Table 7. Summary of Household and Vehicle Characteristics by Categories of Income Assistance, 1991

Household or Vehicle Characteristic	All Households with Vehicles	Households Receiving or Eligible for Assistance			
		Food Stamps	AFDC Income	Eligible for LIHEAP	Received LIHEAP
Number of Households with Vehicles (million)					
All Regions	84.6	3.4	2.2	20.8	2.9
Northeast	16.0	Q	Q	3.0	Q
Midwest	21.1	Q	Q	4.9	0.9
South	29.5	1.4	Q	8.5	0.7
West	18.0	Q	Q	4.3	0.7
Income Spent on Motor Fuel (percent of total income)					
All Regions	5.4	12.6	13.4	11.3	11.7
Northeast	3.9	Q	Q	8.2	13.2
Midwest	5.4	13.1	12.8	11.2	10.7
South	6.0	10.9	11.8	11.7	14.0
West	5.5	12.5	13.4	12.7	9.6
Average Age of Vehicles (years)					
All Regions	7.7	11.8	11.3	9.9	11.6
Northeast	6.1	Q	Q	6.8	8.9
Midwest	7.7	Q	8.9	9.7	12.2
South	7.7	10.7	11.5	9.9	10.9
West	8.9	15.2	Q	11.7	13.1
Number of Vehicles by Vintage (million)					
All Years	151.2	4.3	3.0	29.8	3.8
1989 to 1992	28.5	Q	Q	3.7	0.4
1983 to 1988	70.0	1.1	0.9	10.1	0.8
1977 to 1982	34.2	1.6	Q	10.1	1.5
1976 and Before	18.5	1.2	Q	6.0	1.0
Average Fuel Efficiency (miles per gallon)					
All Years	19.3	17.2	17.4	17.9	17.1
1989 to 1992	21.7	Q	Q	22.7	22.5
1983 to 1988	21.4	22.4	21.3	21.5	22.5
1977 to 1982	16.4	16.8	Q	16.2	16.0
1976 and Before	12.4	12.3	Q	12.1	12.8

Q = Data withheld either because the Relative Standard Error (RSE) was greater than 50 percent or fewer than 10 households were sampled.

Source: Energy Information Administration, Office of Energy Markets and End Use, 1991 Residential Transportation Energy Consumption Survey.

Detailed Tables

The following tables present detailed characteristics of vehicles in the residential sector. Data are from the 1991 Residential Transportation Energy Consumption Survey. The "Glossary" contains the definitions of terms used in the tables.

Table Organization

The "Detailed Tables" section consists of three types of tables: (1) Tables of totals such as number of vehicle miles traveled (VMT) or gallons consumed; (2) Tables of per household statistics such as VMT per household; and (3) Tables of per vehicle statistics such as vehicle fuel consumption per vehicle. The tables have been grouped together by specific topics such as model year data, or family income data to facilitate finding related information. The Quick-Reference Guide to the detailed tables indicates major topics of each table.

Row and Column Factors

These tables present estimates of characteristics, vehicle fuel consumption, miles driven, and fuel efficiencies for all vehicles used for personal transportation in the United States. Since the estimates are based on a sample survey, they are subject to error. To help the reader compute an approximate relative standard error (RSE) for each of the estimates in the detailed tables, row and column factors are displayed on the top line and in the far-right column of each table. To calculate the RSE for a specific estimate, multiply the row factor by the column factor. (See Figure C1 and the related discussion in Appendix C, Quality of the Data," for more details.)

Quick-Reference Guide

Topic	Table Numbers
Summary	
Totals	8
Per Household	9
Per Vehicle	10
Vehicle Model Year	
Total Vehicles	11
Miles per Gallon	12
Gallons per Vehicle	13
Family Income	
Total Miles Traveled	14
Total Gallons	15
Miles per Household	16
Gallons per Household	17
Household Composition	
Total Vehicles	18
Miles per Household	19
Miles per Gallon	
Per Vehicle	20
Vehicle Type	
Total Gallons	21
Miles per Vehicle	22
Total Vehicles	23
Vehicle Fuel Expenditures	

Table 8. Number of Vehicles, Vehicle Miles, Motor Fuel Consumption and Expenditures, 1991

1990 Household and 1991 Vehicle Characteristics	Number of Vehicles		Vehicle Miles Traveled		Consumption			Expenditures		RSE Row Factor
	(million)	(percent)	(billion)	(percent)	(billion gallons)	(gallon percent)	(quadrillion Btu)	(billion dollars)	(percent)	
RSE Column Factor:	0.9	0.8	1.1	1.0	1.1	1.0	1.1	1.1	1.0	
Household Characteristics										
Total	151.2	100.0	1,602	100.0	82.8	100.0	10.3	98.2	100.0	2.4
Census Region and Division										
Northeast	27.0	17.9	295	18.4	14.1	17.1	1.8	17.8	18.2	4.4
New England	6.5	4.3	75	4.7	3.5	4.3	.4	4.5	4.6	9.9
Middle Atlantic	20.5	13.6	221	13.8	10.6	12.8	1.3	13.3	13.6	5.7
Midwest	38.4	25.4	403	25.2	21.3	25.7	2.6	25.0	25.4	4.7
East North Central	27.6	18.2	296	18.4	15.2	18.4	1.9	17.9	18.2	6.9
West North Central	10.8	7.1	108	6.7	6.0	7.3	.7	7.1	7.2	5.9
South	52.7	34.8	571	35.7	29.8	36.0	3.7	34.9	35.6	4.4
South Atlantic	26.6	17.6	291	18.2	14.4	17.4	1.8	17.0	17.3	7.5
East South Central	10.8	7.2	121	7.5	6.5	7.8	.8	7.6	7.7	13.7
West South Central	15.2	10.1	160	10.0	8.9	10.7	1.1	10.4	10.6	11.9
West	33.2	21.9	333	20.8	17.6	21.3	2.2	20.5	20.9	4.3
Mountain	9.1	6.0	89	5.6	5.0	6.1	.6	5.7	5.8	9.4
Pacific	24.1	15.9	244	15.2	12.6	15.2	1.6	14.8	15.1	5.9
Urban Status										
Urban	114.3	75.6	1,219	76.1	61.5	74.3	7.6	73.3	74.6	2.1
Central City	38.8	25.7	387	24.1	19.7	23.8	2.5	23.4	23.8	4.4
Suburban	75.5	49.9	833	52.0	41.8	50.5	5.2	49.9	50.8	2.8
Rural	36.9	24.4	383	23.9	21.3	25.7	2.6	25.0	25.4	4.4
Household Size										
1 Person	22.1	14.6	198	12.4	10.4	12.5	1.3	12.3	12.5	5.0
2 Persons	49.9	33.0	494	30.8	25.6	30.9	3.2	30.3	30.8	4.5
3 Persons	30.3	20.0	339	21.2	16.9	20.4	2.1	20.1	20.5	6.5
4 Persons	29.3	19.4	349	21.8	18.0	21.7	2.2	21.4	21.7	6.4
5 Persons	13.6	9.0	152	9.5	8.0	9.7	1.0	9.5	9.7	8.8
6 or More Persons	6.0	3.9	70	4.4	4.0	4.8	.5	4.7	4.8	17.1
Household Composition										
Households with Children	65.1	43.0	753	47.0	38.9	46.9	4.8	46.1	46.9	4.3
Age of Oldest Child										
Under 7 Years	19.0	12.6	214	13.4	10.7	12.9	1.3	12.7	13.0	9.0
7 to 15 Years	32.3	21.3	378	23.6	19.7	23.8	2.4	23.4	23.8	6.1
16 or 17 Years	13.8	9.1	161	10.1	8.4	10.2	1.0	10.0	10.2	12.7
Households Without Children	86.2	57.0	849	53.0	44.0	53.1	5.5	52.2	53.1	3.3
One Adult	22.1	14.6	198	12.4	10.4	12.5	1.3	12.3	12.5	5.0
Age of Householder										
Under 35 Years	5.0	3.3	59	3.7	2.9	3.5	.4	3.4	3.5	15.3
35 to 59 Years	7.6	5.0	81	5.1	4.2	5.0	.5	5.0	5.0	11.5
60 Years or More	9.6	6.3	58	3.6	3.3	4.0	.4	3.9	4.0	10.4
Two or More Adults	64.0	42.3	651	40.6	33.6	40.6	4.2	39.9	40.6	4.0
Age of Householder										
Under 35 Years	13.2	8.7	156	9.8	7.4	8.9	.9	8.8	8.9	13.1
35 to 59 Years	27.8	18.4	298	18.6	15.4	18.7	1.9	18.3	18.7	6.2
60 Years or More	23.1	15.2	197	12.3	10.7	13.0	1.3	12.8	13.0	6.7
Race of Householder										
White	135.3	89.5	1,429	89.2	73.9	89.2	9.1	87.5	89.1	2.0
Black	12.8	8.4	143	8.9	7.4	8.9	.9	8.9	9.0	11.5
Other	3.1	2.1	30	1.9	1.6	1.9	.2	1.8	1.9	25.3
Hispanic Descent										
Yes	9.4	6.2	95	5.9	5.2	6.3	.6	6.1	6.3	17.1
No	141.8	93.8	1,507	94.1	77.6	93.7	9.6	92.1	93.7	2.5

See footnote at end of table.

Table 8. Number of Vehicles, Vehicle Miles, Motor Fuel Consumption and Expenditures, 1991 (Continued)

1990 Household and 1991 Vehicle Characteristics	Number of Vehicles (million)	Number of Vehicles (percent)	Vehicle Miles Traveled (billion)	Vehicle Miles Traveled (percent)	Consumption (billion gallons)	Consumption (gallon percent)	Consumption (quadrillion Btu)	Expenditures (billion dollars)	Expenditures (percent)	RSE Row Factor
RSE Column Factor:	0.9	0.8	1.1	1.0	1.1	1.0	1.1	1.1	1.0	
1990 Family Income										
Less than $5,000	3.6	2.4	33	2.0	1.8	2.1	0.2	2.1	2.1	25.1
$5,000 to $9,999	9.1	6.0	77	4.8	4.3	5.2	.5	5.1	5.1	12.6
$10,000 to $14,999	13.5	8.9	120	7.5	6.6	7.9	.8	7.7	7.9	9.2
$15,000 to $19,999	10.9	7.2	106	6.6	5.7	6.9	.7	6.7	6.8	13.3
$20,000 to $24,999	15.6	10.3	153	9.5	8.5	10.3	1.1	10.1	10.2	9.5
$25,000 to $34,999	27.5	18.2	284	17.7	14.9	18.0	1.8	17.7	18.0	6.8
$35,000 to $49,999	32.1	21.2	361	22.6	17.8	21.5	2.2	21.1	21.5	5.6
$50,000 to $74,999	22.9	15.1	273	17.0	13.5	16.4	1.7	16.1	16.4	6.8
$75,000 or More	16.0	10.6	196	12.3	9.7	11.7	1.2	11.7	11.9	10.2
Below Poverty Line										
100 Percent	11.5	7.6	110	6.9	6.1	7.4	.8	7.2	7.3	13.3
125 Percent	17.6	11.6	163	10.2	9.3	11.2	1.2	10.9	11.1	10.4
Eligible for Federal Assistance1/	29.8	19.7	279	17.4	15.6	18.8	1.9	18.3	18.6	7.2
Number of Drivers (Fall 1990)										
1	34.6	22.9	321	20.0	16.8	20.3	2.1	20.0	20.3	5.2
2	86.7	57.3	934	58.3	48.5	58.6	6.0	57.5	58.6	2.7
3	22.0	14.5	258	16.1	13.0	15.7	1.6	15.5	15.8	7.0
4 or More	7.2	4.7	84	5.2	4.2	5.1	.5	4.9	5.0	14.4
Age of Primary Driver										
16 to 17 Years	.7	.5	8	.5	.4	.4	(*)	.4	.4	28.4
18 to 22 Years	4.5	3.0	50	3.1	2.3	2.8	.3	2.7	2.7	13.8
23 to 29 Years	9.6	6.3	117	7.3	5.6	6.8	.7	6.7	6.8	9.7
30 to 39 Years	23.5	15.5	284	17.7	13.8	16.6	1.7	16.3	16.6	5.4
40 to 49 Years	18.1	12.0	219	13.7	11.3	13.6	1.4	13.4	13.7	6.2
50 to 59 Years	14.0	9.2	151	9.4	8.1	9.7	1.0	9.6	9.8	7.0
60 to 69 Years	12.2	8.0	100	6.3	5.4	6.6	.7	6.5	6.6	8.2
70 to 79 Years	8.0	5.3	58	3.6	3.3	4.0	.4	3.9	4.0	11.0
80 Years and Over	2.2	1.5	12	.7	.7	.8	.1	.8	.8	22.4
No Answer	58.5	38.7	604	37.7	32.0	38.7	4.0	37.9	38.6	5.7
Sex of Primary Driver										
Female	44.0	29.1	483	30.1	22.9	27.6	2.8	27.2	27.7	3.4
Male	49.6	32.8	526	32.8	28.5	34.4	3.5	33.7	34.3	3.4
No Answer	57.6	38.1	594	37.1	31.5	38.0	3.9	37.3	38.0	5.6
Average Number of Vehicles per Household During the Year										
Part-Year Vehicle	2.1	1.4	21	1.3	1.1	1.3	.1	1.3	1.4	29.1
Only 1	27.5	18.2	269	16.8	13.4	16.2	1.7	16.0	16.3	5.9
Between 1 and 2	14.1	9.3	152	9.5	7.9	9.5	1.0	9.4	9.5	9.1
Only 2	49.4	32.6	534	33.3	27.1	32.7	3.4	32.3	32.9	3.8
Between 2 and 3	19.3	12.8	219	13.7	11.6	14.1	1.4	13.7	14.0	8.7
Only 3	17.6	11.6	187	11.7	9.8	11.8	1.2	11.6	11.8	8.4
Between 3 and 4	10.6	7.0	112	7.0	6.0	7.2	.7	7.0	7.1	11.9
4 or More	10.8	7.2	108	6.8	5.9	7.1	.7	7.0	7.1	14.3

See footnote at end of table.

Table 8. Number of Vehicles, Vehicle Miles, Motor Fuel Consumption and Expenditures, 1991 (Continued)

1990 Household and 1991 Vehicle Characteristics	Number of Vehicles (million)	Number of Vehicles (percent)	Vehicle Miles Traveled (billion)	Vehicle Miles Traveled (percent)	Consumption (billion gallons)	Consumption (gallon percent)	Consumption (quadrillion Btu)	Expenditures (billion dollars)	Expenditures (percent)	RSE Row Factor
RSE Column Factor:	0.9	0.8	1.1	1.0	1.1	1.0	1.1	1.1	1.0	
Vehicle Characteristics										
Model Year										
1991 to 1992	5.5	3.6	77	4.8	3.5	4.3	.4	4.2	4.3	10.7
1990	10.5	6.9	132	8.3	6.2	7.5	.8	7.4	7.5	8.2
1989	12.5	8.3	166	10.4	7.6	9.2	.9	9.1	9.3	6.5
1986 to 1988	39.0	25.8	478	29.8	21.7	26.2	2.7	25.8	26.3	4.3
1983 to 1985	31.1	20.5	335	20.9	16.2	19.6	2.0	19.4	19.7	4.7
1980 to 1982	17.5	11.6	161	10.0	8.4	10.2	1.0	10.0	10.2	7.4
1977 to 1979	16.7	11.0	135	8.4	9.6	11.6	1.2	11.3	11.5	9.0
1974 to 1976	7.3	4.8	53	3.3	4.2	5.1	.5	4.8	4.9	14.0
1973 or Earlier	11.1	7.4	65	4.1	5.3	6.5	.7	6.1	6.2	12.8
Type of Vehicle										
Passenger Car	108.3	71.6	1,150	71.8	54.5	65.8	6.7	65.1	66.2	2.5
Minivan	5.1	3.4	65	4.1	3.3	4.0	.4	3.9	3.9	12.0
Sport-Utility Vehicle	7.3	4.8	85	5.3	5.2	6.3	.6	6.2	6.4	10.7
Large Van	3.9	2.6	40	2.5	2.9	3.5	.4	3.4	3.4	15.6
Pickup Truck	25.9	17.1	258	16.1	16.4	19.7	2.0	19.1	19.4	6.2
Other	Q	Q	Q	Q	Q	Q	Q	Q	Q	a
Fuel Efficiency (miles per gallon)										
10.9 or Less	11.6	7.7	61	3.8	6.6	8.0	.8	7.6	7.7	9.0
11 to 12.9	10.7	7.1	77	4.8	6.4	7.8	.8	7.5	7.7	9.0
13 to 15.9	21.1	13.9	178	11.1	12.3	14.8	1.5	14.5	14.8	8.6
16 to 18.9	23.5	15.5	232	14.5	13.2	16.0	1.6	15.8	16.1	5.5
19 to 21.9	30.0	19.8	361	22.5	17.7	21.4	2.2	21.2	21.6	4.9
22 to 24.9	24.0	15.9	283	17.7	12.1	14.7	1.5	14.5	14.8	5.0
25 to 29.9	22.7	15.0	301	18.8	11.1	13.4	1.4	13.2	13.5	6.5
30 or More	7.7	5.1	109	6.8	3.3	4.0	.4	3.9	4.0	11.5
Engine Size (liters)										
2.49 or Less	57.2	37.8	653	40.8	25.8	31.1	3.2	30.6	31.2	4.7
2.50 to 3.49	24.8	16.4	297	18.5	14.4	17.4	1.8	17.2	17.5	5.4
3.50 to 4.49	21.7	14.3	226	14.1	12.3	14.8	1.5	14.6	14.9	6.6
4.50 or Greater	47.5	31.4	426	26.6	30.4	36.7	3.8	35.8	36.5	4.0
Number of Cylinders										
4	59.4	39.3	680	42.4	26.9	32.5	3.3	31.9	32.5	4.1
6	42.4	28.1	478	29.8	24.8	29.9	3.1	29.5	30.0	4.3
8	47.6	31.5	423	26.4	30.1	36.3	3.7	35.5	36.2	3.9
Other	1.8	1.2	22	1.4	1.1	1.3	.1	1.3	1.3	20.5
Type of Transmission										
Automatic	110.5	73.1	1,151	71.8	62.4	75.4	7.7	74.2	75.5	2.4
Manual Shift	40.7	26.9	452	28.2	20.4	24.6	2.5	24.1	24.5	5.9
Type of Drive										
Front-Wheel	63.7	42.1	742	46.3	31.3	37.8	3.9	37.3	38.0	3.2
Rear-Wheel	73.9	48.9	706	44.1	42.2	50.9	5.2	49.9	50.8	3.1
4-Wheel	13.6	9.0	154	9.6	9.3	11.2	1.1	11.0	11.2	7.5
Type of Fuel System										
Carburetor	90.7	60.0	861	53.7	48.5	58.6	6.0	57.1	58.2	2.9
Fuel Injection	58.7	38.8	720	44.9	33.3	40.3	4.1	39.9	40.6	3.4
Diesel Engine	1.8	1.2	21	1.3	1.0	1.2	.1	1.2	1.2	20.5

See footnote at end of table.

Table 8. Number of Vehicles, Vehicle Miles, Motor Fuel Consumption and Expenditures, 1991 (Continued)

1990 Household and 1991 Vehicle Characteristics	Number of Vehicles (million)	Number of Vehicles (percent)	Vehicle Miles Traveled (billion)	Vehicle Miles Traveled (percent)	Consumption (billion gallons)	Consumption (gallon percent)	Consumption (quadrillion Btu)	Expenditures (billion dollars)	Expenditures (percent)	RSE Row Factor
RSE Column Factor:	0.9	0.8	1.1	1.0	1.1	1.0	1.1	1.1	1.0	
Type of Fuel Purchased										
Motor Gasoline	147.7	97.7	1,563	97.6	81.0	97.8	10.1	96.0	97.7	2.3
Unleaded	141.7	93.7	1,518	94.7	77.5	93.6	9.7	92.3	93.9	2.5
Regular Grade	92.6	61.2	971	60.6	49.9	60.3	6.2	56.8	57.8	2.8
Intermediate Grade	16.7	11.1	194	12.1	9.5	11.5	1.2	11.7	11.9	6.6
Premium Grade	32.4	21.4	354	22.1	18.1	21.8	2.3	23.8	24.2	5.9
Leaded	6.0	4.0	45	2.8	3.4	4.1	.4	3.7	3.8	16.9
Gasohol	1.6	1.1	17	1.1	.8	1.0	NC	.9	1.0	24.7
Diesel Fuel	1.8	1.2	21	1.3	1.0	1.2	.1	1.2	1.2	20.5
Type of Primary Service										
Full-Service Pumps	19.7	13.0	193	12.0	9.9	11.9	1.2	12.1	12.3	12.0
Self or Mini-Service Pumps	126.3	83.5	1,359	84.8	70.4	85.0	8.7	83.0	84.5	2.5
Both Equally	4.7	3.1	46	2.9	2.3	2.7	.3	2.7	2.8	16.1
Bulk Sales/Other	Q	Q	Q	Q	Q	Q	Q	Q	Q	a
Vehicle Used for Commuting to and from Work										
Yes	88.6	58.6	1,081	67.5	53.3	64.3	6.6	63.3	64.4	2.5
No	62.7	41.4	521	32.5	29.5	35.7	3.7	34.9	35.6	3.6

a = No applicable Relative Standard Error (RSE) row factor.
1/ Below 150 percent of poverty line or 60 percent of median State income.
NC = No cases in sample.
(*) = Data rounds to zero in the units given
Q = Data withheld because the RSE was greater than 50 percent or fewer than 10 households were sampled.
Note: ╫ "Households with Children" category includes members under age 18 years old unless the member is the householder or spouse.
╫ Approximately 0.5 percent of the vehicle stock was owned by households that had no drivers as of fall 1990. ╫ To obtain the RSE percentage for any table cell, multiply the corresponding column and row factors. ╫ Because of rounding data may not sum to totals.
╫ Data in this table are for households with vehicles for personal transportation. ╫ See Glossary for definition of terms used in this report. ╫ "No Answer" includes no contacts, refusals, or the respondent didn't know.
Source: Energy Information Administration, Office of Energy Markets and End Use, Forms EIA-876 A, B, and C of the 1991 Residential Transportation Energy Consumption Survey and Forms EIA-457 A and B of the 1990 Residential Energy Consumption Survey. (For specific title of forms, see Appendix D.)

