

## **Section 4**

# **Consumer Vehicle Preferences**

## 4.1. Introduction

The major aims of this study are to analyze and summarize the results of a national telephone survey of consumer vehicle preferences and attitudes toward alternative-fuel vehicles. The study approach, the sample design specifications, the questionnaire, and the processing specifications were developed by students enrolled in a survey practicum course at the University of Maryland. This course is one of the graduate degree requirements of the Joint Program in Survey Methodology sponsored by the University of Maryland, the University of Michigan, and Westat, Inc. The professor for the course, who oversaw all aspects of the survey, was Dr. Stanley Presser.

The eligible population for the study consisted of telephone households in the continental United States that owned or leased one or more motor vehicles driven on a regular basis. The respondent was the adult in the household most knowledgeable about the use of the household's vehicle(s). Interviewing for the survey occurred from February 17 to May 16, 1994, in the Maryland Survey Research Center (SRC) Telephone Facility on the College Park campus. The total number of respondents was 1,712.

### Highlights

The following are selected findings, estimated by analysis of the data obtained from the Consumer Preference Survey, concerning the consumer population.

- Eighty-seven percent use personal vehicles as their main type of transportation
- Fifty-nine percent belong to households with two persons over the age of 18
- Eighty-five percent have heard of alternative-fuel vehicles
- Sixty-two percent feel that electricity is a safer vehicle fuel than gasoline
- Seventy-seven percent are concerned about outdoor air pollution in their area
- Sixty-one percent feel that vehicle emissions are extremely or very dangerous
- Forty-eight percent consider themselves to be environmentalists
- More than one-half are willing to refuel a vehicle twice as often as usual to reduce vehicle emissions
- About one-third are willing to reduce their current trunk or cargo space by one-half in order to reduce vehicle emissions

In order to understand much of the data presented in this report, it is necessary to understand the design of the questionnaire and the way in which data were collected. The next section provides this essential information.

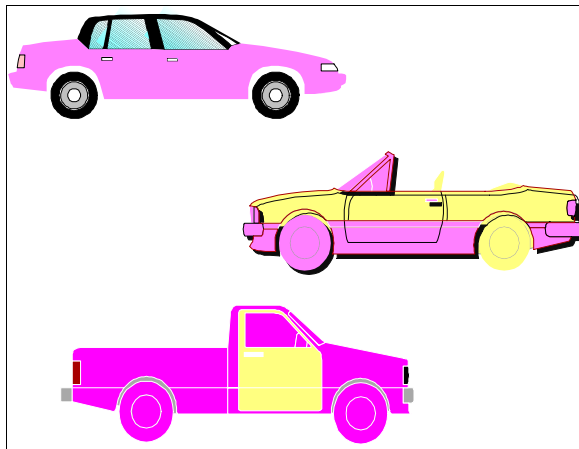
### Design of the Questionnaire

The questionnaire opened with an eligibility question about the number of vehicles in the household. If the household owned or leased one or more vehicles, a question was asked to identify the adult in the household who knew most about the vehicle(s) and how they were used. If this adult was someone other than the initial informant, this person was contacted and the number of vehicles was asked again.

The remainder of the questionnaire fell into three broad categories: 1) vehicle questions, 2) vehicle preference questions, and 3) questions concerning attitudes about pollution and the environment.

## Vehicle Questions

For households with four or fewer vehicles, the main part of the interview began with a series of questions about each vehicle (year, make, model, whether bought new or used, and size and usage of trunk (cargo) space), its regular uses (whether driven to work, school, or as part of a job, and if so, how frequently and how far), and its special uses (overnight trips or whether it was entered into competitions). Questions were also asked about fueling patterns and respondent general satisfaction with the vehicle. These questions were, for the most part, asked in order to select the vehicle that was to serve as the vehicle to be replaced in the vehicle preference section of the questionnaire. Consequently, analysis of these variables is not included in this report. The survey assumed that the least used vehicle was the vehicle with the highest likelihood of being replaced by a modified vehicle.



To reduce respondent burden, the very small number of households with more than four vehicles were asked only about the two vehicles driven the least. This was done because in the vehicle preference section the respondent was asked to choose between a modified vehicle and the vehicle in the household used the least. For households with multiple vehicles, the least used was defined as the one least often fueled. If a tie occurred between two vehicles, it was broken according to which had the least used trunk space, then according to which had the fewest overnight trips, and then by random selection.

Estimates for vehicle preference questions may include bias because of the sample's design. Bias may have been introduced in one of two ways. First, while the least-used household vehicle seems a plausible choice as the most likely vehicle to be a candidate for replacement by a modified vehicle, no data are available to support this conclusion. The household vehicle chosen for the vehicle preference questions might not have been the vehicle that the respondent would have chosen if given the choice. Therefore, with respect to the vehicle population, the study cannot claim to represent preferences over the entire stock, or even over the subset of vehicles most likely to be replaced by modified vehicles. The population that is covered can be described most accurately as the subpopulation of least-used vehicles in U.S. households. Second, the respondent may not have been the most appropriate person to make decisions about the vehicle addressed in the questionnaire. The respondents were chosen on the basis of their knowledge of all the household vehicles, not on the basis of whether or not they were directly responsible for the upkeep and operation of the least-used vehicle. Consequently, the respondent may not have been the household member who was the main driver of the vehicle to be replaced or the member in the position to make purchasing decisions regarding the vehicle. Likewise, the personal characteristics, opinions, and concerns for the environment are those of the respondent and not the main driver of the vehicle to be replaced, except where otherwise stated. This population would most closely represent the subpopulation of most vehicle-knowledgeable persons in U.S. households. With these caveats in mind, some national estimates based on responses about households' least-used vehicles are given below.

### Characteristics of Vehicles to be Replaced

- 73% were domestic vehicles
- 70% were automobiles
- 51% were bought