Table 9. U.S. per Household Vehicle Miles Traveled, Vehicle Fuel Consumption and Expenditures, 1991

1990 Household Characteristics	Number of Households (million)	Average per Household: Number of Vehicles	Vehicle Miles Traveled (thousands)	Consumption (gallons)	Expenditures (dollars)	RSE Row Factor
RSE Column Factor:	1.5	0.6	1.0	1.0	1.0	
Household Characteristics						
Total	84.6	1.8	18.9	979	1,161	1.7
Census Region and Division						
Northeast	16.0	1.7	18.5	886	1,117	4.1
New England	3.9	1.7	19.2	911	1,157	7.9
Middle Atlantic	12.1	1.7	18.3	877	1,105	5.0
Midwest	21.1	1.8	19.1	1,008	1,184	3.6
East North Central	15.1	1.8	19.5	1,008	1,185	4.7
West North Central	6.0	1.8	18.0	1,008	1,183	4.6
South	29.5	1.8	19.3	1,008	1,182	3.5
South Atlantic	15.0	1.8	19.4	963	1,135	4.7
East South Central	6.0	1.8	20.1	1,083	1,262	8.3
West South Central	8.6	1.8	18.6	1,033	1,208	7.5
West	18.0	1.8	18.5	978	1,138	3.5
Mountain	4.7	1.9	19.0	1,072	1,218	5.0
Pacific	13.3	1.8	18.3	945	1,109	4.5
Urban Status						
Urban	65.0	1.8	18.8	947	1,127	2.0
Central City	24.3	1.6	15.9	812	964	3.9
Suburban	40.8	1.9	20.4	1,026	1,224	2.7
Rural	19.6	1.9	19.5	1,085	1,273	3.8
Household Size						
1 Person	18.6	1.2	10.6	556	660	4.3
2 Persons	27.9	1.8	17.7	916	1,085	2.9
3 Persons	15.2	2.0	22.3	1,110	1,319	4.0
4 Persons	13.3	2.2	26.2	1,350	1,604	3.6
5 Persons	6.5	2.1	23.6	1,244	1,470	5.0
6 or More Persons	3.1	1.9	22.6	1,286	1,529	8.6
Household Composition						
Households with Children	33.0	2.0	22.8	1,176	1,395	2.9
Age of Oldest Child						
Under 7 Years	10.6	1.8	20.3	1,011	1,205	5.1
7 to 15 Years	16.7	1.9	22.6	1,180	1,398	3.4
16 or 17 Years	5.7	2.4	28.0	1,468	1,736	6.6
Households Without Children	51.6	1.7	16.5	852	1,011	2.3
One Adult	18.6	1.2	10.6	556	660	4.3
Age of Householder						
Under 35 Years	4.2	1.2	14.2	685	817	10.4
35 to 59 Years	6.5	1.2	12.5	644	764	6.6
60 Years or More	8.0	1.2	7.3	417	492	6.9
Two or More Adults	33.0	1.9	19.7	1,019	1,210	2.6
Age of Householder						
Under 35 Years	7.4	1.8	21.0	996	1,178	5.6
35 to 59 Years	12.5	2.2	23.9	1,240	1,472	3.8
60 Years or More	13.1	1.8	15.0	822	977	4.9
Race of Householder						
White	75.0	1.8	19.0	985	1,167	1.9
Black	7.7	1.7	18.5	954	1,148	7.5
Other	1.9	1.7	16.2	836	981	13.2

See footnote at end of table.

Table 9. U.S. per Household Vehicle Miles Traveled, Vehicle Fuel Consumption and Expenditures, 1991 (Continued)

1990 Household Characteristics	Number of Households (million)	Average per Household: Number of Vehicles	Average per Household: Vehicle Miles Traveled (thousands)	Average per Household: Consumption (gallons)	Average per Household: Expenditures (dollars)	RSE Row Factor
RSE Column Factor:	1.5	0.6	1.0	1.0	1.0	
Hispanic Descent						
Yes...........................	5.6	1.7	16.9	927	1,093	7.1
No	79.0	1.8	19.1	982	1,166	1.8
1990 Family Income						
Less than $5,000..............	2.8	1.3	11.5	627	737	15.0
$5,000 to $9,999..............	7.3	1.3	10.6	598	695	8.9
$10,000 to $14,999............	9.7	1.4	12.3	674	795	6.7
$15,000 to $19,999............	7.3	1.5	14.4	777	913	9.3
$20,000 to $24,999............	9.3	1.7	16.5	918	1,084	6.9
$25,000 to $34,999............	14.8	1.9	19.2	1,009	1,194	3.7
$35,000 to $49,999............	16.2	2.0	22.3	1,096	1,302	3.7
$50,000 to $74,999............	10.3	2.2	26.4	1,310	1,562	4.4
$75,000 or More...............	6.8	2.4	28.9	1,421	1,715	7.0
Below Poverty Line						
100 Percent...................	8.7	1.3	12.7	705	824	8.2
125 Percent...................	12.8	1.4	12.8	723	848	6.7
Eligible for Federal Assistance1/....................	20.8	1.4	13.4	750	883	5.1
Number of Drivers (Fall 1990)						
1.............................	29.5	1.2	10.9	571	678	3.6
2.............................	43.6	2.0	21.4	1,112	1,319	1.9
3.............................	8.4	2.6	30.7	1,548	1,841	4.2
4 or More.....................	2.3	3.1	36.7	1,830	2,145	7.5
Average Number of Vehicles per Household During the Year						
Part-Year Vehicle.............	3.7	.6	5.7	291	356	17.6
only 1........................	27.5	1.0	9.8	490	582	3.7
Between 1 and 2...............	9.4	1.5	16.2	840	999	3.7
Only 2........................	24.7	2.0	21.6	1,099	1,309	2.3
Between 2 and 3...............	7.9	2.4	27.7	1,473	1,737	3.8
Only 3........................	5.9	3.0	32.0	1,670	1,974	4.6
Between 3 and 4...............	3.1	3.4	36.1	1,926	2,267	4.4
4 or More.....................	2.5	4.3	43.3	2,354	2,777	4.4

1/ Below 150 percent of poverty line or 60 percent of median State income.

Note: ╫ "Households with Children" category includes members under age 18 years old unless the member is the householder or spouse. ╫ Approximately 0.5 percent of the vehicle stock was owned by households that had no drivers as of fall 1990. ╫ To obtain the Relative Standard Error (RSE) percentage for any table cell, multiply the corresponding column and row factors. ╫ Because of rounding data may not sum to totals. ╫ Data in this table are for households with vehicles for personal transportation. ╫ See Glossary for definition of terms used in this report.

Source: Energy Information Administration, Office of Energy Markets and End Use, Forms EIA-876 A, B, and C of the 1991 Residential Transportation Energy Consumption Survey and Forms EIA-457 A and B of the 1990 Residential Energy Consumption Survey. (For specific title of forms, see Appendix D.)

Table 10. U.S. per Vehicle Miles Traveled, Vehicle Fuel Consumption and Expenditures, 1991

1990 Household and 1991 Vehicle Characteristics	Number of Vehicles (million)	Average per Vehicle: Vehicle Miles Traveled (thousands)	Average per Vehicle: Consumption (gallons)	Average per Vehicle: Expenditures (dollars)	Miles per Gallon	RSE Row Factor
RSE Column Factor:	1.6	1.1	1.1	1.1	0.5	
Household Characteristics						
Total	151.2	10.6	548	650	19.3	1.5
Census Region and Division						
Northeast	27.0	10.9	523	660	20.9	2.6
New England	6.5	11.4	541	687	21.1	4.7
Middle Atlantic	20.5	10.8	517	651	20.8	3.1
Midwest	38.4	10.5	554	651	19.0	3.2
East North Central	27.6	10.7	553	650	19.4	4.3
West North Central	10.8	10.0	557	654	17.9	3.4
South	52.7	10.8	566	663	19.2	2.7
South Atlantic	26.6	10.9	542	639	20.2	3.8
East South Central	10.8	11.1	599	698	18.6	5.7
West South Central	15.2	10.5	582	681	18.0	5.7
West	33.2	10.0	532	618	18.9	2.8
Mountain	9.1	9.8	555	631	17.8	5.2
Pacific	24.1	10.1	523	614	19.3	3.5
Urban Status						
Urban	114.3	10.7	538	641	19.8	1.6
Central City	38.8	10.0	508	603	19.6	3.2
Suburban	75.5	11.0	554	661	19.9	1.9
Rural	36.9	10.4	576	676	18.0	3.3
Household Size						
1 Person	22.1	9.0	468	555	19.1	4.2
2 Persons	49.9	9.9	512	607	19.3	2.6
3 Persons	30.3	11.2	559	664	20.1	3.1
4 Persons	29.3	11.9	613	728	19.4	3.1
5 Persons	13.6	11.2	590	696	18.9	3.2
6 or More Persons	6.0	11.7	665	791	17.6	7.8
Household Composition						
Households with Children	65.1	11.6	597	708	19.4	2.3
Age of Oldest Child						
Under 7 Years	19.0	11.2	561	668	20.0	4.2
7 to 15 Years	32.3	11.7	612	724	19.2	2.6
16 or 17 Years	13.8	11.7	613	725	19.1	5.7
Households Without Children	86.2	9.9	510	605	19.3	2.1
One Adult	22.1	9.0	468	555	19.1	4.2
Age of Householder						
Under 35 Years	5.0	11.9	575	687	20.7	9.4
35 to 59 Years	7.6	10.7	549	652	19.4	6.2
60 Years or More	9.6	6.1	347	409	17.5	7.3
Two or More Adults	64.0	10.2	525	623	19.4	2.4
Age of Householder						
Under 35 Years	13.2	11.9	563	666	21.1	5.9
35 to 59 Years	27.8	10.7	556	659	19.3	3.5
60 Years or More	23.1	8.5	466	554	18.3	3.8
Race of Householder						
White	135.3	10.6	546	647	19.3	1.6
Black	12.8	11.2	578	695	19.4	6.2
Other	3.1	9.7	499	586	19.3	12.7
Hispanic Descent						
Yes	9.4	10.1	555	655	18.3	6.7
No	141.8	10.6	547	649	19.4	1.5

See footnote at end of table.

Table 10. U.S. per Vehicle Miles Traveled, Vehicle Fuel Consumption and Expenditures, 1991 (Continued)

1990 Household and 1991 Vehicle Characteristics	Number of Vehicles (million)	Average per Vehicle: Vehicle Miles Traveled (thousands)	Average per Vehicle: Consumption (gallons)	Average per Vehicle: Expenditures (dollars)	Miles per Gallon	RSE Row Factor
RSE Column Factor:	1.6	1.1	1.1	1.1	0.5	
1990 Family Income						
Less than $5,000..............	3.6	9.1	492	578	18.4	12.0
$5,000 to $9,999..............	9.1	8.4	477	554	17.7	8.2
$10,000 to $14,999............	13.5	8.9	488	576	18.2	6.3
$15,000 to $19,999............	10.9	9.7	524	616	18.6	6.7
$20,000 to $24,999............	15.6	9.8	545	644	17.9	5.6
$25,000 to $34,999............	27.5	10.3	542	642	19.0	3.1
$35,000 to $49,999............	32.1	11.2	553	657	20.3	3.0
$50,000 to $74,999............	22.9	11.9	592	706	20.1	3.3
$75,000 or More...............	16.0	12.3	604	729	20.3	4.2
Below Poverty Line						
100 Percent...................	11.5	9.6	533	624	18.0	7.2
125 Percent...................	17.6	9.3	527	618	17.6	5.8
Eligible for Federal Assistance1/....................	29.8	9.4	522	615	17.9	4.3
Number of Drivers (Fall 1990)						
1.............................	34.6	9.3	486	577	19.1	3.5
2.............................	86.7	10.8	560	664	19.3	2.0
3.............................	22.0	11.8	593	705	19.8	4.1
4 or More.....................	7.2	11.7	584	684	20.0	5.4
Age of Primary Driver						
16 to 17 Years................	.7	10.8	522	599	20.7	13.9
18 to 22 Years................	4.5	11.2	512	599	21.9	6.9
23 to 29 Years................	9.6	12.2	584	697	20.9	5.1
30 to 39 Years................	23.5	12.1	587	697	20.6	2.7
40 to 49 Years................	18.1	12.1	624	741	19.4	3.7
50 to 59 Years................	14.0	10.8	578	691	18.7	3.7
60 to 69 Years................	12.2	8.2	446	530	18.5	4.4
70 to 79 Years................	8.0	7.2	414	489	17.5	6.3
80 Years and Over.............	2.2	5.3	301	350	17.5	14.0
No Answer.....................	58.5	10.3	547	647	18.9	2.9
Sex of Primary Driver						
Female........................	44.0	11.0	520	620	21.1	1.9
Male..........................	49.6	10.6	573	679	18.5	2.2
No Answer.....................	57.6	10.3	547	647	18.8	3.1
Average Number of Vehicles per Household During the Year						
Part-Year Vehicle.............	2.1	10.1	519	636	19.5	15.4
Only 1........................	27.5	9.8	490	582	20.0	3.4
Between 1 and 2...............	14.1	10.8	561	667	19.3	4.3
Only 2........................	49.4	10.8	549	654	19.7	2.2
Between 2 and 3...............	19.3	11.3	603	712	18.8	4.9
Only 3........................	17.6	10.7	557	658	19.1	4.4
Between 3 and 4...............	10.6	10.6	564	664	18.7	6.4
4 or More.....................	10.8	10.0	545	643	18.4	5.5
Vehicle Characteristics						
Model Year						
1991 to 1992..................	5.5	14.0	643	772	21.8	4.9
1990..........................	10.5	12.6	589	705	21.5	3.9
1989..........................	12.5	13.2	607	727	21.8	3.6
1986 to 1988..................	39.0	12.3	557	663	22.0	2.3
1983 to 1985..................	31.1	10.8	522	623	20.6	2.9
1980 to 1982..................	17.5	9.2	480	571	19.1	4.2
1977 to 1979..................	16.7	8.1	577	680	14.1	5.2
1974 to 1976..................	7.3	7.2	571	661	12.6	9.0
1973 or Earlier...............	11.1	5.8	479	548	12.2	9.2

See footnote at end of table.

Table 10. U.S. per Vehicle Miles Traveled, Vehicle Fuel Consumption and Expenditures, 1991 (Continued)

1990 Household and 1991 Vehicle Characteristics	Number of Vehicles (million)	Average per Vehicle: Vehicle Miles Traveled (thousands)	Average per Vehicle: Consumption (gallons)	Average per Vehicle: Expenditures (dollars)	Miles per Gallon	RSE
RSE Column Factor:	1.6	1.1	1.1	1.1	0.5	Row Factor
Type of Vehicle						
Passenger Car	108.3	10.6	503	601	21.1	1.8
Minivan	5.1	12.7	646	753	19.6	5.4
Sport-Utility Vehicle	7.3	11.6	717	856	16.2	5.3
Large Van	3.9	10.1	736	856	13.7	8.9
Pickup Truck	25.9	10.0	632	738	15.8	3.6
Other	Q	Q	Q	Q	Q	a
Fuel Efficiency (miles per gallon)						
10.9 or Less	11.6	5.3	569	654	9.3	6.1
11 to 12.9	10.7	7.2	601	703	12.0	6.1
13 to 15.9	21.1	8.5	583	690	14.5	4.6
16 to 18.9	23.5	9.9	564	672	17.5	3.2
19 to 21.9	30.0	12.0	591	707	20.4	2.5
22 to 24.9	24.0	11.8	506	604	23.3	2.7
25 to 29.9	22.7	13.2	490	583	27.0	2.9
30 or More	7.7	14.2	427	504	33.2	5.2
Engine Size (liters)						
2.49 or Less	57.2	11.4	450	535	25.4	2.4
2.50 to 3.49	24.8	12.0	580	691	20.6	2.8
3.50 to 4.49	21.7	10.4	565	674	18.5	3.4
4.50 or Greater	47.5	9.0	640	755	14.0	2.7
Number of Cylinders						
4	59.4	11.4	452	537	25.3	2.2
6	42.4	11.3	584	694	19.3	2.7
8	47.6	8.9	632	746	14.1	2.6
Other	1.8	12.4	618	748	20.1	12.7
Type of Transmission						
Automatic	110.5	10.4	565	671	18.4	1.6
Manual Shift	40.7	11.1	501	591	22.1	3.4
Type of Drive						
Front-Wheel	63.7	11.6	492	586	23.7	1.9
Rear-Wheel	73.9	9.6	571	675	16.7	2.4
4-Wheel	13.6	11.3	686	810	16.5	3.9
Type of Fuel System						
Carburetor	90.7	9.5	535	630	17.7	2.0
Fuel Injection	58.7	12.3	568	680	21.6	1.8
Diesel Engine	1.8	11.5	524	659	22.0	11.8
Type of Fuel Purchased						
Motor Gasoline	147.7	10.6	548	650	19.3	1.4
Unleaded	141.7	10.7	547	651	19.6	1.5
Regular Grade	92.6	10.5	539	613	19.4	1.9
Intermediate Grade	16.7	11.6	569	698	20.3	4.0
Premium Grade	32.4	10.9	558	734	19.6	3.0
Leaded	6.0	7.6	569	623	13.3	11.1
Gasohol	1.6	10.6	517	588	20.5	11.8
Diesel Fuel	1.8	11.5	524	659	22.0	11.8

See footnote at end of table.

Table 10. U.S. per Vehicle Miles Traveled, Vehicle Fuel Consumption and Expenditures, 1991 (Continued)

1990 Household and 1991 Vehicle Characteristics	Number of Vehicles (million)	Average per Vehicle: Vehicle Miles Traveled (thousands)	Average per Vehicle: Consumption (gallons)	Average per Vehicle: Expenditures (dollars)	Miles per Gallon	RSE Row Factor
RSE Column Factor:	1.6	1.1	1.1	1.1	0.5	
Type of Primary Service						
Full-Service Pumps............	19.7	9.8	503	616	19.5	4.8
Self or Mini-Service Pumps....	126.3	10.8	557	657	19.3	1.8
Both Equally..................	4.7	9.7	479	582	20.3	8.6
Bulk Sales/Other..............	Q	Q	Q	Q	Q	a
Vehicle Used for Commuting to and from Work						
Yes...........................	88.6	12.2	602	715	20.3	1.8
No............................	62.7	8.3	471	557	17.7	2.3

a = No applicable Relative Standard Error (RSE) row factor.
1/ Below 150 percent of poverty line or 60 percent of median State income.
Q = Data withheld because the RSE was greater than 50 percent or fewer than 10 households were sampled.
Note: • "Households with Children" category includes members under age 18 years old unless the member is the householder or spouse. • Approximately 0.5 percent of the vehicle stock was owned by households that had no drivers as of fall 1990. • To obtain the RSE percentage for any table cell, multiply the corresponding column and row factors. • Because of rounding data may not sum to totals. • Data in this table are for households with vehicles for personal transportation. • See Glossary for definition of terms used in this report. • "No Answer" includes no contacts, refusals, or the respondent didn't know.
Source: Energy Information Administration, Office of Energy Markets and End Use, Forms EIA-876 A, B, and C of the 1991 Residential Transportation Energy Consumption Survey and Forms EIA-457 A and B of the 1990 Residential Energy Consumption Survey. (For specific title of forms, see Appendix D.)

Total Households	24
Energy/Expenditures	
Dollars per Household	25
Energy/Consumption	
Per Household	26
Vehicle Stock Changes	
Total Households	27

Appendix A

How the Survey Was Conducted

Appendix A

How the Survey Was Conducted

Introduction

The Residential Transportation Energy Consumption Survey (RTECS) was designed by the Energy Information Administration (EIA) to provide data about vehicles that are used for personal transportation in the United States. These data include the motor vehicle stock, the vehicle miles traveled (VMT), and the vehicle fuel consumption and expenditures. The RTECS is a companion survey to the Residential Energy Consumption Survey (RECS), which collects household energy consumption and expenditure data. The RTECS collects vehicle information through a telephone interview with a representative national sample of households. Copies of the data collection forms are provided in Appendix D, "Survey Forms." The 1991 RTECS is the fourth such survey covering a calendar year conducted by EIA; previous surveys were collected in 1983, 1985 and 1988. Prior to the 1983 RTECS, monthly surveys were conducted from June 1979 to September 1981. Beginning with 1985, the surveys have been conducted triennially, with the next one scheduled in 1994.

This appendix provides detailed information concerning: (1) the RTECS survey design, including a comparison between the 1991 and previous years RTECS designs; (2) the sample design; (3) the data-collection procedures; (4) the Vehicle Identification Number (VIN); (5) interviewer training; (6) efforts undertaken to minimize the nonresponse biases; (7) survey estimate weights; (8) data-editing procedures; (9) data-preparation procedures; and (10) data confidentiality and the preparation of the public-use data tape.

Changes in Survey Design and Data Collection

The survey design for the 1991 RTECS was unchanged from the 1988 survey, but there were several additional questions and minor changes in the data collection procedures. Fuel efficiencies continue to be estimated by using the Environmental Protection Agency (EPA) laboratory-test miles per gallon (MPG) adjusted for on-road fuel efficiency shortfall. (See Appendix B, "Estimation Methodologies," for further discussion.) Major details of the 1991 RTECS design and data collection included the following:

- The sample size of the 1991 RTECS was 3,045 households, similar to the 1988 RTECS which had 2,986 households.

- Respondents in the 1991 RTECS were once again not asked to maintain monthly fuel-purchase diaries.

- The number of contacts with respondents required to collect the data in 1991 was 10 per household.

- In 1991, MPG and fuel-price data were estimated in the same manner as in 1988. MPG data were estimated using adjusted test laboratory MPG as recorded on the EPA Emissions Certification files. Fuel-price data were obtained from the Bureau of Labor Statistics (BLS) gasoline pump price series and the Lundberg Survey, Inc., price series. (See Appendix B, "Estimation Methodologies," for a detailed discussion of the estimation procedures used in this report.)

- Respondents were again asked to provide the VIN for each vehicle. The decoded VIN was used to enhance the accuracy of reported vehicle characteristics. These characteristics were used to match sampled vehicles to the EPA Certification files. (See "The Vehicle Identification Number" section in this appendix for a detailed discussion of the VIN).

- Households in the 1991 RTECS, as in 1988, did not receive a monetary incentive to participate, as they did in the 1985 RTECS.

Sample Design

The sample design for the 1991 RTECS consisted of a core (self-weighting) national sample of households plus an oversample of high-mileage households. (See "Glossary" for definition of High-Mileage Households.) Oversampling high-mileage households allowed the RTECS to: (1) collect data on more vehicles, and (2) provide better estimates for major statistics such as VMT and vehicle stock.

As of July 1991, the target population for the RTECS was estimated at 94.6 million households, based on adjusted estimates of households from the U.S. Bureau of the Census, *Current Population Survey* (CPS). The universe for the RTECS is comprised of all housing units occupied as the primary residence in the 50 States and the District of Columbia. (See "Glossary" for a definition of Housing Unit.) The sample of households selected for the 1991 RTECS was based on the 1990 RECS multistage area probability sample. The RECS incorporates a rotating panel that allows the observation of changes in energy use over time when the same households are in two successive surveys. The original RECS sample consisted of 6,757 units, of which 150 either were not used for dwelling purposes or were not habitable. Of the 6,607 habitable housing units, 698 units were considered ineligible either because of current vacancies or seasonal occupancy. Of the 5,909 eligible units, energy-related information was collected from 4,828 households, for an 81.7 percent response rate for the RECS. An additional 267 responses were obtained from a mail follow up for a total of 5,095 responding households. (See *Housing Characteristics 1990* (published May 1992), DOE/EIA-0314(90), GPO Stock No. 061-003-00754-6 for a detailed discussion of the RECS Sample Design.)

The RTECS sample consisted of 3,045 housing units selected from the 5,095 available 1990 RECS housing units for which data were successfully collected.

The fraction of RECS housing units selected for RTECS was 59.8 percent. At the beginning of the data collection period in January 1991, 2,842 (93.3 percent) of the 3,045 housing units were identified as housing units that could potentially be contacted by telephone, and 200 housing units (6.6 percent) were identified as households that could not be contacted by telephone, either because they did not have telephones, had unlisted numbers, or refused to provide a telephone number during the RECS interview. This group was classified as mail households and data were collected from these households via a mailed questionnaire rather than a telephone interview. Contact was not attempted for an additional 3 households. By the end of the RTECS survey cycle (February 1992), the percent of households considered mail households had increased to 485, or 16 percent, because of an increased number of households with unlisted numbers or disconnected telephones.

The 1991 RTECS sample was selected in two groups. This was necessary because the Beginning-of-Year (B-O-Y) RTECS contacts were scheduled to begin in early January 1991, before the completion of the 1990 RECS interviews. The first RTECS sample group was selected from the RECS households that had completed RECS interviews as of November 1990. The RTECS interviews for this group were scheduled for early January 1991. The first calls to households began the night of the attack on Kuwait by the United States. A decision was made to halt collection, and resume calls in February. The second RTECS sample group was selected from the RECS households that had completed RECS interviews as of January 31, 1991. The RTECS interviews for this group began in March 1991.

Data Collection

The RTECS was divided into four data collection phases. The first phase occurred as part of the RECS personal interview. During this interview, the household's vehicle stock was enumerated, and when possible, the VIN and the odometer reading for each vehicle were recorded. Household characteristics were also collected. The vehicle inventory collected at this time provided a baseline for the remaining three data-collection phases. Phases two through four: B-O-Y data collection, Mid-Year (M-Y) data-collection, and End-of-Year (E-O-Y) data collection, respectively, were conducted via telephone interviews. For households that could not be contacted by telephone, the data were collected via a mail questionnaire.

B-O-Y and E-O-Y Data-Collection Phase: Data collected during the B-O-Y and E-O-Y phases consisted of an update of the vehicle stock and the following vehicle characteristics for each vehicle recorded: the make, model and model year, engine size, fuel system type, and transmission type; vehicle fuel characteristics such as the fuel type, fuel grade and type of pump service; odometer readings; and VIN. See below for description of M-Y data collection.

One week prior to each B-O-Y, M-Y, and E-O-Y data collection, a mailing was sent to the RTECS respondents. The B-O-Y and the E-O-Y mailings consisted of the following: (1) Odometer Reading Cards; (2) VIN cards; (3) a page of instructions; (4) a letter from the Director of the Office of Energy Markets and End Use of the EIA explaining the survey; and (5) a letter from the survey contractor explaining their role in the survey. (See "Data Collection Instruments" listed below in this appendix.)

M-Y Data-Collection Phase: The M-Y mailing consisted of a letter from the Director of the Office of Energy Markets and End Use and a vehicle update worksheet for the respondents to complete. At this time, no vehicle characteristic data were obtained; only an inventory update was collected. The respondent was instructed to either keep the worksheet by the telephone for the telephone interview or return the worksheet by mail, if the household was classified as a no-telephone household. A vehicle-shaped magnet was included in the mailing to the no-telephone households. Any respondent who had refused at the B-O-Y interview was not contacted during the M-Y data collection phase. These households were not contacted at the M-Y interview, in order to increase the probability that the household would respond to the E-O-Y data collection. During the telephone interview, data were collected using the RTECS questionnaires.

Data Collection Dates

The initial enumeration of vehicle stock and the characteristics of the households were collected in the fall of 1990. The B-O-Y data collection occurred during the end of February 1991 through early April 1991. The M-Y update occurred in July and August 1991, and the E-O-Y data collection took place during January and February 1992.

Data-Collection Instruments

The data-collection instruments for the RTECS consisted of four types: (1) the 1990 RECS questionnaire, (2) Odometer Reading Card, (3) Vehicle Identification Number Card, and (4) RTECS questionnaires. (See Appendix D, "Survey Forms," for examples of these data collection instruments.)

1990 Residential Energy Consumption Survey Questionnaire (Form EIA-457A)--This form was used during the RECS personal interview. Questions on this form included the number of vehicles in the household, and for each vehicle: the VIN; the vehicle type; the vehicle make, model, and model year; the odometer reading; and estimated miles traveled during the past year or since the vehicle was acquired, if the vehicle was acquired within the previous 12 months. Household characteristics questions included the number of household members, and for each household member: their age, gender, employment status, and relationship to the head of household. The education level and ethnic background were collected for the head of the household only. The number of drivers, annual family income, and income assistance were collected for the household.

Odometer Reading Card (Form EIA-876A,D)--This form was mailed to the respondent prior to the B-O-Y and E-O-Y data collections and was used as a reference by the respondent during the telephone interview. The card was used to record, on an assigned date, the odometer readings for each reported vehicle during both the B-O-Y and E-O-Y data collections. A computer-generated label attached to the card identified each vehicle by make, model, and year of the vehicle. The respondents were instructed to enter the vehicle's odometer reading on the card after the last use of the vehicle on the specified assigned date. For the B-O-Y data collection, respondents were assigned one of the following dates: February 25, March 4, March 11, or March 18, 1991. For the E-O-Y data collection, they were assigned either of the following dates: January 4, January 12, January 19, or January 26, 1992. No odometer reading cards were provided during the M-Y data collection. An additional odometer reading card without a computer-generated label was included for the respondent to record odometer readings for any vehicle acquired since the last contact.

VIN Card (Form EIA-876)--This form was mailed to the respondent and used as a reference during the telephone interview. The card was used to record the VIN for each reported vehicle. Each VIN card had a computer-generated label identifying the specific vehicle assigned to the card. A thorough explanation of the VIN and where to locate it was provided on the card. A blank VIN card was also provided to record the VIN for any vehicle acquired since the last contact. For the B-O-Y data collection, the VIN cards were mailed only if the VIN was not obtained during the RECS interview or if the VIN had been transcribed incorrectly. For the E-O-Y data collection, the VIN was collected only from households that had acquired a new vehicle at the M-Y data collection phase. Households were not mailed a VIN card if they had refused to provide a VIN during any previous RTECS contact, at the time of the RECS contact, or if they were previously classified as a nonrespondent household.

The odometer and VIN cards were mailed to the respondents approximately 1 week prior to the telephone interview. The respondents were requested to keep both the odometer and VIN cards by their telephones so they would be readily available when the interviewer telephoned. If the household was classified as a no-telephone household, the respondent was requested to return the cards in a self-stamped, business reply envelope that was provided.

Residential Transportation Energy Consumption Survey Questionnaire (Form EIA-876A-C)--This form was used by the telephone interviewer to record information gathered during the telephone interviews. Vehicle data obtained with this questionnaire included: verification of the stock of vehicles; motor vehicle characteristics for each vehicle, such as transmission type, drive type, fuel system type, engine size, and number of cylinders; vehicle fuel characteristics such as fuel type, fuel grade and type of pump service; odometer readings; and VIN. The questionnaire consisted of three types: the B-O-Y telephone questionnaire (Form EIA-876A), the M-Y mail and telephone questionnaire (Form EIA-876B), and the E-O-Y telephone questionnaire (Form EIA-876C).

The B-O-Y and E-O-Y telephone questionnaires were used only by the telephone interviewers to record respondents answers during the telephone interview. These questionnaires were divided into discrete sections that were color-coded to help the interviewer in determining the correct skip patterns.

B-O-Y Questionnaire: The discrete sections for the B-O-Y Questionnaire consisted of:

- A call record sheet and protocol.

- Questions pertaining to vehicle characteristics for only vehicles that were recorded during the RECS interview. A computer-generated fold-out page was included that listed the make, model and year of all vehicles obtained during the RECS interview. The status of the VIN was also included (whether it was obtained, or whether it was transcribed correctly).

- Questions pertaining to vehicles that were disposed of since the RECS interview

- Questions pertaining to vehicles acquired since the RECS interview or any vehicles not recorded during the RECS interview

- Questions pertaining to the household's intention to move within 12 months.

M-Y Questionnaire: The M-Y Questionnaire that was mailed to the respondents requested only minimal vehicle update information on the acquisition and disposition of vehicles since the B-O-Y data collection. Respondents with telephones were requested to complete the form and to keep it by the telephone in preparation for the telephone interview. The respondents without telephones were requested to complete and return the form to the survey contractor. The M-Y questionnaire used by the telephone interviewers to record the respondents answers contained:

- A call record sheet and protocol

- Computer-generated pages showing the most recent vehicle inventory for the household

- Questions relating to the vehicles disposed of since the RECS interview or the B-O-Y interview

- Questions relating to the vehicles acquired since the RECS interview or the B-O-Y interview

- Questions pertaining to the household's intention to move within the following 6 months.

Note: For a selected number of households, additional questions pertaining to government assistance to low-income households and interruptions in home heating were asked at the end of the RTECS interviews. These data, collected as part of the Family Support Administration (FSA) update to RECS, were completely independent from the RTECS questions. The FSA questions were collected during the RTECS data collection as a cost-saving measure and as a method of reducing the respondent burden by combining the two telephone contacts into one telephone call.

E-O-Y Questionnaire: Two types of questionnaires were used for the E-O-Y data collection, depending on the responses at the M-Y interview. For households that had indicated at the M-Y update that they had acquired or disposed of a vehicle, the questionnaire contained two additional sections. The first new section pertained to acquired vehicles and contained questions about the vehicle characteristics, the VIN, and the odometer reading. The second section pertained to disposed vehicles. An additional computer printout was included listing the new vehicles obtained at the M-Y. For households that did not indicate at the M-Y update that they had acquired or disposed of a vehicle, the questionnaire was similar to the B-O-Y questionnaire, including questions pertaining to vehicle acquisitions and disposals since the last contact. A section on other transportation modes was also added. Questions relating to the household's intention to move were eliminated.

Vehicle Identification Number

In the 1991 survey, respondents were again asked to provide the VINs for their vehicles. The VIN is a unique identification number assigned to a vehicle by the automobile manufacturers for the purpose of identification.

Beginning with the 1981 vehicle model year, the U.S. Department of Transportation (DOT) has required that a standard identification format consisting of 17 characters be attached to all over-the-road vehicles sold in the United States. Between 1954 and the 1981 DOT standard, automobile manufacturers in the United States had included an 11- to 15-digit VIN on all vehicles.

In the 1991 RTECS, the MPG data were estimated using EPA laboratory test results of MPG (See Appendix B, "Estimation Methodologies," for a complete discussion of the consumption and expenditure estimation procedures used in the 1991 RTECS.) To assign a test MPG to a particular vehicle, the specific characteristics of the vehicle were required. In the 1991 RTECS, these vehicle characteristics were obtained from two sources: (1) the decoded VIN's, and (2) the RTECS questions about vehicle characteristics that the respondent answered. The 1991 RTECS also provided a unique opportunity to assess the reliability of the respondents' answers by comparing their responses to the RTECS vehicle characteristic questions with an independent source of data containing the vehicle characteristics for the same vehicles, that is, the VIN.

The Decoded VIN

The VIN is a sequence of numbers and letters that, when decoded, provides vehicle characteristics that range from the nation of origin to the individual assembly plant where the vehicle was manufactured. The first three characters of the standard VIN format, designated as the World Manufactures Identification (WMI), identify the nation of origin, the manufacturer, and the vehicle make. The next five characters are the Vehicle Description Section (VDS). These characters identify the vehicle model; the body type such as sedan or station wagon; the engine type, which includes characteristics like the number of cylinders, cubic inch displacement and net brake horsepower; the restraint system found in the vehicle; and a model change code. There is no fixed format or standard codes within this five-character field. The ninth field contains a check digit. The check digit is an internally consistent number computed from the other identification numbers according to a mathematical formula. It is used during the decoding process to verify the accuracy of the other identification numbers. The next section is the Vehicle Identification Section (VIS) and contains eight characters. The first character in this section is the vehicle model year, the second character is the assembly plant name and/or location. The last six letters in this final section represent the sequential production number for a specific vehicle. To protect the confidentiality of the respondents, the sequential production number for a specific vehicle was not included on the RTECS public-use tape.

Figure A1 provides an example of a VIN and the type of data that can be obtained from decoding the VIN. (Detailed information about the VIN can be obtained from the annual editions of the *Passenger Vehicle Identification Manuals* published by the National Automobile Theft Bureau.)

Figure A1. Example of a Decoded Vehicle Identification Number

Location of the VIN

In most passenger cars the VIN is attached to the left side of the dash or instrument panel and is visible through the outside of the windshield. In some instances, the VIN is located on the inside of the door panel on the driver's side. Imported automobiles often attach the VIN to the windshield pillar post or on top of the steering column (Figure A2). Also, the VIN can be inscribed on the following documents: insurance cards, vehicle registrations, vehicle titles, safety or emission certificates, insurance policies, and bills of sale.

Figure A2. Location of the Vehicle Identification Number

Collecting the VIN

The initial collection of the VIN occurred during the RECS. Since the RECS data are collected in personal interviews, this survey would allow the interviewer to actually record the VIN from either the vehicle or a document.

The survey design allowed for the collection of the VIN during several different stages of the RTECS, thus eliminating the need to rely on a one-time effort. The VIN could be obtained during the RECS interview, the RTECS B-O-Y interview or during the E-O-Y interview. Only the RTECS households that did not provide a VIN at the time of the RECS interview, or for which the VIN was incorrectly transcribed during the RECS, were asked to provide the VIN again during the RTECS B-O-Y data collection. A household that had refused to provide a VIN at any time was not asked for the VIN a second time. RTECS precollection mailings to the households contained an explanation of the VIN and how to locate and record it.

The importance of obtaining an accurate VIN for a successful RTECS was emphasized during both the RECS and RTECS interviewer training sessions. Considerable interviewer training time was allocated to describing the VIN and providing the interviewers with thorough directions for locating and recording the VIN. The RECS interviewers were provided with examples of the VIN and with a timely article encouraging vehicle owners to inscribe the VIN on their vehicle windows as a method of providing vehicle identification in the event of theft. (*American Automobile Association World Magazine*, September/October 1990, pp. 30-31).

The Interview

The primary method of data collection for the 1991 RTECS was a telephone interview. (For the 6.5 percent of the RTECS households that could not be contacted by telephone, the VIN Cards, Odometer Reading Cards, and a postage-paid return envelope were mailed along with instructions directing the respondents to return the cards in the envelopes.) The average B-O-Y and E-O-Y telephone interviews lasted 12 minutes. The M-Y interview lasted approximately 5 minutes. Most respondents had recorded the odometer readings and VIN for each vehicle on the cards they received prior to the telephone calls.

The initial vehicle data were collected in the RECS personal interview. This interview lasted an average of 62 minutes. However, motor vehicle data were only one type of energy data collected at this time and were a small part of the respondent burden. Information about the structural features of the housing unit, the heating and cooling systems, energy fuel used, and conservation improvements were among the nonvehicle type of energy data collected.

Interviewers and Interview Training

All interviewers attended 3-hour training sessions held just prior to the B-O-Y and E-O-Y data collection and a 75-minute training session prior to the M-Y data collection. Interviewer trainers were staff members from the survey contractor who were familiar with the RTECS. The B-O-Y training sessions were observed by the EIA RTECS Survey Manager.

All interviewers were provided with a booklet of instructions. The first half of the training sessions consisted of general instructions pertaining to the RTECS forms, with a thorough explanation of the VIN and a discussion of possible trouble areas. During the second half of the training session, the interviewers were divided into three small groups. Three mock interviews were completed in each of these groups.

Immediately following each training session, the interviewers began contacting respondents. All telephone interviews were initially monitored by contractor supervisory personnel who were then able to provide instant feedback to the interviewer. Subsequent periodic monitoring occurred during each data-collection phase.

Because particular emphasis was placed on maintaining or improving B-O-Y response rate, special refusal conversion measures were undertaken for the E-O-Y collection. For example, the most experienced interviewers were used; most of the E-O-Y interviewers had worked on the B-O-Y data collection. Interviewers made an extraordinary effort and succeeded in converting households that were formerly classified as refusals at the B-O-Y or M-Y interviews to respondents at the E-O-Y interview.

Minimizing Nonresponse Bias

Nonresponse bias is one type of nonsampling error that contributes to the total error of a survey. Other nonsampling errors include population undercoverage during sampling, interviewer error, coding and/or key punching errors, and response bias. The wording and format of the survey questionnaires, the procedures used to select and train interviewers, and the quality-control procedures built into the data collection and processing operations were all designed to minimize these sources of error (See Appendix C, "Quality of the Data," for a discussion of nonsampling errors other than nonresponse bias.)

It was recognized in the early planning stages of the 1991 RTECS that special attention would have to be given to minimizing nonresponse bias, since the RTECS households were contacted several times a year, in addition to the initial RECS personal interview. The following steps were taken to minimize the nonresponse:

- If possible, the VIN was collected during the RECS interview, thus, reducing the need to ask for the VIN during the RTECS, if it was successfully collected during the RECS

- The M-Y data collection instrument was streamlined with the primary emphasis placed on updating the vehicle stock and obtaining the odometer readings for any disposed of or acquired vehicle. The vehicle characteristics and VIN for newly acquired vehicles were collected during the E-O-Y data collection instead of during the M-Y update

- No M-Y data collection was attempted for households declared as legitimate refusals at the B-O-Y interview. All households were recontacted for the E-O-Y data collection; however, only households that previously had a valid odometer reading were asked to provide the E-O-Y odometer reading. None of the households that previously refused were asked any VIN questions

- A letter describing the survey and its importance was mailed to the households approximately one week prior to the B-O-Y and E-O-Y telephone interviews

- Most of the interviewers that had worked on the E-O-Y interview had also participated on the B-O-Y data collection

- The interviewers were requested to attempt a minimum of eight telephone calls before the household was classified as a noncontact and in many cases made up to 16 or more attempts to contact the household. (See *Housing Characteristics 1990*, DOE/EIA-0314(90), for a detailed discussion of the efforts to minimize nonresponse bias in the RECS.)

Imputations

In the instances when a RECS respondent refused to participate in one or more of the RTECS data collection phases, a decision was made to impute the missing data rather than readjust the weights to account for the RTECS nonresponse because of the availability of RECS data for these households. Missing data items were imputed using the following: RECS data files on vehicle characteristics; decoded VIN; hot- and cold-deck procedures; linear and logistic regression; predictive mean matching; and EPA data files. (See Appendix C, "Quality of the Data," for a discussion of the imputation procedures used.)

Survey Estimate Weights

All the statistics published in this report are estimates of population values, such as the total number of households in the United States. These estimates are based on a subset of the entire population of households chosen according to multistage probability sample selection rules. The universe includes all households in the 50 States and the District of Columbia, including households on military installations. Survey estimates inflate the RTECS sample results to represent the target population. This required the development of weights for each sample household using a multistage weighting procedure. The weights for the RTECS were developed from the weights that originally had been used in the 1990 RECS. These original weights were divided by the probability that a RECS household was selected into the RTECS sample. The probability that an individual 1990 RECS household was selected for the 1991

RTECS varied by the Secondary Sampling Unit (SSU) and the estimated vehicle annual mileage for the household as obtained from the RECS interview. Households were classified as a high-mileage household if the RECS estimate of the annual miles traveled of all household vehicles was 12,500 miles or more and a low-mileage household if otherwise. The RTECS selection probability or sampling rate is denoted by P, when P is defined as follows:

If the household was a high-mileage household then:

P = 545/(Number of RECS sample households per 10 million in SSU).

If the household was not a high-mileage household then:

P = 365/(Number of RECS sample households per 10 million in SSU).

If P exceeded 1.0, P was set equal to 1.0. The goal for the number of households to be sampled for RTECS was 3,000 households with 50 percent of these households considered high-mileage households. The equations for P given above were chosen with this goal in mind.

These RECS weights were appropriate for estimates of U.S. households as of November 1990 (the midpoint of the RECS data-collection time period). Since the midpoint of the RTECS data-collection period was July 1991, the RTECS weights were adjusted so that RTECS household counts were estimated at their presumed July 1991 levels. This was accomplished by use of poststratification. In poststratification, the survey weights in RTECS (and RECS) were adjusted by factors so that, within certain population subgroups, RTECS estimates of household counts would agree with those estimated from the CPS. Within each population subgroup or poststratification cell, the weight adjustment factor was computed as the CPS household count estimate divided by the RTECS household count estimate. (RTECS household count estimates are produced by summing RTECS survey weights.) The CPS estimates within the subgroups are called "control totals," and they are considered to be more reliable than the corresponding estimates from RTECS.

The poststratification cells were defined by a two-way contingency table. One margin represented metropolitan status within the Census regions. This margin had 12 categories comprised of 4 Census regions (Northeast, Midwest, South, and West) and 3 metropolitan statuses (metropolitan in center city, metropolitan outside of center city, and nonmetropolitan). The other margin of the poststratification table contained three categories (one-person-male households, one-person-female households, and all other households). Thus, the poststratification table had a total of 36 cells. However, 36 separate weight-adjustment factors were not computed. Rather, the RTECS weights within these cells were adjusted by a limited "raking" procedure. The weights were first adjusted to agree with CPS totals for the Census region by metropolitan status margin, using 12 cells. Next the weights were adjusted to CPS totals for the household type margin using 3 cells. Finally, the weights were readjusted to CPS totals for the Census region by metropolitan status margin. Raking allows for the use of more sample units in computing each weight-adjustment factor, by not distributing them around too many cells. However, the method is based on the assumption that there is no significant interaction between the margins of the poststratification table.

Data-Editing Procedures

The following steps were undertaken to ensure the accuracy of the data. Step one in the review process was to verify the accuracy of the basic identifying information. Step two consisted of manually reviewing the questionnaire for completeness and logical consistency of selected patterns of response and to prepare the questionnaires for translation into machine-readable form. In the third step, the data were keyed into machine-readable format. Any inconsistencies in the skip patterns were automatically noted and resolved by one of the editors. In the fourth step, the keypunching of all data was verified. During the fifth step, the data were machine edited to further ensure completeness, logical consistency, and the legitimacy of coded values.

Comparisons were made of the vehicle characteristics provided by the respondent and the vehicle characteristics obtained from the VIN. When a discrepancy occurred the vehicle characteristics obtained from the VIN were usually used.

Report Preparation Procedures

Prior to a final data tape, a preliminary data tape was delivered to the EIA in August 1992. EIA data analysts reviewed and processed the data to prepare it for the final data tape. Crosstabulations were run, checked for internal consistency, and compared with data from previous RTECS. Generally, inconsistencies were resolved by the survey contractor. As a quality control measure, selected tabulations were produced using two different software programs, Table Producing Language (TPL) and Statistical Analysis System (SAS).

A final clean edited data tape of household vehicle survey data was delivered to the EIA in September of 1992. After the edited data tape was provided by the survey contractor, EIA data analysts further reviewed and processed the data to prepare it for release in the statistical reports. Statistical tables of aggregated data were produced and analyzed. The report text is based on these tables.

Confidentiality of Information and Public-Use Tape Preparation

The EIA does not receive or take possession of the names or addresses of individual RTECS respondents or any other individually identifiable energy data that could be linked with information describing the household. All such identifiable information is maintained by the survey contractor.

Following the publication of the statistical report for the RTECS and the statistical reports for the RECS, a final data tape is prepared for release to the public. This tape contains both the housing characteristics and energy supplier data for the RECS and the vehicle data for the RTECS. Additional measures such as the stripping of all geographic identifiers except Census region and Census division, are taken at this time to further mask the data and to ensure that the identity of the individual respondent is kept confidential. At the culmination of these procedures, a final data tape is released to the public through the National Technical Information Service (NTIS). (See Appendix G, "Related EIA Publications on Energy Consumption," for information on how to order these tapes.)

Appendix B

Estimation Methodologies

Appendix B

Estimation Methodologies

Introduction

Statistics concerning vehicle miles traveled (VMT), vehicle fuel efficiency (given in terms of miles per gallon (MPG)), vehicle fuel consumption, and vehicle fuel expenditures are presented in this report. The methodology used to estimate these statistics relied on data from the 1990 Residential Energy Consumption Survey (RECS), the 1991 Residential Transportation Energy Consumption Survey (RTECS), the U.S. Environmental Protection Agency (EPA) fuel efficiency test results, the U.S. Bureau of Labor Statistics (BLS) retail pump price series, and the Lundberg Survey, Inc., price series for 1991.

The estimation of these four statistics (VMT, vehicle fuel efficiency, vehicle fuel consumption, and vehicle fuel expenditures) occurred in several steps (Figure B1). First, for each RTECS vehicle, the VMT were determined from two actual odometer readings or imputed using data from the 1990 RECS. Second, the annual on-road fuel efficiency, given in terms of MPG, was estimated using the questionnaire responses, decoded Vehicle Identification Number (VIN) data, EPA fuel efficiency test results, and the months that the vehicle was in use. The MPG were adjusted to account for the difference between EPA test values and on-road values. Third, estimated vehicle fuel consumption was derived by dividing the VMT by the estimated MPG. Finally, the estimated vehicle fuel expenditures were derived by multiplying the vehicle fuel consumption by the fuel price. The 1991 RTECS, like the 1988 RTECS, did not collect vehicle fuel prices via fuel purchase diaries. Instead each RTECS vehicle was assigned a price based on reported fuel type used in each vehicle. Gasoline prices were obtained from the BLS 1991 Retail Gasoline Pump Price Series. Diesel fuel prices were obtained from the Lundberg Survey, Inc. (See "Other Fuel Types" in this appendix for a discussion of the gasohol and propane prices.)

The following sections of this appendix describe the estimation procedures used for calculating the VMT, the MPG, the vehicle fuel consumption, the vehicle fuel prices, and the vehicle fuel expenditures. Also described in this appendix are the sources of data that were used in the estimation procedures.

The following terms are used throughout this appendix:

Terms	**Definitions**
EPA Composite MPG	The EPA dynamometer test procedure, performed on preproduction prototype vehicles, yields separate test values for EPA city and highway MPG. These city and highway MPG are often combined to form the "composite" MPG.
On-Road MPG	A composite MPG that was adjusted to account for the shortfall between the test value and the fuel efficiency actually obtained on the road. The adjustment did not take into account the driving patterns of individual drivers and seasonal differences.
In-Use MPG	MPG that were adjusted for seasonal differences and annual miles driven. Vehicles that are driven relatively few miles during the year are assumed to be driven mostly on short trips that involve frequent stops. Vehicles that are driven relatively many miles are assumed to be driven mostly on long trips where few stops are needed.

MPG Shortfall — A measure of the difference between actual on-road MPG and the EPA laboratory test MPG. Expressed as the ratio of test MPG to on-road MPG.

Figure B1. Estimation Schematic

Note: RTECS--Residential Transportation Energy Consumption Survey, EPA--Environmental Protection Agency, BLS--Bureau of Labor Statistics; and Lundberg--Lundberg Survey, Inc.

Source: Energy Information Administration, Office of Energy Markets and End Use, 1991 Residential Transportation Energy Consumption Survey.

Vehicle Miles Traveled

When possible, VMT were determined for a sample vehicle by taking the difference between two odometer readings, which spanned a period of time. This method was used to determine VMT for 3,352 (55 percent) of the 6,084 RTECS sample vehicles. Attempts were made to obtain odometer readings during the RECS interviews, the Beginning-of-Year (B-O-Y) RTECS interview, the End-of-Year (E-O-Y) RTECS interview, and any time a vehicle was acquired or disposed. A "span" of odometer readings was the difference between two odometer readings. In most cases, this span was a B-O-Y to E-O-Y span, although due to an occasional nonresponse, only shorter spans were obtained, such as RECS to B-O-Y. Odometer spans of less than a full year were also obtained for vehicles that were either acquired or disposed of during the survey year.

In addition, the onset of the Persian Gulf War caused the start of the 1991 RTECS data collection to be delayed by 7 weeks. However, the E-O-Y data collection was carried out according to the original schedule. Thus, the B-O-Y to E-O-Y span of odometer readings was slightly less than a full year for all vehicles. Response Analysis Corporation (RAC) studied the impact of this delay on annualized VMT. Preliminary data studied by RAC for the first 3 months of 1991 suggest no radical or even moderate departure in relative proportions of travel by month from 1990. Moreover, comparison of the 1984 NPD fractions (See Table B1) with Federal Highway Administration (FHA) monthly fractions for 1984 and 1990 suggests there is no significant bias in continuing to use the 1984 NPD monthly fractions to inflate the odometer spans to a full year. This process is described as step 1 of the 2-step adjustment procedure in the following paragraph.

The VMT that were assigned to each RTECS vehicle corresponded to the period of time that the vehicle was in possession by the sample household. In most cases, however, this period of possession did not correspond exactly with the beginning and ending dates for the odometer span. This was true even for vehicles with a complete B-O-Y to E-O-Y odometer span; because odometer cards were mailed to respondents in several distinct waves at the beginning and end of the RTECS survey; and because the exact dates of odometer readings were often left to the convenience of the respondents. Therefore, all VMT obtained from odometer spans were adjusted to correspond to the period of time that the vehicle was in possession by the sample household. A 2-step adjustment procedure was used. STEP 1 adjusted the odometer-span VMT to a standard annualized mileage covering 365 days, and STEP 2 readjusted the annualized VMT to correspond to the exact period of time that the vehicle was in possession by the household. These adjustments took into account a typical distribution of VMT fractions among the different months of the year. Step 2 was performed only for vehicles that were not in the possession of the household for the entire calendar year 1991.

STEP 1:

This step adjusted the odometer-span VMT to a standard annualized VMT covering a full year, regardless of whether the span of odometer readings covered approximately 1 year or only a short span of time. Annualized VMT for vehicle $_i$ were computed as:

$$Annualized\ VMT_i = \frac{[Odometer - Span\ VMT_i]}{\sum_{j=so_i}^{eo_i} F_j} \tag{1}$$

Where:

F_j = Monthly VMT fractions from the standard distribution in Table B1

so_i = Month of starting odometer readings for vehicle i
eo_i = Month of ending odometer readings for vehicle i.

The starting and ending F_j were prorated according to the exact day of the month for the odometer readings. For example, if a final odometer reading was taken on September 15, then (14/30) x F_{SEP} was used.

Table B1. Distribution of Average Monthly Vehicle Miles Traveled Fractions

Month $_j$	Average VMT per Vehicle	F_j
January	688	0.0728
February	697	0.0738
March	771	0.0816
April	783	0.0829
May	832	0.0880
June	847	0.0896
July	868	0.0919
August	872	0.0923
September	800	0.0847
October	802	0.0849
November	756	0.0800
December	734	0.0777
Total	9,450	1.0000

Source: 1984 Petroleum Marketing Index (PMI) Survey, NPD Research Inc. The survey is a demographically and geographically balanced-quota sample of 4,100 households. Respondents maintained fuel purchase diaries for an average of 10 months. As part of the survey, information was collected on the characteristics of trips taken in vehicles during a designated day. Trip lengths were recorded as respondent perception rather than from odometer readings. The distribution of monthly mileage fractions has been obtained from this survey.

STEP 2:

Once an annualized VMT was obtained from STEP 1 as described earlier, it was adjusted to correspond to the time period that vehicle i was in possession by the sample household as:

$$VMT\ During\ Possession_i = [Annualized\ VMT_i] \times \sum_{j=sp_i}^{ep_i} F_j \qquad (2)$$

Where:

F_j = Monthly VMT fractions from the standard distribution in Table B1
sp_i = Month starting possession of vehicle i by the household, or January 1991, whichever is later
ep_i = Month ending possession of vehicle i by the household, or December 1991, whichever is earlier.

If vehicle i was in the household for the entire year then sp_i = JAN and ep_i = DEC. If a vehicle was acquired or disposed of during the survey, the starting or ending F_j was prorated according to the appropriate day of the month.

To ensure that the distribution of average monthly vehicle miles traveled fractions given in Table B1 reflected 1991 driving patterns, a study of Federal Highway Administration (FHWA) Traffic Volume data for 1991 was conducted. This study resulted in FHWA VMT fractions being constructed for 1984 and 1990. FHWA 1990 data were used since the 1991 data for the entire year was unavailable. Annual VMT calculations were completed using both the NPD and FHWA fractions. The differences in average annual VMT per vehicle between using the NPD and FHWA VMT fractions ranged between 1 and 18 miles and were less than the standard errors of the average annual VMT. Therefore, in 1991 the NPD VMT fractions given in Table B1 will be used to compute annualized VMT since the differences in annual VMT between using the NPD and FHWA fractions were minor (RTECS Technote 5[3]).

Incomplete Odometer or VMT Data

For 1,576 sample vehicles (26 percent), no odometer span was available, although an estimate of annual VMT had been obtained from the respondent during the RECS interview. VMT for these vehicles were imputed from a regression on the estimated VMT obtained from the RECS. For another 1,150 sample vehicles (19 percent), no odometer span was available and a VMT estimate was not obtained during the RECS interview. VMT for these vehicles were imputed using a multiple linear regression model, where the independent variables were number of drivers, household income, age of household head, type of vehicle, and use of vehicle on the job. This regression was also used for imputing VMT for vehicles that were imputed as being acquired or disposed. Both of the regression models described above yielded estimates of annualized VMT. The STEP 2 adjustment described previously was then used to adjust this VMT to correspond with the time the vehicle was in the possession of the household.

Vehicle Fuel Efficiency

Fuel efficiency (MPG) must be estimated for each RTECS sample vehicle in order to estimate each vehicle’s fuel consumption for the survey year. (Fuel consumption is estimated by dividing the VMT for time of possession, by the MPG.) Prior to 1988, the RTECS obtained actual fuel consumption data and on-road MPG from fuel purchase diaries maintained by the respondents. However, no fuel purchase diaries were used in the 1988 or 1991 RTECS. Instead, the 1991 MPG were estimated using EPA laboratory test MPG that were adjusted to account for differences between actual on-road MPG and the EPA test MPG. This difference is known as MPG "shortfall." The feasibility of using shortfall-adjusted MPG in an RTECS survey was investigated by Lax, 1987[6]. That study verified that the method yielded unbiased MPG, when using a data base from a 1984 fuel purchase diary study performed by NPD Research, Inc. The adequacy of current shortfall adjustment methods is sufficient for late 1980 through early 1990’s motor vehicle model years also (RTECS Technote 5[3]).

The RTECS sample vehicles were assigned EPA test MPG from the EPA Emissions Certification Files. Each record of the Certification Files contained EPA test MPG for each unique combination of vehicle attributes within a given make, model, and year. These attributes were (1) number of cylinders, (2) cubic inches of engine displacement (CID), (3) type of transmission (manual or automatic), (4) gasoline or diesel fuel, and (5) whether the vehicle’s emissions control package met Federal or California standards. Each record of the Certification Files also contained the number of vehicles sold for each unique combination of attributes. The vehicle attributes needed to assign a test MPG for sample vehicles were obtained from the Vehicle Identification Number (VIN), and/or from the RTECS questionnaire responses when the VIN was unavailable. The VIN was decoded to yield the vehicle attributes, by use of the Highway Loss Data Institute’s "Vindicator" software.

In addition to assigning test MPG, the EPA Certification Files were used to impute for missing vehicle attributes. Based on the nonmissing vehicle attributes obtained from the questionnaire and VIN, several records from the EPA Certification Files were usually found as potential "matches" to a given sample vehicle. A matching record was chosen from among the several applicable ones, with probability proportional to sales, using the sales figures on the EPA Certification Files. Once chosen, a record provided EPA test MPG (city and highway), as well as any vehicle attributes that were missing.

The 1991 RTECS used a sequential adjustment procedure where the EPA Composite MPG was adjusted first to an on-road MPG, and then to an in-use MPG. Figure B2 shows the MPG adjustments that were used to determine the final in-use MPG.

The EPA Composite MPG

Beginning in the early 1970's, EPA measured fuel efficiency from tests that were conducted on a dynamometer to simulate actual driving conditions. By 1975, EPA had incorporated separate "city" and "highway" driving cycles into the test. The city and highway MPG were combined to form a "composite" MPG, that was then weighted according to sales of the production vehicles in order to assess compliance with Corporate Average Fuel Economy (CAFE) standards. The EPA Composite MPG is based on the assumption of a "typical" vehicle-use pattern of 55 percent city driving and 45 percent highway driving, and has become a convenient single fuel efficiency measure for analytical and regulatory purposes.

The EPA Composite MPG is defined as:

$$MPG_{(EPA55/45)} = \frac{1}{0.55 \times \frac{1}{MPG_{(EPAcity)}} + 0.45 \times \frac{1}{MPG_{(EPAhighway)}}} \quad \textbf{(3)}$$

where:

$MPG_{(EPA\ 55/45)}$ = the composite MPG
$MPG_{(EPA\ city)}$ = the fuel efficiency when vehicle use pattern is city driving only
$MPG_{(EPA\ highway)}$ = the fuel efficiency when vehicle use pattern is highway driving only.

Fuel Efficiency Shortfall

Fuel efficiency shortfall occurs when the fuel efficiency that is actually obtained while using the vehicle is lower than the EPA test results. Reasons for this shortfall are (1) a result of the differences between EPA test vehicles and the vehicles actually in use and (2) the differences between EPA procedures for simulated driving conditions and actual driving conditions. For example, EPA test vehicles are prototypes that do not contain the wide variety of power-consuming accessories often found on vehicles sold to consumers. The test procedures also do not simulate the actual driving conditions that affect fuel efficiency such as speed and acceleration of individual drivers, road conditions, weather, and traffic. In the 1991 RTECS, adjustments for this fuel efficiency shortfall were made to the composite MPG ($MPG_{(EPA\ 55/45)}$) that were assigned to the sample vehicles.

Fuel efficiency shortfall was expressed in terms of the "Gallons per Mile Ratio" or GPMR:

$$GPMR_i = \frac{MPG_{i(EPA55/45)}}{MPG_i} \quad \textbf{(4)}$$

Where:

$GPMR_i$ = Gallons per Mile Ratio for vehicle i
MPG_i = On-road MPG or in-use MPG for vehicle i, depending on the analysis

$MPG_{(EPA\ 55/45)}$ = EPA Composite MPG applicable to vehicle i.

Figure B2. Miles per Gallon Adjustment Procedures

Source: Energy Information Administration, Office of Energy Markets and End Use, 1991 Residential Transportation Energy Consumption Survey.

If $GPMR_i$ = 1 then there is no shortfall. If $GPMR_i$ > 1 then there is a shortfall for vehicle i (That is, the on-road or in-use fuel efficiency is less than the fuel efficiency indicated by the EPA Composite MPG.) Note that $GPMR_i$ can represent shortfall with respect to either the on-road or in-use MPG_i, depending on the analysis being performed. $GPMR_i$ is commonly chosen as a measure of shortfall as opposed to MPG_i for the following reasons:

- A shortfall adjustment is most often thought of as a correction factor, or multiplicative constant, rather than as an additive correction. $GPMR_i$ satisfies this convention.

- Shortfall is usually dependent on a vehicle's fuel efficiency level. That is, shortfall is usually higher at high levels of $MPG_{(EPA\ 55/45)}$ than at low levels of $MPG_{(EPA\ 55/45)}$. Therefore, it is more informative to express the amount of shortfall relative to $MPG_{(EPA\ 55/45)}$ rather than as an absolute quantity.

- $GPMR_i$ is a linear function of $MPG_{(EPA\ 55/45)}$ and can be modeled using ordinary least squares linear regression.

- $GPMR_i$ is a transformation that stabilizes error variances for the purposes of least squares linear regression.

The On-Road MPG

On-road MPG is a composite MPG that was adjusted to account for the shortfall between the EPA fuel efficiency and the actual fuel efficiency obtained on the road.

The EPA developed two general procedures for adjusting $MPG_{(EPA\ 55/45)}$ to an on-road value. One procedure bases the size of the adjustment on specific technology features of the vehicle. The other procedure uses just two MPG discount factors, one to adjust the EPA highway estimate, the other to adjust the city estimate. These two factors are used for all vehicles, regardless of technology class. Either of these procedures could be used to adjust $MPG_{(EPA\ 55/45)}$ to an on-road MPG value for use in the 1991 RTECS. Since both procedures were unbiased for trucks, the choice as to which to employ in the 1991 RTECS should be based on their performance with cars. The adjustment based on discount factors seemed to be less biased than the Technology-Specific Adjustment. The discount factors are also less expensive since they do not require collection or imputation of information on fuel delivery system and drive-train. Because of these reasons the Discount Factors Adjustment Method was selected.

Shortfall Adjustment Based on Discount Factors

EPA's discount factors have widespread appeal because of their simplicity (Hellman and Murrell, 1985[4]; Hellman and Murrell, 1984[5]). The factors are .10 percent for city MPG and .22 percent for highway MPG. That is, for any vehicle i,

$$MPG_{i(on\text{-}road,city)} = 0.90 \times MPG_{i(EPA\,city)} \quad (5)$$

$$MPG_{i(on\text{-}road,highway)} = 0.78 \times MPG_{i(EPA\,highway)}$$

These discount factors are the ones used to produce the "sticker" MPG figures seen on vehicles on dealer lots, and are used to produce the DOE/EPA *Gas Mileage Guide*. The analysis behind the development of these factors was performed on a conglomerate data base with data from Ford Motor Company, General Motors, Chrysler Corporation, DOE, and EPA. The data base contained approximately 38,000 vehicle records with model years from 1979 through

1981 with some 1982 models included. The data base contained predominately American-made vehicles, but also included foreign vehicles as well. The technology mix was dominated by rear-wheel drive and carbureted vehicles, but contained some vehicles with front-wheel drive or fuel injection. Vehicle records contained make, model, year, vehicle characteristics, the MPG as measured on the road, $MPG_{(EPA\ city)}$, and $MPG_{(EPA\ highway)}$. The data base also included the driver's perceptions of the proportion of their travel that was mostly urban (so called "city fraction"), and their average miles driven per day (AMPD).

Fuel economy shortfall is affected by the vehicle use pattern: city-driving pattern is characterized by frequent starts and short trip lengths, while highway-driving pattern is characterized by infrequent starts and long trips. AMPD is a good surrogate variable for representing these different driving patterns.

The city-driving pattern was characterized by AMPD from 5 to 22 miles per day, while the highway-driving pattern was characterized by AMPD's from 15 to 105 miles per day (Hellman and Murrell, 1984). City fraction and AMPD were used to split the data into two sets, one for development of the city discount factor, the other for development of the highway factor. The "city" and "highway" data sets were each stratified by vehicle technology classes. Linear regression was performed within each stratum. GPMR was regressed on city fraction, AMPD, $MPG_{(EPA\ 55/45)}$, odometer reading, and average temperature. The fitted models were then weighted and combined across vehicle technology strata, to produce a single "city" shortfall model and a single "highway" shortfall model. The weights were used to increase the influence of those models that represented technology mixes expected to become more prominent in the future (e.g., front-wheel drive and fuel-injected vehicles). The discount factors were derived from the two weighted models set at average or typical values of the independent variables.

For each RTECS vehicle, discounted city and highway on-road MPG were computed and then combined to form an on-road 55/45 composite as follows:

$$MPG_{i(on\text{-}road,55/45)} = \frac{1}{0.55 \times \frac{1}{MPG_{i(on\text{-}road,city)}} + 0.45 \times \frac{1}{MPG_{i(on\text{-}road,highway)}}} \quad \textbf{(6)}$$

A shortfall ratio based on EPA discount factors was computed for each RTECS vehicle as follows:

$$GPMR_{i(on\text{-}road)} = \frac{MPG_{i(EPA\ 55/45)}}{MPG_{i(on\text{-}road,55/45)}} \quad \textbf{(7)}$$

The In-Use MPG

In-use MPG are MPG that are adjusted for individual driving circumstances. The on-road adjustments to $MPG_{(EPA\ 55/45)}$ discussed in the previous sections were "general" in that they did not take into account any effects on fuel economy that are due to the driver's individual circumstances. They, instead, utilized general attributes such as the technology features of the vehicle and average driving conditions. Fuel economy shortfall estimates can be refined for an individual vehicle by taking into account the following "in-use" effects.

- Urban versus rural driving pattern. That is, frequent starts and short trips as opposed to infrequent starts and longer trips. As mentioned in the previous section, a useful single variable for representing this effect is AMPD. High AMPD's usually represent mileage accumulated on the highway.

- Traffic congestion, which increases with population density.

- Seasonal temperature variations, especially for gasoline-carbureted vehicles.

- Humidity, which together with temperature, affects air-conditioner use.

- Differences among geographic areas of the country.

- Altitude.

- Wind.

- Road gradient and road surface conditions.

In general, the first four items are considered the most significant in-use influences (Crawford, 1983[1]). In the cited study, shortfall variations as high as 25 percent or more occurred over the range of typical AMPD. Shortfall was 16 percent higher in urban areas than in completely uncongested areas, and was 12 percent higher in suburban areas. Shortfall varied seasonally (i.e., monthly) by 7 percent in the South and by 13 percent in the North.

Regression models were developed (Crawford, 1983) for use in adjusting $GPMR_{i(on\text{-}road)}$ to an in-use shortfall employing measurements of several in-use effects as the independent variables.

The regressions yielded a shortfall adjustment that was an additive one, as follows:

$$GPMR_{i(in\text{-}use)} = GPMR_{i(on\text{-}road)} + \delta_{ij} \tag{8}$$

where:

$GPMR_{ij(in\text{-}use)}$ = the in-use shortfall ratio estimated for vehicle i and month j (j = 1...12),
$GPMR_{i(on\text{-}road)}$ = the on-road shortfall ratio estimated for vehicle i, from the above equations, and
δ_{ij} = an adjustment calculated for vehicle i and month j, from a regression model.

One regression model from the Crawford reference which is appropriate for use in RTECS is as follows:

$$\delta_{ij} = \begin{array}{l} 3.296[(1/AMPD_{ij})-(1/35.6)] \\ +NORTH[0.050\sin(j\pi/6)] \\ +SOUTH[0.031\cos(j\pi/6)] \end{array} \tag{9}$$

Where:

$AMPD_{ij}$ = Average Miles per Day for vehicle i and month j, typically 35.6 (i.e., 13,000 miles per year).
NORTH = 1 if the household is in the North.
0 if the household is not in the North.
SOUTH = 1 if the household is in the South.
0 if the household is not in the South.

This regression model was chosen because the independent variables that are important in explaining shortfall were readily available from the 1991 RTECS data. The model had two components. One component involved $AMPD_{ij}$ and represented the influence of individual driving patterns for a given vehicle and month. The other component represented the change in shortfall that occurred throughout the seasons, due to the annual temperature cycle. The original regression equation also contained a minor term which accounted for the influence of air-conditioner use during hot, humid weather. This term was dropped in the 1991 RTECS estimations because it involved the rather complex computation of "Discomfort Index" from NOAA weather records, and the slight additional precision was judged insufficient to warrant the additional processing expense. Additional terms representing geographic regional effects, and the natural logarithm of population density (people per square mile, to represent the influence of traffic congestion) were not considered because of the computational cost.

Once a $GPMR_{ij(in\text{-}use)}$ was estimated it was used to estimate the final in-use fuel economy for vehicle i and month j as follows:

$$MPG_{ij(in\text{-}use)} = \frac{MPG_{i(EPA55/45)}}{GPMR_{ij(in\text{-}use)}} \qquad \textbf{(10)}$$

The regression equation had separate seasonal components for the "North" and "South," because the difference between the winter shortfall and the summer shortfall was greater in the North than in the South. This difference can be seen in the model parameters. To define the North and South geographic areas the continental United States were divided into 97 two-digit ZIP Code regions. These regions were grouped to form two aggregate regions ("North" and "South") according to average winter and summer temperatures, and seasonal shortfall trends.

Annual Vehicle Fuel Consumption

In the 1991 RTECS, annual consumption was calculated by dividing the annual VMT by the annual MPG. The following is a derivation of the annual VMT and annual MPG.

The $MPG_{ij(in\text{-}use)}$ shown in the above section about fuel efficiency estimation procedures were final estimates of monthly in-use fuel economies for vehicle i, and could have been used for estimating monthly fuel consumptions and expenditures if monthly VMT were known. However, RTECS collected only annual VMT, as calculated from the B-O-Y and E-O-Y odometer readings. Nevertheless, the 1991 RTECS still made use of the $MPG_{ij(in\text{-}use)}$ by disaggregating the annual VMT of sample vehicles into monthly VMT.

The annual consumption for vehicle i can be thought of as the sum of the individual monthly consumptions:

$$C_i = \sum_{j=sp_i}^{ep_i} c_{ij} \qquad \textbf{(11)}$$

Where:

C_i = Annual consumption of vehicle fuel for vehicle i, in gallons
sp_i = Month starting possession of vehicle i by the household, or January 1991, whichever is later
ep_i = Month ending possession of vehicle i by the household, or December 1991, whichever is earlier
c_{ij} = Consumption of vehicle fuel for vehicle i, during month j.

Consumption is calculated over only those months that vehicle i was reported to be owned or used by the household. In this sense, "annual" does not necessarily mean a full 12 months. This is an important point since fuel economy varies seasonally. If vehicle i was in the household for the entire year, then sp_i = JAN and ep_i = DEC.

Consumption for each month can be expressed in terms of monthly VMT and monthly fuel economy:

$$C_{ij} = \frac{m_{ij}}{mpg_{ij}} \qquad \textbf{(12)}$$

Where:

m_{ij} = VMT for vehicle i, month j
mpg_{ij} = Fuel economy in miles per gallon for vehicle i, month j

so that:

$$C_i = \sum_{j=sp_i}^{ep_i} \frac{m_{ij}}{mpg_{ij}} \tag{13}$$

In the 1991 RTECS C_i was estimated by substituting the estimated $MPG_{ij(in\text{-}use)}$ for mpg_{ij}. The m_{ij} was estimated in RTECS by disaggregating the annual VMT from odometer readings into monthly VMT. The disaggregation was performed as follows:

$$m_{ij} = M_i \times f_{(i,j)} \tag{14}$$

Where:

M_i = Annual VMT for vehicle i, calculated using odometer readings and the two-step adjustment procedure discussed in the section titled "Vehicle Miles Traveled"
$f_{(i,j)}$ = Average fraction of "annual" VMT that was driven during month j, estimated for vehicle i

There is no single distribution of average monthly VMT fractions $f_{(ij)}$. Rather, there was a family of distributions, the members of which were determined by the particular months a vehicle was owned or used by a household. According to this definition of monthly VMT fractions, no matter which months vehicle i was in a household, it was always true that:

$$\sum_{j=sp_i}^{ep_i} f_{(ij)} = 1 \tag{15}$$

The $f_{(i,j)}$ were derived from the F_j in Table B1 as follows:

$$f_{(i,j)} = F_j, \ f \ sp_i = JAN \ and \ ep_i = DEC$$

Otherwise

$$f_{(i,j)} = \frac{F_j}{\sum_{j=sp_i}^{ep_i} F_j} \tag{16}$$

Substituting $mpg_{ij} = MPG_{ij(in\text{-}use)}$ and $m_{ij} = M_i$ x $f_{(i,j)}$ into Equation 13.

yields the following estimate of annual consumption for vehicle i:

$$C_i = \sum_{j=sp_i}^{ep_i} \frac{M_i \times f_{(i,j)}}{MPG_{ij(in\text{-}use)}} \tag{17}$$

The estimator of annual consumption in the above equation was constructed with 1991 RTECS data.

For vehicles that were acquired or disposed of during 1991, the estimator took into account seasonal differences in the overall fuel economy and the effects of these differences on the overall fuel consumption.

Substituting $MPG_{(EPA\ 55/45)}$ in the above equation, and slightly rearranging the terms, the estimator of consumption is:

$$C_i = \frac{M_i}{MPG_{(EPA55/45)}} \sum_{j=sp_i}^{ep_i} f_{(i,j)} \times GPMR_{ij(in\text{-}use)} \tag{18}$$

A single "annualized" fuel economy that is analogous to the "annualized" MPG_i from previous RTECS, was estimated as:

$$MPG_{i(annualized)} = \frac{MPG_{(EPA55/45)}}{\sum_{j=sp_i}^{ep_i} f_{(i,j)} \times GPMR_{ij(in\text{-}use)}} \tag{19}$$

Thus

$$C_i = \frac{M_i}{MPG_{i(annualized)}}\ . \tag{20}$$

Annual Vehicle-Fuel Expenditures and Price

Vehicle Fuel Expenditures

In the 1991 RTECS, fuel expenditures were calculated by multiplying the vehicle-fuel consumption by the price of the vehicle fuel. The 1991 RTECS, like the 1988 RTECS, did not collect vehicle fuel prices via fuel purchase diaries. Instead, each RTECS vehicle was assigned a price based on reported fuel type used in the vehicle. Gasoline prices were obtained from the BLS 1991 Retail Gasoline Pump Price Series. Diesel fuel prices were obtained from the Lundberg Survey, Inc. (See "Other Fuel Types" in this appendix for a discussion of the gasohol and propane prices.)

Respondents were asked if they purchased leaded or unleaded gasoline, and if unleaded, they were asked the grade.

(See Appendix D, "Survey Forms.") The BLS prices are published by month, by Census region, and by type and grade of fuel. In 1988, the BLS monthly prices (for the Census region in which the household lived) were averaged across the months that the vehicle was in the possession of the household. This yielded for each RTECS vehicle a single fuel price, P_i, dependent on the Census region, type and grade of gasoline, and the months that the vehicle was in the possession of the household. In 1988, the annual fuel expenditures in dollars for each sample vehicle, E_i, was estimated by multiplying its assigned average fuel price, P_i, by its total consumption in gallons, C_i, as estimated in the previous section. However, in 1991, annual fuel expenditures, E_i, was estimated by multiplying monthly gasoline prices by monthly consumption to produce monthly expenditures and summing the monthly expenditures to produce annual expenditures.

Type of Fuel Used

Table B2 provides the percentage distribution of RTECS vehicles by fuel type categories. In 1991, 93.7 percent of the 151.2 million RTECS vehicles used unleaded gasoline. The remaining 6.3 percent of vehicles used leaded gasoline, diesel fuel or other fuel types.

Table B2. Distribution of Residential Transportation Energy Consumption Survey Vehicles by Type of Fuel Used, 1991

Type of Vehicle Fuel	Number of Vehicles (millions)	Percent of Vehicles
Total	151.2	100.0
Gasoline	147.7	97.7
Leaded	6.0	4.0
Unleaded	141.7	93.7
Regular	92.6	61.2
Premium	32.4	21.4
Intermediate	16.7	11.1
Diesel	1.8	1.2
Gasohol	1.6	1.1

Notes: •Because of rounding, data may not sum to totals. •For a discussion of underreporting of gasohol see Appendix C, "Quality of the Data."

Source: Energy Information Administration, Office of Energy Markets and End Use, 1991 Residential Transportation Energy Consumption Survey.

Gasoline Prices

Prices published by the BLS survey are retail prices for leaded regular, unleaded regular, and unleaded premium gasoline. These prices are published monthly by Census region. The BLS Pump Price Survey is conducted as input to the *Consumer Price Index (CPI)*. Prices are collected in 85 urban areas. The population covered excludes the institutional population and households located on military bases. The covered population includes approximately 85 percent of all U.S. households. The BLS uses a rotating sample of approximately 1,100 service stations.

Each vehicle in the 1991 RTECS that used one of the three gasoline types, was assigned a monthly BLS fuel price. The BLS "leaded regular" price was assigned to all vehicles that reported using leaded gasoline. Also since BLS stopped publishing leaded prices in May (Lundberg, 1991[7]), leaded and unleaded gasoline prices were used to establish leaded prices from the BLS unleaded prices from May to December. Because the BLS survey did not publish a price for an intermediate grade of unleaded gasoline in 1991, an average of the BLS regular and premium unleaded prices was assigned to the 11.1 percent of RTECS vehicles that used an intermediate grade of unleaded fuel.

Diesel Fuel Prices

Diesel fuel prices were obtained from the "Lundberg Letter-PS" published by Lundberg Survey, Inc. The Lundberg Survey, Inc. collects pump prices at retail service stations in approximately 80 major metropolitan markets. The survey includes about 15,000 service stations divided into 2 bimonthly panels. At least one city from every State is included. Service stations on military bases and in rural areas are excluded. Sales-weighted price data for both full-and self-service stations are published bimonthly. Regional prices are not published. All RTECS vehicles that used diesel fuel were assigned the same diesel fuel prices regardless of Census region.
For the RTECS, the following two steps were used to create diesel prices. (1) Bimonthly diesel fuel full-service and self-service prices, obtained from the Lundberg Letter-PS, were averaged to create prices for each grade in the intermediate months. (2) The monthly full- and self-service prices were then weighted and averaged to obtain overall diesel fuel prices. The weights used to create an average diesel fuel price from the full- and self-service prices were based on RTECS data on "type of service" (full-service or self-/mini-service) used when purchasing diesel fuel. For each vehicle monthly prices were multiplied by monthly consumption to yield monthly expenditures. The monthly expenditures were summed to produce annual expenditures.

Other Fuel Type Prices

Approximately 1.6 million 1991 RTECS vehicles were reported using gasohol. In the absence of applicable national estimates of the average price paid for gasohol, the RTECS vehicles using gasohol were assigned fuel prices using the same methodology as the most common group of vehicles in the survey--vehicles using regular unleaded gasoline. (See above for methodology assigning unleaded regular gasoline prices and Appendix C, "Quality of the Data" for a discussion of RTECS underestimation of other fuels.)

References

1. Crawford, R. 1983. *"Seasonal and Regional MPG as Influenced by Environmental Conditions and Travel Patterns."* Research performed under contract for DOE. Energy and Environmental Analysis, Inc., Arlington, VA.

2. Harrison, I.M. *"Retail Fuel Pump-Prices,"* Residential Transportation Energy Consumption Survey Technical Note 4, unpublished document. (Washington, DC, 1991).

3. Harrison, I.M. *"VMT 1991 Patterns,"* Residential Transportation Energy Consumption Survey Technical Note 5, unpublished document. (Washington, DC, 1991).

4. Hellman, K.H., and Murrell, J.D. 1985. *"On the Stability of the EPA MPG Adjustment Factors."* Society of Automotive Engineers Technical Paper Series, SAE Paper No. 851216, Warrendale, PA.

5. Hellman, K.H., and Murrell, J.D. 1984. *"Development of Adjustment Factors for the EPA City and Highway MPG Values."* Society of Automotive Engineers Technical Paper Series, SAE Paper No. 840496, Warrendale, PA.

6. Lax, D. 1987. *"Feasibility of Estimating In-Use Vehicle Fuel Efficiency from Household Survey Data."* Research performed under contract for ORNL/DOE/EIA. Energy and Environmental Analysis Inc., Arlington, VA.

7. *"Lundberg Letter-PS,"* Lundberg Survey Inc. 1991. (North Hollywood, CA).

8. U.S. Department of Energy and U.S. Environmental Protection Agency, *Gas Mileage Guide, EPA Fuel Economy Estimates*. (Washington, DC).

9. *"Average Prices for Gasoline, U.S. City Average and Selected Areas,"* U.S. Department of Labor, Bureau of Labor Statistics, 1991. (Washington, DC).

Appendix C

Quality of the Data

Appendix C

Quality of the Data

Introduction

This appendix discusses several issues relating to the quality of the Residential Transportation Energy Consumption Survey (RTECS) data and to the interpretation of conclusions based on these data. The first section discusses under-coverage of the vehicle stock in the residential sector. The second section discusses the effects of using July 1991 as a time reference for the survey. The remainder of this appendix discusses the treatment of sampling and nonsampling errors in the RTECS, the quality of specific data items such as the Vehicle Identification Number (VIN) and fuel prices, and poststratification procedures used in the 1991 RTECS.

The quality of the data collection and the processing of the data affects the accuracy of estimates based on survey data. All the statistics published in this report such as total vehicle miles traveled (VMT) are estimates of population values. These estimates are based on observations from a randomly chosen subset of the entire population of occupied housing units. Consequently, the estimates always differ from the true population values. Because the RTECS is a sample survey, data from the 1991 RTECS are subject to various sources of nonsampling and sampling error.

Nonsampling error is a measure of variability due to the conduct of the survey. These errors can include: population undercoverage during sampling; questionnaire wording and format; response bias and variance; interviewer error; coding and/or keypunching error; and nonresponse bias. Nonsampling errors are treated in several sections of this appendix. The main section pertains to the imputation procedures used for item nonresponses, and the special treatment given to the fuel efficiency, reported in miles per gallon (MPG), of pre-1975 vehicles.

Sampling error is a measure of the variability in the data because a sample of households was surveyed rather than the entire population. The different samples that could be selected would each produce different values for the survey statistics. Because the survey used probability sampling techniques, it is possible to estimate the size of the sampling error for any statistic. These estimates can be used as a guide in making inferences from the sample estimates to the total population. The final section on sampling error pertains to estimating the magnitude of the error and the presentation of sampling errors as row and column factors in the detailed tables of this report.

Noncovered Residential Vehicles

The RTECS is a subsample of the Residential Energy Consumption Survey (RECS). Therefore, any type of household not covered in the RECS would affect the type of household vehicles not covered in the RTECS. The following types of individuals or families were not covered by RECS and, hence, the vehicles corresponding to these households were not covered by RTECS.

- Families or individuals living in group quarters such as college dormitories, military barracks, or large boarding houses (10 or more unrelated adults).

- Families or individuals living in recreation vehicles or other vehicles.

- Families or individuals with no fixed address.

The effect of these omissions is an underestimation of the total number of vehicles in the residential sector and an underestimation in the number of miles driven, gallons consumed, and dollars spent.

July 1991 as a Reference for Number of Households

The design of RTECS calls for households to be followed for the 1991 calendar year. Consequently, households formed during 1991 are represented in the sample by households that existed at the time the 1990 RECS was fielded. Hence, RTECS may have an over-representation of established households at the expense of newly formed households.

The decision to follow households for the entire year and not add a sample of households formed during 1991 means that as the survey progressed through 1991, the estimate of the number of vehicles accumulated a negative bias. This happens for several reasons.

- When established households separate, only part of the household is followed by RTECS. If the part of the household that is not followed takes a vehicle with them, that vehicle is counted as a disposed vehicle.

- Any vehicle acquired by a household member that leaves the household is not included in the RTECS.

- The number of households for the 1991 RTECS is set equal to the Current Population Survey (CPS) estimate of the number of households as of July 1991. (See the section below on poststratification.) RTECS does not provide for an increasing number of households from January to December. The household number for July is the number used for the entire year. This has the effect of overestimating the number of households and vehicles for January 1991 and underestimating the number for December 1991.

Nonsampling Error

Nonsampling errors are due to the conduct of the survey, and include both random errors and systematic errors or biases. The magnitudes of nonsampling biases cannot be estimated from the sample data. Thus, avoidance of systematic biases is a primary objective of all stages of survey design. (See Appendix A, "How the Survey was Conducted," for a discussion of procedures implemented to minimize all types of nonsampling errors.) Subsequent to conducting a survey, problems of unit nonresponse and item nonresponse need to be addressed. The treatment in the RTECS of these types of errors are discussed in separate sections below.

Unit Nonresponse

Unit nonresponse is the type of nonresponse that occurs when no data are available for an entire sampled household. Most unit nonresponse cases are caused by the respondent being unavailable or the respondent's refusal to cooperate.

Unit nonresponse for the 1991 RTECS must be addressed in the context of the unit nonresponse for the 1990 RECS, since the 1991 RTECS sample was drawn from households that responded to the 1990 RECS. Thus, in all cases, at least the RECS data were available for every RTECS household, therefore, no RTECS household was a total nonrespondent. Generally, weight adjustment was the method used to reduce unit nonresponse bias in the RECS statistics and that adjustment carried over automatically to the RTECS subsample. (See *Housing Characteristics 1990* (published May 1992), DOE/EIA-0314(90) Appendix A, for a discussion of unit nonresponse adjustment.)

Imputation Procedures for Item Nonresponse

Item nonresponse occurs when the respondents do not know the answer or refuse to answer a question, or when an interviewer does not ask a question or does not record an answer. To facilitate "full-sample" data analyses, imputations were made to provide the most probable responses when responses were missing. The following imputation techniques were used: hot-decking, predictive mean matching, and regression.

Hot-Deck Procedure

The most commonly used technique of imputation for the RTECS was the hot-deck procedure. In hot-decking, when a certain response is missing for a given household or vehicle, another household or vehicle called a donor is randomly chosen to furnish its reported value for that missing item. The value is then assigned to the nonrespondent household or vehicle. To serve as a potential donor, a household or vehicle had to be similar to the nonrespondent in characteristics correlated with the missing item.

The RTECS items that were imputed using the hot-deck procedure were pre-1975 vehicle characteristics and fuel grade. Household demographic items such as family income and ethnic background were hot-decked as part of the RECS. (See *Housing Characteristics 1990* (published May 1992), DOE/EIA-0314(90), Appendix C, for a discussion of imputation of household characteristics.)

Predictive Mean Matching

Predictive mean matching was used for imputing changes in vehicle stock to households when those households were not followed for the complete duration of the RTECS. Changes to the vehicle stock were defined as acquisitions, dispositions, or a combination of both. In an ideal RTECS, a beginning vehicle stock inventory reported in the 1990 RECS interview would be followed throughout the 1991 RTECS calendar year and, at the time of each RTECS contact, changes in vehicle stock would be reported. However, because in some cases it was impossible to follow a household for the entire RTECS year due to attrition, it was unknown if, for these households, vehicle stock changes were made.

In the 1991 RTECS, 795 households (26 percent) were not followed for the entire RTECS calendar year. This figure represents the percentage of households that had imputations with respect to change in their vehicle stock. Within these households, 149 vehicles (2.4 percent) of the 6,084 total RTECS sample vehicles were imputed as acquisitions and 164 (2.7 percent) of the total sample vehicles were imputed as disposed vehicles.

To impute vehicle stock changes in the 1991 RTECS, logistic regression equations were used to compute a predicted probability (or propensity) of a household making a change in the vehicle stock during the RTECS data year. These propensities were computed for all households in the data set including households lost through attrition. For each household that was not followed during the year, a donor household was found by selecting the respondent household with a propensity closest in value to the "lost" household. This procedure of matching a donor and recipient using a prediction model is called "predictive mean matching." Once a donor household was found, it provided all vehicle stock changes, if any, to the "lost" household.[13] The independent variables were the following four household attributes: (1) age of head of household; (2) number of drivers in the household; (3) total number of vehicles; and (4) vintage of household's newest vehicle.

Backward elimination was used to fit the final models. The binary response variable took a value of 1 if the respondent changed vehicle stock, and 0 if otherwise. The equations were independently fitted and employed within categories defined by (1) time of last contact which could be the RECS interview, the RTECS Beginning-of-Year (B-O-Y) interview, or the RTECS Mid-Year (M-Y) interview, and (2) the number of vehicles in the household at the time of last contact (expressed as two categories: one vehicle, and more than one vehicle). Use of these categories excluded the possibility, for example, of a recipient household (one that was not tracked) with one vehicle being matched to a donor household that had disposed of two of its three vehicles. To achieve additional consistency, the matching procedure was carried out within geographic cells defined by the nine Census divisions and Metropolitan Statistical Area (MSA) versus non-MSA.

[13]R. Little, "Missing-Data Adjustments in Large Surveys," *Journal of Business and Economic Statistics*, pp. 287-301.

If a recipient household was imputed to have acquired a vehicle, certain attributes for that vehicle were "borrowed" from the donor household. These attributes were date of acquisition, date of disposal, vehicle type, vehicle make, model and year, number of cylinders, type of transmission, type of fuel and MPG.

In addition to imputing vehicle acquisitions, some recipient households were imputed to have disposed of some of their vehicle stock. This occurred when a recipient household was matched to a donor that had disposed of some of its vehicle stock. The recipient household was imputed to have disposed of the same number of vehicles that the donor household had disposed of. The vehicles imputed as disposed of by the recipient household were chosen so that they occupied the same rank in terms of model year, as the vehicles disposed of by the donor household (for example, the oldest vehicle, or the next oldest).

The predictive mean matching procedure was validated by simulating the imputation task. Of the 2,366 1985 RTECS donor households, 600 households were randomly selected to act as recipient households. Since the actions of these 600 pseudo-recipient households were known, a direct comparison was made between the known action and the predicted action.

Overall, the prediction accuracy at the national level was 92.3 percent. That is, the distribution of the observed stock changes among the 600 recipient households differed from the distribution of the predicted vehicle stock changes by 46 households. At the regional level, the prediction accuracy was 78.4 percent in the Northeast Census Region, 84.4 percent in the Midwest Census Region, 71.5 percent in the South Census Region and 79.0 percent in the West Census Region.

Predictive mean matching could not be used for households with zero vehicles in stock. There was an insufficient number of households with zero vehicles to achieve significant estimates of parameters for the logistic regression models. For households without vehicles, that were lost from the survey through attrition, a hot-deck procedure was employed for imputing changes to the vehicle stock.

Regression Procedures

Multiple regressions were used to impute for annual VMT for vehicles imputed as acquired, since two odometer readings were not available in these cases. Simple linear and multiple regressions were also used to impute annual mileage for other vehicles when two odometer readings were not obtained. (See Appendix B, "Estimation Methodologies," for details on the imputation of VMT).

Imputation of Vehicle Characteristics for 1975 and Later

Vehicle characteristics that were missing for vehicle model years 1975 and later were imputed using either the VIN or the Environmental Protection Agency (EPA) certification files (CERT files) containing laboratory test results of MPG. When the vehicle characteristic was missing from the questionnaire, but the VIN was available, the characteristics from the VIN were used. Additionally, when there was a discrepancy between the VIN and the RTECS respondent's answer, the VIN generally overrode the response provided by the respondent. If both the VIN and questionnaire responses were missing, the vehicle characteristics were imputed from the CERT files. An individual record from the CERT files was chosen as a donor for a recipient sample vehicle by first narrowing the choice by using the known vehicle characteristics of the recipient vehicle, and then second, selecting a single CERT record according to probabilities proportional to vehicle sales. The type of fuel (gasoline or diesel) used in the vehicle was also imputed using the EPA CERT files (See Appendix B, "Estimation Methodologies," for more details on the use of EPA CERT files in the 1991 RTECS.)

Imputation of Vehicle Characteristics and MPG for Pre-1975 Vehicle Model Years

For all RTECS sample vehicles, the questionnaires and VIN's jointly provided the following vehicle characteristics: make, model, model year, number of cylinders, engine displacement (liters or cubic inches), transmission type (automatic or manual), and fuel system type (carbureted, gasoline fuel injected, or diesel). Many of these characteristics were used to assign EPA test MPG to the sample vehicles. EPA records, in the form of CERT files, were used to provide these MPG, as well as to provide any vehicle characteristics that were not obtained from the questionnaire or VIN (See Appendix B, "Estimation Methodologies," for more details.)

The EPA CERT files, however, have only been available since 1975. The 1991 RTECS file contained 556 pre-1975 vehicles (9 percent), and for these vehicles, missing characteristics were imputed by a hot-deck procedure using 1991 respondents as donor vehicles. Each donor and recipient vehicle was paired on as many of the following characteristics as possible: make, model, model year, transmission type, number of cylinders, and engine displacement.

The MPG for pre-1975 vehicles were imputed using a cold-deck procedure. The donor vehicles were respondents from the 1985 RTECS. Fuel purchase diaries were used in the 1985 RTECS; therefore, no shortfall adjustments were needed for the MPG. Cold-decking was performed within categories defined by make, model, model year, transmission type, and number of cylinders, with collapsing of categories performed where necessary. For example, MPG could be selected from donor vehicles of a certain size class in either the Pontiacs or the Chevrolets, if they shared similar model years, transmission type, and the General Motors 350 cubic inch V-8 engine. However, it appeared that a greater share of the variability in the 1985 RTECS MPG was due to individual driving habits, automotive maintenance and diary keeping, rather than to vehicle characteristics.

Quality of Specific Data Items

Vehicle Identification Number

The VIN is a unique combination of numbers and letters that when decoded provide the characteristics of a particular vehicle. Since 1954, the VIN has been used by American automobile manufacturers. Beginning with the 1981 model year, a standard 17-character VIN was assigned to all vehicles sold in the United States. VIN's were obtained for most of the vehicles in the 1991 RTECS. The vehicle characteristics from decoded VIN's were employed in the 1991 RTECS to enhance the accuracy of reported vehicle characteristics. These characteristics were used in determining vehicle fuel efficiency based on the EPA certification files of test laboratory MPG estimates (See Appendix A, "How the Survey Was Conducted," for a discussion of the VIN.)

There were three occasions where attempts were made to obtain the VIN's: the RECS interview, the Beginning-of-Year (B-O-Y) interview, and the End-of-Year (E-O-Y) interview.

A computer software program, VINDICATOR, from the Highway Loss Data Institute, was used to decode the VIN's. For VIN's that could not be decoded immediately using this program, a computer routine was developed to correct for common errors in the transcription of VIN's. The vehicle characteristics produced for these "fixed" VIN's were then carefully compared to respondent information. Approximately 200 VIN's were salvaged using this routine.

Overall, the collection of the VIN was a highly successful endeavor that yielded quality data. VIN's were obtained for 4,617 (76 percent) of the 6,084 total sample vehicles. Of the 4,617 obtained VIN's, 3,842 (83 percent) were considered "good" VIN's. In summary, "good" VIN's were obtained for 3,842 (63 percent) of the 6,084 sampled vehicles. (A good VIN was one that did not require correcting for common transcription error before it could be decoded.)

Vehicle Fuel Price and Expenditures

Vehicle Fuel Price: In the 1991 and 1988 RTECS, compared to previous RTECS, the fuel price data were not collected via fuel purchase diaries. Instead, fuel prices were determined from Bureau of Labor Statistics (BLS) Retail Pump Average Gasoline Prices and the Lundberg Survey, Inc., prices. (See Appendix B, "Estimation Methodologies" for a discussion of the sources of vehicle fuel prices and the assignment of specific prices to the RTECS data.)

To validate the 1988 and 1991 RTECS price methodology prior to the 1988 and 1991 RTECS, the 1985 RTECS gasoline prices were recalculated and analyzed using the new 1991 methodology (BLS price data). Results of this analysis suggest that if the 1985 BLS price data had been used in 1985 instead of fuel purchase diary data, the average vehicle fuel price reported for the 1985 RTECS would have increased by approximately 2 cents per gallon.

For this analysis, only the prices for unleaded regular gasoline, unleaded premium gasoline, and leaded regular gasoline were recalculated. The prices for leaded premium, diesel, and other fuels were left equal to the prices used in the 1985 RTECS.

The BLS prices that were used for recalculating the 1985 RTECS prices were monthly 1985 regional retail gasoline prices for leaded regular, unleaded regular, and unleaded premium. The prices were averaged across months for each of the above fuel types within each of the four Census regions. One of these average prices was assigned to each of the RTECS vehicles depending on Census region and on vehicle fuel type used.

Table C1 presents the BLS prices (monthly prices were for 1985) with the corresponding average prices from the 1985 RTECS. Overall, the BLS prices compared well with the corresponding average regional fuel prices from RTECS. The largest difference corresponded to unleaded premium gasoline.

While there was general consistency between the BLS prices and the 1985 RTECS prices, the differences that did exist may have stemmed from the differences in the two survey populations and survey collection procedures.

- The BLS population (approximately 85 percent of the total U.S. population) consisted of the U.S. urban, noninstitutional population excluding households living on military bases. The RTECS population represented both urban and rural areas and included military bases.

- BLS prices were based on prices gathered from service stations and sales volume. The 1985 RTECS prices were produced from fuel quantities and expenditures for individual vehicle refuelings.

- The BLS sample was a rotating sample of service stations. Every year approximately one-fifth of the service stations in the sample were replaced with service stations that consumers reported using in that year's "Point of Purchase Survey" conducted by the BLS. Thus, the BLS prices included service stations where consumers currently purchased fuel as well as stations where they had previously purchased fuel. The RTECS prices were based entirely on the service stations where consumers were currently purchasing their vehicle fuel.

Table C1. Average Bureau of Labor Statistics Gasoline Prices and 1985 Residential Transportation Energy Consumption Survey Prices by Census Region and Fuel Type

Census Region and Fuel Type	Average Price (dollars per gallon)	
	1985 RTECS	1985 BLS[a]
Total U.S.		
Total	$1.1805	$1.1969
Unleaded Regular	1.1848	1.2001
Unleaded Premium	1.2945	1.3396
Leaded Regular	1.1080	1.1128
Leaded Premium	1.3087	[b]
Diesel	1.1845	[b]
Other	1.1702	[b]
Northeast		
Total	1.2033	1.2082
Unleaded Regular	1.1931	1.2000
Unleaded Premium	1.3151	1.3327
Leaded Regular	1.1358	1.1243
Leaded Premium	1.3220	[b]
Diesel	1.2123	[b]
Other	1.2209	[b]
Midwest		
Total	1.1831	1.2098
Unleaded Regular	1.1916	1.2185
Unleaded Premium	1.2838	1.3572
Leaded Regular	1.1244	1.1333
Leaded Premium	1.2495	[b]
Diesel	1.1862	[b]
Other	1.1965	[b]
South		
Total	1.1620	1.1847
Unleaded Regular	1.1615	1.1805
Unleaded Premium	1.2795	1.3302
Leaded Regular	1.0806	1.0927
Leaded Premium	1.2333	[b]
Diesel	1.1706	[b]
Other	1.1112	[b]
West		
Total	1.1909	1.1938
Unleaded Regular	1.2075	1.2091
Unleaded Premium	1.3300	1.3562
Leaded Regular	1.1170	1.1153
Leaded Premium	1.3985	[b]
Diesel	1.1885	[b]
Other	1.2040	[b]

[a]BLS average prices in this table were derived by assigning BLS prices to the 1985 RTECS sample vehicles, then producing national averages using the 1985 RTECS sample weights.

[b]Prices for these fuels were not collected by BLS; therefore, the 1985 RTECS prices were used.

Vehicle Fuel Expenditures: Vehicle fuel expenditures were calculated by multiplying the price paid for fuel by the quantity of fuel used. Expenditures per household were the sum of the expenditures for each vehicle in the household. To assess the effect of the 1988 RTECS price methodology on vehicle fuel expenditures, the 1985 household vehicle fuel expenditures were recalculated using the 1985 BLS price data. Table C2 compares average expenditures by fuel type and Census region using both sources of price data.

The use of BLS prices for the 1985 RTECS would have increased the per household expenditures for vehicle fuel from $1,274 per year to $1,292 per year. The changes in expenditures reflect differences in the average price of gasoline between the new 1988 methodology and the 1985 RTECS methodology since the average consumption used to calculate the expenditures comes from the RTECS data under the new and original methodologies. The estimated total 1985 U.S. expenditures for vehicle fuel increased from 99.1 billion dollars to 100.4 billion dollars when the 1988 methodology was applied to the 1985 RTECS data.

The 1988 RTECS price methodology seemed to have little effect on the standard errors of expenditure statistics. When the 1985 RTECS prices were recalculated using 1985 BLS price data, the standard errors of the expenditures were close to the standard errors reported using the 1985 RTECS fuel purchase diary data. While the standard errors of the fuel prices were reduced, in some cases by 50 percent, the variability in fuel prices was very small relative to the variability in gallons of fuel consumed. Therefore, the standard errors of the vehicle fuel expenditures were largely controlled by the variability in gallons of fuel consumed.

Gasohol

In the 1991 RTECS, a little over 1.6 million households reported that they purchased gasohol. In the 1988 RTECS, there was no category for "gasohol" in the detailed tables showing "Type of Fuel Purchased" but there is reason to believe that a small portion of the 81.1 billion gallons of gasoline was gasohol since an estimated 8,138 gallons of gasohol was sold in 1988. This estimate was derived from Federal Highway Administration Statistics (Department of Transportation, Washington, D.C., *Monthly Gasohol Reported by States--1988*, Table MF-33GLA). Only a few 1988 RTECS households reported purchasing gasohol. Gasohol, a mixture of 10 percent ethanol and 90 percent gasoline, is not sold under the name "gasohol". It is sold as "ethanol blends." Given the disparity between the few households reporting purchasing gasohol and the amount of gasohol sold, it does seem likely that some households that reported purchasing gasoline actually bought "gasohol" or "ethanol blends," resulting in an underestimation of the amount of gasohol consumed in 1988. Whether the use of "ethanol blend" in the questionnaire in place of "gasohol" would have increased reports of the alcohol fuel is speculative.

Sampling Error

The random differences between the survey estimates and the true population value that occur because of the particular sample that was selected are known as sampling errors. The average sampling error, averaged over all possible samples, should be zero. Although the sampling error is nonzero and unknown for the particular sample chosen, the sample design permits sampling errors to be estimated. The typical magnitude of the sampling error is measured by the "standard error" of the estimate. Standard errors in this report are given as percents of their estimated values, that is, as relative standard errors (RSE). The RSE is also known as the coefficient of variation.

Table C2. Average Bureau of Labor Statistics Vehicle Fuel Expenditures and 1985 Residential Transportation Energy Consumption Survey Vehicle Fuel Expenditures by Census Region and Fuel Type

Census Region and Fuel Type	Average Expenditures	
	1985 RTECS	1985 BLS[a]
Total U.S.		
Total	$1,274	$1,292
Unleaded Regular	686	695
Unleaded Premium	213	220
Leaded Regular	341	342
Leaded Premium	10	[b]
Diesel	22	[b]
Other	2	[b]
Northeast		
Total	1,169	1,174
Unleaded Regular	694	698
Unleaded Premium	225	228
Leaded Regular	232	229
Leaded Premium	6	[b]
Diesel	12	[b]
Other	1	[b]
Midwest		
Total	1,266	1,294
Unleaded Regular	724	741
Unleaded Premium	164	174
Leaded Regular	352	355
Leaded Premium	5	[b]
Diesel	17	[b]
Other	3	[b]
South		
Total	1,321	1,347
Unleaded Regular	659	670
Unleaded Premium	281	292
Leaded Regular	348	352
Leaded Premium	10	[b]
Diesel	21	[b]
Other	2	[b]
West		
Total	1,304	1,307
Unleaded Regular	678	679
Unleaded Premium	147	149
Leaded Regular	418	417
Leaded Premium	21	[b]
Diesel	39	[b]
Other	2	[b]

[a]BLS average expenditures in this table were derived by assigning BLS prices by fuel type and region to the 1985 RTECS sample vehicles, then producing expenditure averages by using the 1985 RTECS quantities of vehicle fuel consumed.
[b]Prices for these fuels were not collected by BLS; therefore, the 1985 RTECS prices were used in the computations.

For a given survey statistic, Y, the relative standard error, RSE(Y) is given by:

$$RSE(Y) = (S_y/Y) \times 100. \quad \textbf{(1)}$$

The standard error of Y is S_Y. Therefore:

$$S_y = RSE(Y) \times Y/100. \quad \textbf{(2)}$$

The following sections provide a discussion of the procedure used to estimate sampling variances as well as an explanation and example of the procedures used to calculate approximate RSE's for each statistic shown in Tables 6 through 23 in the "Detailed Tables" section of this publication.

Balanced Half-Sample Replication

For some surveys, a convenient algebraic formula for computing variances can be obtained. However, the RECS (of which the RTECS is a subsample) used a multistage area sample design of such complexity that it is virtually impossible to construct an exact algebraic expression for estimating variances (See *Housing Characteristics 1990* (published May 1992), DOE/EIA-0314(90) Appendix A). Instead, the method used to estimate sampling variances for this survey was balanced half-sample replication. This numerical method involves pairing primary sampling units (PSU) in the strata so that differences between the members of each pair can be used to build an estimate of sampling variance. The strata were collapsed to 85 new strata to achieve this pairing of PSU's. Of these 85 strata, 44 each contained two nonself-representing PSU's belonging to the same Census division, with one PSU constituting each member of a pair. Of the remaining 41 strata, 32 were each composed of one self-representing PSU; that is, they consisted of large metropolitan areas that came into the sample with certainty. In each of the latter strata, all of the PSU's were treated as a composite PSU, while the segments within the composite PSU were segregated into two groups representing the two members of a pair. There was no between-PSU component of variance for self-representing PSU's. The nine remaining strata contained nonself-representing PSU's that were treated as if they were self-representing PSU's. These nine strata were in separate Census divisions, and were not collapsed to form pairs of nonself-representing PSU's due to a desire to restrict pairing to within the nine Census divisions, and also due to the desire to treat Alaska and Hawaii as two separate and unique strata.

Balanced half-sample replication involved repeatedly drawing pair members from the 85 strata. Each replication is called a "half-sample" because only one member of the pair within each of the 85 strata was selected. The poststratification procedure described in Appendix A, "How the Survey Was Conducted," was performed independently for each half-sample, so that the resulting variance estimates would reflect the benefits of poststratification. The sample units drawn into each half-sample and adjusted by poststratification can produce unbiased survey statistics based on roughly one-half of the data. Using different combinations of members from the 85 pairs, it is possible to produce a total of $2^{85} = 3.9 \times 10^{25}$ unique half-samples.

Although desirable for good variance estimation, a large number of half-samples would be computationally infeasible. However, the method of balanced half-sample replication allows a small number of half-samples (approximately equal to the number of strata) to produce estimates of variance that are identical to estimates based on all possible unique half-samples for linear survey statistics. The use of ratio adjustments such as poststratification means that even a statistic giving the number of households in a category is not a linear statistic. For nonlinear survey statistics, the variance estimate computed using the method of balanced half-samples is approximately equal to the variance estimate computed using all possible half-samples. With this balancing method each half-sample is constructed by using an orthogonal matrix to control the selection of pair members from strata. For the RTECS, 128 balanced half-samples were used in variance estimation.

The variances are estimated from the 128 half-sample-based statistics in the following way. Let Y' be a survey estimate of characteristic Y for a certain category of housing units (for example, total consumption of vehicle fuel in the West Census Region). Then, the estimated variance of Y' is given by:

$$S_{y'}^2 = \frac{1}{128} \sum_{i=1}^{128} (Y_i' - Y')^2, \qquad \textbf{(3)}$$

where Y_i' is the i[th] half-sample estimate of Y. The standard error of Y' is given by:

$$S_{y'} = \sqrt{S_{y'}^2} \qquad \textbf{(4)}$$

Row and Column Factors

RSE's were calculated for all statistics in this publication, although they cannot be presented due to space limitations. However, the RSE's are presented in a generalized form. The method of presenting generalized RSE's of statistics uses sets of row and column factors inserted in the top row and right-most column of figures in each table. This method of presentation allows the readers to calculate an approximate RSE for each statistic. To estimate the RSE of a statistic in the i[th] row and j[th] column of a particular table, the approximation $RSEA_{i,j}$ for the original $RSE_{i,j}$ is given by:

$$RSEA_{ij} = R_i \times C_j \qquad \textbf{(5)}$$

Where: R_i is the RSE row factor given at the right-most margin of row i in the tables, and C_j is the RSE column factor given at the top of column j.

The following example illustrates this procedure:

Referencing the second row of the table (Figure C1) labeled "Northeast," and the third column labeled "Vehicle Miles Traveled (billion)," yields an estimate of 295 billion miles driven. The RSE row factor is R_2 = 4.4, and the RSE column factor is C_3 = 1.1. The approximate RSE for the estimate is, therefore,

$$RSEA_{2,3} = 4.4 \times 1.1 = 4.84\, percent. \qquad \textbf{(6)}$$

The standard error derived from row and column factors can be used to construct confidence intervals as in Figure C1, and to perform hypothesis tests by standard statistical methods. However, because the generalized variance procedure gives only approximate RSE's, such confidence intervals and statistical tests must also be regarded as only approximate.

For the example above, the RSE determined directly by the half-sample method is actually 5.20 percent, not 4.84 percent.

Figure C1. Use of RSE Row and Column Factors

Total Vehicle Miles Traveled in the Northeast Census Region = 295 billion miles R (Northeast Census Region) = 4.4 C (Vehicle Miles Traveled) = 1.1 Approximate RSE (Total Vehicle Miles Traveled in the Northeast Census Region) = (4.4) X (1.1) = 4.84 percent Approximate Standard Error (Total Vehicle Miles Traveled in the Northeast Census Region) = (4.4) X (1.1) X 295/100 = 14.29 billion miles Approximate 2 Standard Errors (95 percent confidence interval) = (1.96) X (14.29) = 28.01 billion miles Therefore, with approximately 95 percent confidence, the total vehicle miles traveled in the Northeast Census Region in 1991 was between 267 billion and 323 billion miles (295 ± 28)

Source: Energy Information Administration, Office of Energy Markets and End Use, the 1991 Residential Transportation Energy Consumption Survey.

Derivation of Row and Column Factors

The row and column factors are determined from a two-factor analysis of the table of RSE's on the basis of the two-way model,

$$
\begin{aligned}
m &= \overline{(\log RSE)} \\
a_i &= \overline{(\log RSE)}_{i.} - \overline{(\log RSE)} \\
b_j &= \overline{(\log RSE)}_{.j} - \overline{(\log RSE)}
\end{aligned}
\tag{7}
$$

Where:

$\overline{(\log RSE)}$ = the mean of log $RSE_{i,j}$ over all rows i and columns j,

$\overline{(\log RSE)}_{i.}$ = the mean over all columns j for a particular row i, and

$\overline{(\log RSE)}_{.j}$ = the mean over all rows i for a particular column j.

The row and column RSE factors are than computed as:

The RSE row factor, R_i, is the geometric mean of the RSE's in row i. The RSE column factor, C_j, is an adjustment factor with geometric mean equal to 1.0.[14]

$$R_i = antilog(m + a_i) = antilog\overline{(\log RSE)_i} \quad \textbf{(8)}$$

$$C_j = antilog\, b_j = antilog\overline{((\log RSE)_j} - \overline{(\log RSE))}. \quad \textbf{(9)}$$

Statistics in the tables in the "Detailed Tables" section are suppressed by the footnote symbol "Q" if (1) the RSE exceeds 50 percent, or (2) for tables showing household counts, fewer than 10 sample households were used to compute the statistics, or (3) for tables showing vehicle counts, fewer than 18 sample vehicles were used to compute the statistics. The estimation procedure used to obtain the row and column factors does not use RSE's for statistics that were suppressed by the footnote "Q" or for statistics with RSE's that are less than 1.0 percent. In addition, if the statistic for a cell is not listed for any other reason, the RSE for that cell is not used in the procedure. This convention is used because the product of the row and column factors frequently is an inaccurate estimate for these RSE's.

Using these cells in the calculation of the row and column factors may result in factors that give inaccurate RSE estimates for other cells actually presented in the table.

Whenever a household count is a poststratification control total, its RSE estimate is zero. An example is the cell in the first row and first column of Table 25. This cell contains an estimate of the national total of households as of July 1991 (that is, households with and without vehicles). Because the RSE is zero, this cell was not used in the computation of row and column factors. Zero RSE's are never used in row and column calculations, because their inclusion would make the row and column factors inappropriately low for the bulk of the statistics in the tables. Therefore, RSE's calculated from row and column factors for the total household count in Table 25 or for any other poststratification control total, will be inappropriately overestimated.

Determination of the Standard Error of the Difference Between Two Statistics

The procedure used to compute the standard error of the difference between two statistics follows:

$$SE(x_i - x_2) = \sqrt{[SE(x_i)]^2 + [SE(x_2)]^2}. \quad \textbf{(10)}$$

This procedure assumes the two statistics are not correlated. The following example illustrates this procedure. Households with children drove an average of 22,800 miles per household in 1991. Households without children drove an average of 16,500 miles, for a difference of 6,300 miles. The RSE's for households with and without children are 2.9 and 2.3, respectively. The corresponding standard errors are 661 miles and 380 miles, respectively. Therefore, the standard error for the difference is:

$$SE(6,300) = \sqrt{[661]^2 + [380]^2} = 762\ miles. \quad \textbf{(11)}$$

If 1.96 times the standard error is greater than the difference between the statistics, the difference is not statistically significant at the .05 level of significance (the level used to test significance of inferences in this report). In this example, 1.96 times the standard error equals 1,494 miles, while the difference is 6,300 miles. Therefore, the con-

[14]For detailed discussions of the accuracy of the RSE approximation, the procedure for estimating confidence intervals, and the statistical tests of hypotheses, see Nonresidential Buildings Energy Consumption Survey: Commercial Buildings, Consumption and Expenditures, 1983, DOE/EIA-0318(83) (Washington, DC, October 1986).

clusion is that, in 1991, there was a significant difference in average mileage driven per household, between households with and without children.

Appendix D

Survey Forms

This appendix contains copies of the following data collection forms used in the 1991 Residential Transportation Energy Consumption Survey (Forms EIA-876A-D2). Vehicle information collected during the 1990 Residential Energy Consumption Survey (RECS) are included on Form EIA-457A. (See *Housing Characteristics 1990*, Published May 1992, DOE/EIA-0314(90), for the complete survey form.)

- EIA-457A Household Questionnaire (Pages 48, 49, and Vehicles Page).

- EIA-876A Beginning-of-the-Year Questionnaire.
  This questionnaire was used for the beginning- and end-of-year surveys. When used for the end-of-year collection, a short section on "Other Vehicles" was included. Also the closing was changed (Pages 14 an 15 are included).

- EIA-876B Mid-Year Questionnaire.
  Vehicle Update Worksheet.

- EIA-876C Beginning-of-the-Year Odometer Reading Card (Telephone).

- EIA-876-D2 Vehicle Identification Number Card (Mail).

Copies of these forms are available on request.

Appendix E

U.S. Climate Zone and Census Regions and Divisions Maps

Copies of these maps are available on request.

Appendix F

Related EIA Publications on Energy Consumption

Appendix F

Related EIA Publications on Energy Consumption

For information about how to obtain these publications, see the inside cover of this report. Please note that the prices quoted here are subject to change.

In addition to the reports listed below, public use data tapes and data diskettes for the residential, residential transportation, and commercial sectors are available from the National Technical Information Service (NTIS). To obtain information on how to order the tapes/diskettes, you may call NTIS at 703-487-4807, FAX number 703-321-8547. Data diskettes can also be obtained from GPO. For GPO ordering information, call 202-512-2235.

Residential Transportation Sector

Note: The survey name was dropped from the beginning of the report title starting with the 1988 data report, and the report title changed to *Household Vehicles Energy Consumption 1988*.

Household Vehicles Energy Consumption 1988; February 1990, DOE/EIA-0464(88), GPO Stock No. 061-003-00652-3, $11.00.

Residential Transportation Energy Consumption Survey: Consumption Patterns of Household Vehicles 1985; April 1987, DOE/EIA-0464(85), GPO Stock No. 061-003-00521-7, $8.50.

Residential Transportation Energy Consumption Survey: Consumption Patterns of Household Vehicles, 1983; January 1985, DOE/EIA-0464(83), GPO Stock No. 061-003-00420-2, $4.50.

Residential Energy Consumption Survey: Consumption Patterns of Household Vehicles, Supplement: January 1981 to September 1981; February 1983, DOE/EIA-0328, GPO Stock No. 061-003-00297-8, $4.75.

Residential Energy Consumption Survey: Consumption Patterns of Household Vehicles, June 1979 to December 1980; April 1982, DOE/EIA-0319 (no GPO Stock No.).

Residential Sector

Housing Characteristics

Note: The survey name was dropped from the beginning of the report title starting with the 1987 data reports.

Housing Characteristics 1990; May 1992, DOE/EIA-0314(90), GPO Stock No. 061-003-00754-6, $23.00.

Housing Characteristics 1987; May 1989, DOE/EIA-0314(87), GPO Stock No. 061-003-00619-1, $13.00.

Residential Energy Consumption Survey: Housing Characteristics 1984; October 1986, DOE/EIA-0314(84), GPO Stock No. 061-003-00499-7, $12.00.

Residential Energy Consumption Survey: Housing Characteristics, 1982; August 1984, DOE/EIA-0314(82), GPO Stock No. 061-003-00393-1, $7.00.

Residential Energy Consumption Survey Housing Characteristics, 1981; August 1983, DOE/EIA-0314(81), GPO Stock No. 061-003-00330-3, $6.50.

Residential Energy Consumption Survey: Housing Characteristics, 1980; June 1982, DOE/EIA-0314, GPO Stock No. 061-003-00256-1, $11.00.

Residential Energy Consumption Survey: Characteristics of the Housing Stock and Households, 1978; February 1980, DOE/EIA-0207/2, GPO Stock No. 061-003-00093-2, $4.25.

Residential Energy Consumption Survey: Conservation; February 1980, DOE/EIA-0207/3, GPO Stock No. 061-003-00087-8, $6.00.

Preliminary Conservation Tables from the National Interim Energy Consumption Survey; August 1979, DOE/EIA-0193/P (no GPO Stock No.).

Characteristics of the Housing Stock and Households: Preliminary Findings from the National Interim Energy Consumption Survey; October 1979, DOE/EIA-0199/P (no GPO Stock No. available).

Consumption and Expenditures

Note: The survey name was dropped from the beginning of the report title starting with the 1987 data reports. The titles were changed to *Household Energy Consumption and Expenditures 1987, Part 1: National* and *Part 2: Regional*.

Household Energy Consumption and Expenditures 1990; February 1993, DOE/EIA-0321/1(90), GPO Stock No. 061-003-00795-3, $22.00.

Household Energy Consumption and Expenditures 1990\S; DOE/EIA-0321/2(90), GPO Stock No. 061-003-00796-1, $21.00.

Household Energy Consumption and Expenditures 1987, Part 1: National Data; October 1989, DOE/EIA-0321/1(87), GPO Stock No. 061-003-00635-3, $15.00. Note: Energy end-use data are included in this report.

Household Energy Consumption and Expenditures 1987, Part 2: Regional Data; DOE/EIA-0321/2(87) (no GPO Stock No. available), $16.00.

Residential Energy Consumption Survey: Consumption and Expenditures, April 1984 Through March 1985, Part 1: National Data; March 1987, DOE/EIA-0321/1(84), GPO Stock No. 061-003-00519-5, $9.50.

Residential Energy Consumption Survey: Consumption and Expenditures, April 1984 Through March 1985, Part 2: Regional Data; May 1987, DOE/EIA-0321/2(84), GPO Stock No. 061-003-00528-4, $17.00. Note: Energy end-use data are included in this report.

Residential Energy Consumption Survey: Consumption and Expenditures, April 1982 Through March 1983, Part 1: National Data; November 1984, DOE/EIA-0321/1(82), GPO Stock No. 061-003-00411-3, $7.00.

Residential Energy Consumption Survey: Consumption and Expenditures, April 1982 Through March 1983, Part 2: Regional Data; December 1984, DOE/EIA-0321/2(82), GPO Stock No. 061-003-00414-8, $9.50.

Residential Energy Consumption Survey: Consumption and Expenditures, April 1981 Through March 1982, Part 1: National Data; September 1983, DOE/EIA-0321/1(81), GPO Stock No. 061-003-00340-1, $6.00.

Residential Energy Consumption Survey: Consumption and Expenditures, April 1981 Through March 1982, Part 2: Regional Data; October 1983, DOE/EIA-0321/2(81), GPO Stock No. 061-003-00357-5, $8.00.

Residential Energy Consumption Survey: Consumption and Expenditures, April 1980 Through March 1981, Part 1: National Data; September 1982, DOE/EIA-0321/1(80), GPO Stock No. 061-003-00278-1, $7.50.

Residential Energy Consumption Survey: Consumption and Expenditures, April 1980 Through March 1981, - Part 2: Regional Data; June 1983, DOE/EIA-0321/2(80), GPO Stock No. 061-003-00319-2, $7.00.

Residential Energy Consumption Survey: 1979-1980 Consumption and Expenditures, Part 1: National Data (Including Conservation); April 1981, DOE/EIA-0262/1, GPO Stock No. 061-003-00191-2, $6.50.

Residential Energy Consumption Survey: 1979-1980 Consumption and Expenditures, Part II: Regional Data; May 1981, DOE/EIA-0262/2, GPO Stock No. 061-003-00189-1, $8.50.

Residential Energy Consumption Survey: Consumption and Expenditures, April 1978 Through March 1979; July 1980, DOE/EIA-0207/5, GPO Stock No. 061-003-00131-9, $7.50.

Single-Family Households: Fuel Oil Inventories and Expenditures: National Interim Energy Consumption Survey; December 1979, DOE/EIA-0207/1, GPO Stock No. 061-003-00075-4, $3.50.

Other Publications on the Residential Sector

Energy Consumption Series--*User-Needs Study of the 1993 Residential Energy Consumption Survey*, September 1993, DOE/EIA-0555(93)/2, GPO 061-003-00819-4, $13.00.

"End-Use Consumption of Residential Energy" Monthly Energy Review (Article), pp. vii-xiv, July 1987, DOE/EIA-0035(87/07).

Residential Energy Consumption Survey: Trends in Consumption and Expenditures 1978-1984 June 1987, DOE/EIA-0482, GPO Stock No. 061-003-00535-7, $12.00.

Residential Conservation Measures; July 1986, SR/EEUD/86/01 (no GPO Stock No.).

An Economic Evaluation of Energy Conservation and Renewable Energy Tax Credits; October 1985, Service Report (no GPO Stock No.).

Residential Energy Consumption and Expenditures by End Use for 1978, 1980, and 1981; December 1984, DOE/EIA-0458, GPO Stock No. 061-003-00415-6, $4.50.

Weatherization Program Evaluation, SR-EEUD-84-1; August 1984 (available from the Office of the Assistant Secretary for Conservation and Renewable Energy, Department of Energy).

Residential Energy Consumption Survey: Regression Analysis of Energy Consumption by End Use; October 1983, DOE/EIA-0431, GPO Stock No. 061-003-00347-8, $5.00.

National Interim Energy Consumption Survey: Exploring the Variability In Energy Consumption; July 1981, DOE/EIA-0272, GPO Stock No. 061-003-00205-6, $5.00.

National Interim Energy Consumption Survey: Exploring the Variability in Energy Consumption--A Supplement; October 1981, DOE/EIA-0272/S, GPO Stock No. 061-003-00217-0, $4.50.

Energy Use by U.S. Households; November 1980, DOE/EIA-0248 (brochure, no GPO Stock No.).

Commercial Sector

Note: The name of the Nonresidential Buildings Energy Consumption Survey was changed to the Commercial Buildings Energy Consumption Survey, beginning with the 1989 survey. The survey name was also dropped from the report title.

Characteristics of Buildings

Commercial Buildings Characteristics 1989; June 1991, DOE/EIA-0246(89), GPO Stock No. 061-003-00699-0, $18.00.

Nonresidential Buildings Energy Consumption Survey: Characteristics of Commercial Buildings, 1986;

September 1988, DOE/EIA-0246(86), GPO Stock No. 061-003-00580-2, $16.00.

Nonresidential Buildings Energy Consumption Survey: Characteristics of Commercial Buildings, 1983; July 1985, DOE/EIA-0246(83), GPO Stock No. 061-003-00439-3, $7.50.

Nonresidential Buildings Energy Consumption Survey: Characteristics of Commercial Buildings, 1983; A Supplemental Reference, DOE/EIA-M008, $22.95. Available from the NTIS, Order No. DE-85015581.

Nonresidential Buildings Energy Consumption Survey: Fuel Characteristics and Conservation Practices; June 1981, DOE/EIA-0278, GPO Stock No. 061-003-00200-5, $9.00.

Nonresidential Buildings Energy Consumption Survey: Building Characteristics; March 1981, DOE/EIA-0246, GPO Stock No. 061-003-00171-8, $6.50.

Consumption and Expenditures

Commercial Buildings Consumption and Expenditures 1989; April 1992, DOE/EIA-0318(89), GPO Stock No. 061-003-00753-8, $25.00.

Nonresidential Buildings Energy Consumption Survey: Commercial Buildings Consumption and Expenditures 1986; May 1989, DOE/EIA-0318(86), GPO Stock No. 061-003-00613-2, $19.00.

Nonresidential Buildings Energy Consumption Survey: Commercial Buildings, Consumption and Expenditures 1983; September 1986, DOE/EIA-0318(83), GPO Stock No. 061-003-00496-2, $13.00.

Nonresidential Buildings Energy Consumption Survey: 1979 Consumption and Expenditures, Part 1: Natural Gas and Electricity; March 1983, DOE/EIA-0318/1, GPO Stock No. 061-003-00298-6, $9.50.

Nonresidential Buildings Energy Consumption Survey: 1979 Consumption and Expenditures, Part 2: Steam, Coal, Fuel Oil, LPG, and Total Fuels; December 1983, DOE/EIA-0318(79)/2, GPO Stock No. 061-003-00366-4, $6.00.

Other Publications on the Commercial Sector

Energy Consumption Series--*Assessment of Energy Use in Muiltibuilding Facilities*, August 1993, DOE/EIA-0555(93)/1, GPO Stock No. 061-003-00817-8, $7.50.

Energy Consumption Series--*User-Needs Study for the 1992 Commercial Buildings Energy Consumption Survey*, September 1992, DOE/EIA-0555(92)/4, GPO Stock No. 061-003-00770-8, $8.50.

Energy Consumption Series--*Lighting in Commercial Buildings*; March 1992, DOE/EIA-0555(92)/1, GPO Stock No. 061-003-00749-0, $6.50.

Industrial Sector

"Energy Efficiency in the Manufacturing Sector," Monthly Energy Review (Article), p.1, December 1992.

Manufacturing Energy Consumption Survey: Changes in Energy Intensity in the Manufacturing Sector 1980-1988, December 1991, DOE/EIA-0552(80-88). GPO Stock No. 061-003-00734-1, $4.75.

Manufacturing Energy Consumption Survey: Manufacturing Fuel-Switching Capability 1988; September 1991, DOE/EIA-0515(88), GPO Stock No. 061-003-00720-1, $9.00.

Manufacturing Energy Consumption Survey: Consumption of Energy, 1988; May 1991, DOE/EIA 0512(88), GPO Stock No. 061-003-00703-8, $11.00.

Manufacturing Energy Consumption Survey: Energy Efficiency in Manufacturing, 1985; January 1990, DOE/EIA-0516(85), GPO Stock No. 061-003-00650-7, $4.25.

Manufacturing Energy Consumption Survey: Fuel-Switching Capability, 1985; December 1988, DOE/EIA-0515(85), GPO Stock No. 061-003-00601-9, $3.50.

Manufacturing Energy Consumption Survey: Methodological Report, 1985; November 1988, DOE/EIA-0514(85), GPO Stock No. 061-003-00595-1, $6.00.

Manufacturing Energy Consumption Survey: Consumption of Energy, 1985; November 1988,

DOE/EIA-0512(85), GPO Stock No. 061-003-0059-4-2, $6.00.

"Manufacturing Sector Energy Consumption 1985 Provisional Estimates," Monthly Energy Review(Article), pp. vii-x, January 1987, DOE/EIA-0035(87/01).

Report on the 1980 Manufacturing Industries' Energy Consumption Study and Survey of Large Combustors; February 1983, DOE/EIA-0358, GPO Stock No. 061-003-00293-5, $5.00.

Industrial Energy Consumption, "Survey of Large Combustors: Report on Alternate Fuel-Burning-Capabilities of Large Boilers in 1979"; February 1982, DOE/EIA-0304, GPO Stock No. 061-003-0233-1, $2.50.

Methodological Report of the 1980 Manufacturing Industries Survey of Large Combustors (EIA-463); March 1982, DOE/EIA-0306 (no GPO Stock No.).

Other Publications on the Industry Sector

Energy Consumption Series--*Derived Annual Estimates of Manufacturing Energy Consumption 1974-1988*, August 1992, DOE/EIA-0555(92)/3, GPO Stock No. 061-003-00766-0, $7.00.

Energy Consumption Series--*Development of the 1991 Manufacturing Energy Consumption Survey*, May 1992, DOE/EIA-0555(92)/2, GPO Stock No. 061-003-00757-1, $5.50.

Cross-Sector

Energy Consumption by End-Use Sector: A Comparison of Measures by Consumption and Supply Surveys; April 6, 1990, DOE/EIA-0533 (no GPO Stock No. available), $2.50.

Natural Gas: Use and Expenditures; April 1983, DOE/EIA-0382, GPO Stock No. 061-003-00307-9, $5.50.

Public Use Tapes

Note: All tapes are available through the NTIS.

Residential and Residential Transportation Sectors

Residential Energy Consumption Survey: 1987 and Residential Transportation Energy Consumption Survey, 1988, Order No. PB90-501461, $220.

Residential Energy Consumption Survey: 1984 and Residential Transportation Energy Consumption Survey, 1985; Order No. PB87-186540, $220.

Residential Energy Consumption Survey: 1982 and Residential Transportation Energy Consumption Survey, 1983; Order No. PB85-221760, $220.

Residential Energy Consumption Survey: Consumption and Expenditures, 1980-1981; Monthly Billing Data; Order No. PB84-166230, $220.

Residential Energy Consumption Survey: Housing Characteristics, 1981; Consumption and Expenditures, 1981-1982; Monthly Billing Data; Order No. PB84-1-20476, $220.

Residential Energy Consumption Survey: Housing Characteristics, Annualized Consumption and Expenditures, 1980-1981; Order No. PB83-199554, $220.

Residential Energy Consumption Survey: Household Transportation Panel Monthly Gas Purchases and Vehicle and Household Characteristics, 6/79-9/81; Order No. PB84-162452, $220.

Residential Energy Consumption Survey: Household Screener Survey, 1979-1980; Order No. PB82-114877, $220.

Residential Energy Consumption Survey: Household Monthly Energy Consumption and Expenditures, 1978-1979; Order No. PB82-114901, $220.

National Interim Energy Consumption Survey (Residential), 1978; Order No. PB81-108714, $220.

Commercial Sector

Nonresidential Buildings Energy Consumption Survey: 1986 Data; Order No. PB90-500034, $220.

Nonresidential Buildings Energy Consumption Survey: 1979 and 1983 Data; Order No. PB88-245162, $220.

Public Use Diskettes

Note: Diskettes are available through the NTIS and GPO.

Residential Energy Consumption Survey 1987 Data, **NTIS** - ASCII format: Order No. PB-91-505115, $130, and dBASE format: Order No. PB-91-505107, $130. **GPO** - ASCII/dBASE format, order by title, $45 for each set.

Commercial Buildings Energy Consumption Survey 1989 data, **GPO** - ASCII format, order by title, $45.00. **NTIS** - ASCII format: Order No. PB92-504232, $140.

Nonresidential Buildings Energy Consumption Survey 1986 Data, **NTIS** - ASCII format: Order No. PB91-506808, $130.

Residential Transportation Energy Consumption Survey 1988 Data, **NTIS** - ASCII format: Order No. PB91-507269, dBASE format: Order No. PB91-507277, $50 each. **GPO** - ASCII/dBASE format, order by title, $15 for each set.

Planned Publications

Manufacturing Energy Consumption Survey: Changes in Energy Consumption 1985-1988; planned for early 1993.

Household Vehicles Energy Consumption 1991; planned for Mid-1993.

Note: The Energy Information Administration also publishes the *State Energy Data Report, Consumption Estimates*, DOE/EIA-0214, annually; the *State Energy Price and Expenditures Report*, DOE/EIA-0376, annually; and the

Monthly Energy Review, DOE/EIA-0035, monthly. These reports contain monthly and annual consumption information derived from EIA supply surveys.

Glossary

Aggregate Ratio: See **Mean** and **Ratio Estimate**.

AMPD: Average miles driven per day. See **Appendix B**, "Estimation Methodologies."

Annual Vehicle Miles Traveled: See **Vehicle Miles Traveled.**

Automobile: Includes standard passenger car, 2-seater car and station wagons; excludes passenger vans, cargo vans, motor homes, pickup trucks, and jeeps or similar vehicles. See **Vehicle.**

Average Household Energy Expenditures: A ratio estimate defined as the total household energy expenditures for all RTECS households divided by the total number of households. See **Ratio Estimate, and Combined Household Energy Expenditures.**

Average Number of Vehicles per Household: The average number of vehicles used by a household for personal transportation during 1991. For this report, the average number of vehicles per household is computed as the ratio of the total number of vehicles to the total number of households within any subgroup or "table cell." The total number of vehicles used by a household is based on the number of days each vehicle is used. For example, a total of one vehicle may represent two vehicles, each used for half of the year. See **Vehicle.**

Average Vehicle Fuel Consumption: A ratio estimate defined as total gallons of fuel consumed by all vehicles, divided by: (1) the total number of vehicles (for average fuel consumption per vehicle) or (2) the total number of households (for average fuel consumption per household). See **Ratio Estimate.**

Average Vehicle Miles Traveled: A ratio estimate defined as total miles traveled by all vehicles, divided by: (1) the total number of vehicles (for average miles traveled per vehicle) or (2) the total number of households (for average miles traveled per household). See **Ratio Estimate** and **Vehicle Miles Traveled.**

BLS: Bureau of Labor Statistics within the U.S. Department of Labor. See **Price.**

British thermal unit (Btu): The amount of energy required to raise the temperature of 1 pound of water 1 degree Fahrenheit (F) at or near 39.1 degrees F and 1 atmosphere of pressure. One Btu is about equal to the heat given off by a blue-tip match. See **Conversion Factor.**

Btu: See British thermal unit.

Btu Conversion Factor: See **Conversion Factor.**

Bureau of Labor Statistics (BLS) Pump Price Series: See **Price.**

Carburetor: A fuel delivery device for producing a proper mixture of gasoline vapor and air, and delivering it to the intake manifold of an internal combustion engine. Gasoline is gravity fed from a reservoir bowl into a throttle bore, where it is allowed to evaporate into the stream of air being inducted by the engine. The fuel efficiency of carburetors is more temperature dependent than fuel injection systems. See **Fuel Injection** and **Diesel Fuel System.**

Census Division: A geographic area consisting of several States defined by the U.S. Department of Commerce, Bureau of the Census. See the map in **Appendix F**, "U.S. Census Regions and Divisions." The States are grouped into nine divisions and four regions:

Region	**Division**	**States**
Northeast	New England	Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, and Vermont
	Middle Atlantic	New Jersey, New York, and Pennsylvania
Midwest	East North Central	Illinois, Indiana, Michigan, Ohio, and Wisconsin
	West North Central	Iowa, Kansas, Minnesota, Missouri, Nebraska, North Dakota, and South Dakota
South	South Atlantic	Delaware, the District of Columbia, Florida, Georgia, Maryland, North Carolina, South Carolina, Virginia, and West Virginia
	East South Central	Alabama, Kentucky, Mississippi, and Tennessee
	West South Central	Arkansas, Louisiana, Oklahoma, and Texas
West	Mountain	Arizona, Colorado, Idaho, Montana, Nevada, New Mexico, Utah, and Wyoming
	Pacific	Alaska, California, Hawaii, Oregon, and Washington

Census Region: See **Census Division** and the map in **Appendix F,** "U.S. Census Regions and Divisions."

Central City: Usually one or more legally incorporated cities within the Metropolitan Statistical Area (MSA) that is significantly large by itself or large relative to the largest city in the MSA. Additional criteria for being classified as "Central City" include having at least 75 jobs for each 100 employed residents and having at least 40 percent of the resident workers employed within the city limits. Every MSA has at least one central city, usually the largest city. Central cities are commonly regarded as relatively large communities with a denser population and a higher concentration of economic activities than the outlying or suburban areas of the MSA. "Outside Central City" are those parts of the MSA not designated as central city. See **Metropolitan.**

Certification Files: See **Environmental Protection Agency Certification Files.**

Change in Vehicle Stock: See **Vehicle Acquisition** and **Vehicle Disposition.**

CID: Cubic Inch Displacement. See **Engine Size.**

Cold-Deck Imputation: A statistical procedure that replaces a missing value of an item with a constant value from an external source such as a value from a previous survey. See **Imputation** and **Appendix C**, "Quality of the Data."

Combined Household Energy Expenditures: The total amount of funds spent for energy consumed in, or delivered to, a housing unit during a given period of time; and for fuel used to operate the motor vehicles that are owned or used on a regular basis by the household. For this report, expenditures for energy consumed in the housing unit are presented on an annual basis for calendar year 1990 as collected during the 1990 Residential Energy Consumption Survey. All vehicle expenditure statistics calculated for the RTECS are on an annual basis for calendar year 1991.

The total dollar amount for energy consumed in a housing unit includes State and local taxes but excludes merchandise repairs or special service charges. Electricity, and natural gas expenditures are for the amount of those energy sources consumed. Fuel oil, kerosene and LPG expenditures are for the amount of fuel purchased, which may differ from the amount of fuel consumed.

The total dollar amount of fuel spent for vehicles is the product of fuel consumption and price. In the 1991 RTECS, price data were obtained from the Bureau of Labor Statistics price data and the Lundberg Survey Inc. price series. See **Vehicle Fuel Expenditures, Average Household Energy Expenditures** and **Price.**

Conversion Factor: A number that translates units of one system into corresponding values of another system. Conversion factors are used to translate physical units of measures for various fuels into Btu equivalents. Conversion factors used in this report are:

Motor Gasoline .... .125 million Btu per gallon
Diesel Fuel .... .139 million Btu per gallon
Propane .... .091 million Btu per gallon
Gasohol .... .121 million Btu per gallon
Gasohol = 90 percent motor gasoline and 10 percent ethanol
1 barrel = 42 gallons

Diesel Fuel: A fuel composed of distillates obtained in petroleum refining operation or blends of such distillates with residual oil used in motor vehicles. The boiling point and specific gravity are higher for diesel fuels than for gasoline. See **Diesel Fuel System.**

Diesel Fuel System: Diesel engines are internal combustion engines that burn diesel oil rather than gasoline. Injectors are used to spray droplets of diesel oil into the combustion chambers, at or near the top of the compression stroke. Ignition follows due to the very high temperature of the compressed in-take air, or to the use of "glow plugs," which retain heat from previous ignitions (spark plugs are not used). Diesel engines are generally more fuel efficient than gasoline engines, but must be stronger and heavier due to high compression ratios. See **Diesel Fuel, Carburetor,** and **Fuel Injection.**

Drivers: Household members who drove a vehicle on a regular basis at the time of the 1990 RECS personal interviews.

Electricity: See **Main Heating Fuel.**

Energy Used in the Home: For electricity or natural gas, the quantity is the amount used by the household during the 365- or 366-day period. For fuel oil, kerosene, and liquefied petroleum gas (LPG), the quantity consists of fuel purchased, not fuel consumed. If the level of fuel in the storage tank was the same at the beginning and end of the annual period, then the quantity consumed would be the same as the quantity purchased. Information on the level of fuel in the storage tank was not included in the data collection. The time period for household consumption for energy used in the home is January 1990 through December 1990 and was collected during the 1990 Residential Energy Consumption Survey.

Engine Size: The total volume within all cylinders of an engine, when pistons are at their lowest positions. The engine is usually measured in "liters" or "cubic inches of displacement (CID)." Generally, larger engines result in greater engine power, but less fuel efficiency. There are 61.024 cubic inches in a liter. See **Number of Cylinders.**

Environmental Protection Agency (EPA) Certification Files: Computer files produced by EPA for analysis purposes. For each vehicle make, model and year, the files contain the EPA test MPG's (city, highway and 55/45 composite). These MPG's are associated with various combinations of engine and drive-train technologies (e.g., number of cylinders, engine size, gasoline or diesel fuel, and automatic or manual transmission). These files also contain information similar to that in the DOE/EPA *Gas Mileage Guide*, although the MPG's in that publication are adjusted for shortfall. See **Miles per Gallon, Shortfall** and **Appendix B**, "Estimation Methodologies."

EPA Certification Files: See **Environmental Protection Agency (EPA) Certification Files.**

EPA Composite MPG: The harmonic mean of the EPA city and highway MPG, weighted under the assumption of 55 percent city driving and 45 percent highway driving. See **Appendix B**, "Estimation Methodologies."

Family Income: The total combined annual income in 1990 of all members of the family from all sources before taxes and deductions as collected in the 1990 RECS. It includes wages, salaries, tips, commissions, income from Social Security, pensions, interest, dividends, rent, public assistance, and unemployment insurance. This includes the total income for all family members who lived in the household in 1990. Income of nonfamily members of the household is not included. "Family" includes the following types of relationships: mother, father, sister, brother, son, daughter, father-in-law, uncle, aunt, niece, grandchild, foster child, and similar relationships.

Four-Wheel Drive: See **Type of Drive.**

Front-Wheel Drive: See **Type of Drive.**

Fuel Consumption: See **Vehicle Fuel Consumption.**

Fuel Efficiency: See **Miles per Gallon.**

Fuel Expenditures: See **Vehicle Fuel Expenditures.**

Fuel Injection: A fuel delivery system whereby gasoline is pumped to one or more fuel injectors under high pressure. The fuel injectors are valves that, at the appropriate times, open to allow fuel to be sprayed or atomized into a throttle bore or into the intake manifold ports. The fuel injectors are usually solenoid operated valves under the control of the vehicle's on-board computer (thus the term "electronic fuel injection"). The fuel efficiency of fuel injection systems is less temperature dependent than carburetor systems. Diesel engines always use injectors. See **Carburetor,** and **Diesel Fuel Systems.**

Fuel Oil: See **Main Heating Fuel.**

Fuel Type: See **Type of Vehicle Fuel Purchased.**

Full Service: See **Type of Primary Service.**

GPMR (Gallons per Mile Ratio): See **MPG Shortfall** and **Appendix B**, "Estimation Methodologies."

Gasohol: A fuel used in motor vehicles that is a blend of finished motor gasoline (leaded or unleaded) and alcohol (generally ethanol, but sometimes methanol), limited to 10 percent alcohol by volume. See **Gasoline.**

Gasoline: A complex mixture of relatively volatile hydrocarbons, with or without small quantities of additives, obtained by blending appropriate refinery streams to form a fuel suitable for use in spark ignition engines. Motor gasoline includes both leaded or unleaded grades of finished motor gasoline, blending components, and gasohol.

High-Mileage Households: Households with estimated aggregate annual vehicle mileage that exceeds 12,500 miles, as obtained in the 1990 RECS.

Hispanic Descent: This, as the question on origin, was self-determined by the respondent and is collected in the 1990 RECS. The respondent was asked, "Is the householder of Spanish or Hispanic descent?" and the respondent's answer was recorded. See **Origin.**

Hot-Deck Imputation: A statistical procedure for deriving a probable response to a questionnaire item concerning a household or vehicle, where no response was given during the survey. To perform the procedure, the households or vehicles are sorted by variables related to the missing item. Thus, a series of "sort categories" are formed, which are internally homogeneous with respect to the sort variables. Within each category, households or vehicles for which the questionnaire item is not missing are randomly selected to serve as "donors" to supply values for the missing item of "recipient" households or vehicles. See **Imputation** and **Appendix C,** "Quality of the Data."

Household: A family, an individual, or a group of up to nine unrelated persons occupying the same housing unit at the time of the 1990 RECS interview. "Occupy" means the housing unit was the person's usual or permanent place of residence at the time of the first field contact. The household includes babies, lodgers, boarders, employed persons who live in the housing unit, and persons who usually live in the household but are away traveling or in a hospital. The household does not include persons who are normally members of the household but who were away from home as college students or members of the armed forces at the time of the contact. The household does not include persons temporarily visiting with the household if they have a place of residence elsewhere, persons who take their meals with the household but usually lodge or sleep elsewhere, domestic employees or other persons employed by the household who do not sleep in the same housing unit, or persons who are former members of the household, but have since become inmates of correction or penal institutions, mental institutions, homes for the aged or needy, homes or hospitals for the chronically ill or handicapped, nursing homes, convents or monasteries, or other places in which residents may remain for long periods of time. By definition, the number of households is the same as the number of occupied housing units. The number or households for a subgroup or table cell is estimated by summing the survey weights over all sample households in that subgroup.

Householder: The person (or one of the people) in whose name the home is owned or rented. If there is no lease or similar agreement, or if the person who owns the home or pays the rent does not live in the housing unit, the householder is the person responsible for paying the household bills, or whoever is generally in charge.

Household Composition: The configuration of the household members including number of children, number of household members, and age of household members. For this report, households were divided into households with children and households without children. Within the households with children, a further division was made depending on the age of the oldest child. Within households without children, a further division was made depending on the number of adults and then within that category, the age of the households. See **Household, Householder,** and **Housing Unit.**

Household Energy Expenditures: The total amount of funds spent for energy consumed in, or delivered to, a housing unit during a given period of time. See **Combined Household Energy Expenditures.**

Household Size: Number of individuals occupying a housing unit. See **Household, and Housing Unit.**

Housing Unit: A structure or part of a structure where a household lives. It has direct access from the outside of the building, either directly or through a common hall. Housing units do not include group quarters such as prisons or nursing homes where 10 or more unrelated persons live. Hotel and motel rooms are considered housing units if occupied as the usual or permanent place of residence.

Imputation: A group of statistical techniques for estimating probable responses to questionnaire items concerning households or vehicles, where no responses or poor quality responses were given during the survey. The three most common techniques employed in this survey were "hot-deck," "regression," and "predictive mean matching." See **Hot-Deck Imputation, Cold-Deck Imputation, Predictive Mean Matching, Regression Imputation,** and **Appendix C,** "Quality of the Data."

Intermediate Grade Gasoline: An increasingly common grade of unleaded gasoline with an octane rating intermediate between "regular" and "premium." Octane boosters are added to gasolines to control engine pre-ignition or "knocking" by slowing combustion rates. See **Regular Grade Gasoline** and **Premium Grade Gasoline**.

In-Use MPG: An MPG that was adjusted for seasonality and annual miles traveled. See **Appendix B**, "Estimation Methodologies."

Jeep-like Vehicle: These vehicles are now referred to as sport-utility. See **Sport-Utility Vehicle.**

Kerosene: See **Main Heating Fuel.**

Large Van: See **Van.**

Leaded Gasoline: A fuel that contains more than 0.05 gram of lead per gallon or more than 0.005 gram of phosphorus per gallon. See **Gasoline** and **Unleaded Gasoline.**

Liquefied Petroleum Gas (LPG): See **Main Heating Fuel.**

Liters: See **Engine Size.**

Lundberg Survey Inc. Price Series: See **Price.**

Main Heating Fuel: The primary fuel delivered to a residential site. It may be converted to some other form of energy at the site. The following are defined as primary fuels for this report:

> Electricity: Metered electric power supplied by a central utility company to a residence via underground or above-ground power lines. It does not refer to electricity generated onsite for the exclusive use of a residence. When a residence has its own generating capability, the fuel used for the generator will be specified. The Btu equivalent for electricity is the energy value of electricity as received by the household (3,412 Btu per kilowatthour). For this report, energy losses that occur in generating and transmitting electricity are not included in the conversion of electricity into a Btu equivalent. If these losses were to be included, the conversion rate would generally be about 10,353 Btu per kilowatthour.
>
> Fuel Oil: No. 1, No. 2, or No. 4 grade fuel oil or residual oil that is burned for space- or water-heating purposes. No. 1 distillate fuel oil is a form of heating oil used mostly as a blending stock to insure that heavier grades of fuel flow under severe cold weather conditions. No. 2 distillate refers to both No. 2 heating oil and No. 2 diesel fuel. Although these products are not identical, they are essentially interchangeable for most applications. No. 2 fuel oil is the most common form of heating oil. No. 4

distillate is a blend of No. 2 and No. 5 or No. 6 residual fuel oil, used in large stationary diesel engines and boilers equipped with fuel preheating equipment. Residual fuel oil refers to the heavier oils that remain after the distillate fuel oils and lighter hydrocarbons are boiled off in refinery operations.

Kerosene: The generic name for a distilled product of oil or coal, having properties similar to those of No. 1 fuel oil. Kerosene is used for cooking stoves, for space heating or water heating, or for lighting equipment that uses wicks. It is sometimes sold under the names "range oil," "stove oil," or "coal oil."

LPG or Liquefied Petroleum Gas: Any fuel gas supplied to a residence in liquid form, such as propane or butane. It is usually delivered by tank truck and stored near the residence in a tank or cylinder until used. Propane was the most common liquefied petroleum gas supplied to RECS households. Household use of LPG solely for outdoor gas grills is not considered sufficient use to mark the household as a user of LPG.

Natural Gas: Utility gas supplied by underground pipeline to individual housing units by a central utility company. It does not refer to privately owned gas wells operated by the household, nor to LPG.

Mean: The simple arithmetic average for a population; that is, the sum of all the values in a population divided by the size of the population. For this report, population means are estimated by computing the weighted sum of the sample values, then dividing by the sum of the sample weights. The mean is, thus, an aggregate ratio whose denominator is the total number of households or vehicles. See **Ratio Estimate**.

Measured Heated Area of Residence: The floor area of the housing unit that is enclosed from the weather and heated as collected in the 1990 RECS. Basements are included whether or not they contain finished space. Garages are included if they have a wall in common with the house. Attics that have finished space and attics that have some heated space are included. Crawl spaces are not included even if they are enclosed from the weather. Sheds and other buildings that are not attached to the house are not included. "Measured" area means that the measurement of the dimensions of the home did not rely on the respondent's reports but was an actual measurement by the interviewer using a metallic, retractable, 50-foot tape measure. "Heated area" is that portion of the measured area that is heated during most of the season. Rooms that are shut off during the heating season to save on fuel are not counted. Attached garages that are unheated and unheated areas in the attics and basements are also not counted.

Metropolitan: A group of households located within Metropolitan Statistical Areas (MSA's) as defined by the U.S. Office of Management and Budget. Except in New England, an MSA is (1) a county or group of contiguous counties that contain at least one city of 50,000 inhabitants or more, or (2) an urbanized area of at least 50,000 inhabitants and a total MSA population of at least 100,000 (75,000 in New England). The contiguous counties are included in an MSA if, according to certain criteria, they are essentially metropolitan in character and are socially and economically integrated with the central city. In New England, MSA's consist of towns and cities, rather than counties. See **Nonmetropolitan** and **Central City.**

Metropolitan Status: Refers to the geographic location of the households in relationship to MSA's. See **Metropolitan, Nonmetropolitan,** and **Central City.**

Miles per Gallon (MPG): A measure of vehicle fuel efficiency. Miles per gallon or MPG as presented in this report represents "Fleet Miles per Gallon." For each subgroup or "table cell," MPG is computed as the ratio of the total number of miles traveled by all vehicles in the subgroup to the total number of gallons consumed. For the 1991 RTECS, MPG's were assigned to each vehicle using the EPA certification files and adjusted for on-road driving. See **Appendix B,** "Estimation Methodologies," for a discussion of how MPG's were assigned to each vehicle.

Mini-Service Pumps: See **Type of Primary Service.**

Minivan: New type of small van that first appeared with that designation in 1984. Any of the smaller vans built on an automobile-type frame. Earlier models such as the Volkswagen van are now included in this category.

Model Year: The year in which the particular style or design of vehicle was introduced or manufactured.

Motor Fuel Consumption: See **Vehicle Fuel Consumption**.

Motor Fuel Expenditures: See **Vehicle Fuel Expenditures**.

MPG: See **Miles per Gallon.**

MPG Shortfall: The difference between actual on-road MPG and EPA laboratory test MPG. MPG shortfall is expressed as gallons per mile ratio (GPMR). See **Appendix B**, "Estimation Methodology."

MSA: See **Metropolitan.**

Multistage Area Probability Sample: A sample design executed in stages with geographic "clusters" of sampling units selected at each stage. This procedure reduces survey expense while maintaining national coverage. See **Appendix A,** "How the Survey Was Conducted."

Natural Gas: See **Main Heating Fuel.**

Nonmetropolitan: Households not located within MSA's as defined by the U.S. Office of Management and Budget. See **Metropolitan.**

Number of Cylinders: In a reciprocating engine, a cylinder is the chamber in which combustion of fuel occurs and the piston moves, ultimately delivering power to the wheels. Common engine configurations include 4, 6, and 8 cylinders. Generally, the more cylinders a vehicle has, the greater the amount of engine power it has. However, more cylinders often result in less fuel efficiency. See **Engine Size.**

Number of Households: The total number of households in the United States that are represented by the sample households. In this report, most statistics are shown for the number of households with vehicles, which is a subset of the total number of households.

Number of Vehicles: See **Vehicle** and **Vehicle Stock.**

Occupied Housing Unit: A unit someone was living in as his or her usual or permanent place of residence when the first field contact was made. See **Housing Unit.**

On-road MPG: A composite MPG that was adjusted to account for the difference between the test value and the fuel efficiency actually obtained on the road. See **Appendix B**, "Estimation Methodology."

Origin: The primary ethnic background of the person considered to be the householder as self-determined by the respondent. Origin of householder was collected in the 1990 RECS. Each respondent was asked, "Which of the groups on this exhibit best describes the householder?" The groups included: white, black or Negro, American Indian, Alaskan native, Asian, and Pacific Islander. The word "race" was not used in either the questionnaire or the instructions. See **Hispanic Descent.**

Outside Central City: See **Central City.**

Passenger Car: See **Vehicle** and **Automobile.**

Pickup Truck: Includes compact and full-size pickup trucks. See **Vehicle.**

Poverty: Low-income classifications to which certain households are assigned based on the household's annual income reported in the 1990 RECS. "Below 100 percent of poverty" encompasses a group of households with incomes below the poverty level as defined by the Bureau of the Census. "Below 125 percent of poverty" includes a group of households with incomes below 125 percent of the poverty level. These groups of the poor and near-poor represent alternative levels for defining poverty. The definitions of "poor" are based on the number of family members in the household and the income of the entire family.

Premium Grade Gasoline: A grade of unleaded gasoline with a high octane rating, (approximately 92) designed to minimize preignition or engine "knocking" by slowing combustion rates. See **Regular Grade Gasoline** and **Intermediate Grade Gasoline.**

Predictive Mean Matching: A model-based procedure used to impute for item nonresponse. This method uses logistic models to compute predicted means that are used to statistically match each nonrespondent to a respondent with the closest predicted mean. The respondent's value is directly imputed to the nonrespondent. See **Imputation** and **Appendix C**, "Quality of the Data."

Price: The dollar amount per gallon of fuel purchased. For the 1991 RTECS, fuel prices were not collected directly from the respondent. Instead fuel prices were estimated from the Bureau of Labor Statistics Retail Pump Price Survey and from the Lundberg Survey Inc. Prices. See **Appendix B**, "Estimation Methodologies" and **Appendix C**, "Quality of the Data."

Primary Sampling Unit (PSU): A sampling unit selected at the first stage in multistage area probability sampling. A PSU typically consists of one to several contiguous counties--for example, a metropolitan area with surrounding suburban counties. The approximately 3,100 counties and independent cities of the contiguous United States were grouped into about 1,800 PSU's by a procedure similar to the one used by the Census Bureau for its Current Population Survey. PSU's can be composed of one or more MSA's or can be composed of rural counties. See **Metropolitan** and **Appendix A,** "How the Survey Was Conducted."

PSU: See **Primary Sampling Unit.**

Quadrillion: The number 1,000,000,000,000,000 or 10^{15}.

Ratio Estimate: The ratio of two population aggregates (totals). For example, "average miles traveled per vehicle is the ratio of total miles driven by all vehicles, over the total number of vehicles, within any subgroup or "table cell." In this report, there are two types of ratio estimates: those computed using aggregates for vehicles and those computed using aggregates for households. See **Mean**.

Rear-Wheel Drive: See **Type of Drive.**

RECS: See **Residential Energy Consumption Survey (RECS).**

Regression Imputation: A statistical technique for predicting the value of a numerical variable that is missing. The technique involves developing a regression equation that predicts the value of the missing variable based upon variables that are not missing or have already been imputed. See **Imputation** and **Appendix C,** "Quality of the Data."

Regular Grade Gasoline: A grade of unleaded gasoline with a lower octane rating (approximately 87) than other grades. Octane boosters are added to gasoline to control engine preignition or "knocking" by slowing combustion rates. See **Intermediate Grade Gasoline** and **Premium Grade Gasoline**.

Relative Standard Error: See **RSE (Relative Standard Error)**.

Residential: Occupied housing units, including mobile homes, single-family housing units (attached and detached), and apartments. The definition of "occupied housing units" is the same as that used by the U.S. Bureau of the Census. See **Household** and **Housing Unit.**

Residential Energy Consumption Survey (RECS): A national multistage probability sample survey conducted by the Energy End Use Division of the Energy Information Administration. The RECS provides baseline information on how households in the United States use energy. The RTECS sample is a subset of the RECS. Household demographic characteristics reported in the RTECS publication are collected during the RECS personal interview. See **Appendix A**, "How the Survey Was Conducted."

RSE (Relative Standard Error): A measure of the reliability or precision of a survey statistic. Variability occurs in survey statistics because the different samples that could be drawn would each produce different values for the survey statistics. The RSE is a measure of precision on a percentage scale. The RSE is defined as the standard error of a survey estimate, divided by the survey estimate and multiplied by 100. (Standard error is the square root of the variance.) For example, an RSE of 50 percent means that the standard error is half as large as the survey estimate. See **Appendix C,** "Quality of the Data," for a discussion of sampling errors.

RSE Column Factor: An adjustment factor that appears above each column of the tables and is used to compute RSE's. For a survey estimate in a particular row and column of a table (that is, a particular "cell"), the approximate RSE is obtained by multiplying the RSE row factor by the RSE column factor for that cell. See **RSE, RSE Row Factor,** and **Appendix C,** "Quality of the Data."

RSE Row Factor: A factor that appears to the right of each row of the tables, and is used to compute RSE's. For a survey estimate in a particular row and column of a table (that is, a particular "cell"), the approximate RSE is obtained by multiplying the RSE row factor by the RSE column factor for that particular cell. The row factor is equal to the geometric mean of the RSE's in a particular row of the tables. See **RSE, RSE Column Factor** and **Appendix C,** "Quality of the Data."

Sampling: The procedure used to select housing units for interview from the population of residential housing units in the United States. See **Multistage Area Probability Sample** and **Appendix A,** "How the Survey Was Conducted."

Self-Service or Mini-Service: See **Type of Primary Service.**

Shortfall: See **MPG Shortfall** and **Appendix B**, "Estimation Methodologies."

Sport-Utility Vehicle: Includes light trucks that are similar to jeeps. Other common terms for these vehicles are sport-utility, special purpose, utility or off-the-road vehicles. They may have a four- or two-wheel drive. See **Vehicle.**

Transmission Type: The householder was asked if each vehicle had an automatic or manual shift transmission. The transmission is the part of a vehicle that transmits motive force from the engine to the wheels, usually by means of gears for different speeds using either a hydraulic "torque-converter" (automatic) or clutch assembly (manual). On front wheel drive cars, the transmission is often called a "transaxle." Fuel efficiency is usually higher with manual, rather than automatic transmissions, although modern, computer-controlled automatic transmissions can be efficient.

Transportation Energy Expenditures: See **Vehicle Fuel Expenditures** and **Combined Household Energy Expenditures**.

Type of Drive: Refers to which wheels the engine power is delivered to, the so-called "drive wheels." Rear-wheel drive, has drive wheels on the rear of the vehicle. Front-wheel drive, a newer technology, has drive wheels on the front of the vehicle. Four-wheel drive uses all four wheels as drive wheels, and is found mostly on Jeep-like vehicles and trucks, though it is becoming increasingly more common on station wagons and vans.

Type of Fuel System: See **Carburetor, Fuel Injection** and **Diesel Fuel Systems.**

Type of Vehicle Fuel Purchased: The predominant type of fuel purchased during 1991. Data categories are leaded and unleaded gasoline, diesel motor fuel and "other" which includes propane and gasohol. See **Gasoline, Gasohol, Unleaded Gasoline, Leaded Gasoline, Regular Grade Gasoline, Intermediate Grade Gasoline,** and **Premium Grade Gasoline.**

Type of Primary Service: The dominant type of service the respondent uses at the service station. Response categories include Full-Service Pumps, "Self- or Mini-Service Pumps," or " Both Equally." Mini Service is provided when attendants pump the vehicle fuel but do not provide any other service, such as checking the tire pressure or washing windshields.

Unleaded Gasoline: Contains not more than 0.05 gram of lead per gallon and not more than 0.005 gram of phosphorus per gallon. Premium, regular and intermediate grades are included, depending on the octane rating. See **Gasoline, Leaded Gasoline, Regular Grade Gasoline, Intermediate Grade Gasoline,** and **Premium Grade Gasoline.**

Van: Includes large vans. Generally, the distinction between large vans and minivans is made by the respondents' answers to "Type of Vehicle" question. Exceptions were: (1) Volkswagen vans were categorized as minivans, and (2) all other pre-1983 vans were categorized as vans.

Vehicle: For the RTECS, vehicles were any motorized vehicles used by U.S. households for personal transportation. Excluded were: motorcycles, mopeds, large trucks, and buses. Included were: automobiles, station wagons, passenger vans, cargo vans, motor homes, pickup trucks, and jeeps or similar vehicles. In order to be included, vehicles must be: (1) owned by members of the household; (2) company cars not owned by household members but regularly available to household members for their personal use and are ordinarily kept at home; or (3) rented or leased for 1 month or more. See **Vehicle Stock, Vehicles Used on the Job, Automobile, Mini-vans, Vans, Pickup Trucks,** and Sport-Utility **Vehicles.**

Vehicle Acquisition: The number of vehicles a household acquires or obtains during the RTECS survey year. The average number of vehicles in the stock is computed using these data. See **Vehicle Disposition.**

Vehicle Disposition: The number of vehicles a household disposes of during the RTECS survey year. Disposed vehicles include those sold, traded, or the owner moved out of the household. The average number of vehicles in the stock is computed using these data. See **Vehicle Acquisition.**

Vehicle Fuel Consumption: Vehicle fuel consumption is computed as the vehicle miles traveled divided by the fuel efficiency reported in MPG's. For the 1991 RTECS, vehicle fuel consumption was derived from the actual vehicle mileage collected in the RTECS and the assigned MPG's obtained from the EPA certification files and adjusted for on-road driving. See **Appendix B,** "Estimation Methodologies," for an explanation of procedures used to estimate annual vehicle fuel consumption.

Vehicle Fuel Efficiencies: See **Miles per Gallon (MPG)** and **Appendix B**, "Estimation Methodologies."

Vehicle Fuel Expenditures: The cost, including taxes, of the gasoline, gasohol or diesel fuel added to the vehicle's tank. Expenditures do not include the cost of oil or other items that may have been purchased at the same time as the vehicle fuel. See **Appendix B,** "Estimation Methodologies," for an explanation of procedures used to estimate annual vehicle fuel expenditures.

Vehicle Identification Number (VIN): A set of codes, usually alpha-numeric characters, assigned to a vehicle at the factory and inscribed on the vehicle. When decoded, the VIN provides vehicle characteristics. The VIN was used in the 1991 RTECS to help match vehicles to the EPA certification file for calculating MPG's. See **Environmental Protection Agency Certification Files** and **Appendix A,** "How the Survey Was Conducted."

Vehicle Miles Traveled (VMT): The number of miles traveled nationally by the RTECS vehicles for a period of 1 year. In the RTECS, VMT were either calculated using two odometer readings or, for vehicles with less than two odometer readings, imputed using a regression estimate. See **Average Vehicle Miles Traveled, Appendix A**, "How the Survey Was Conducted," and **Appendix C**, "Quality of the Data."

Vehicle Stock: The number of vehicles owned or used by a household for personal transportation. In the RTECS, with the exception of the statistics reported as of July 1991, a vehicle was defined in terms of a "Vehicle Year." If a vehicle was present in a household for the entire year, it was counted as one vehicle. If a vehicle was present in a household for one-half of the year, it was counted as only one-half of a vehicle. Therefore, the number of vehicles a sample household was considered as having during the survey year was computed as the days of possession summed over all vehicles in the household, divided by 366 days (1991 was a leap year). See **Average Number of Vehicles** and **Vehicles**.

Vehicle Used on the Job: A vehicle used by anyone in the household for job-related activities, excluding commuting to and from work. These vehicles are included in the RTECS. See **Vehicle.**

VIN: See **Vehicle Identification Number.**

VMT: See **Vehicle Miles Traveled.**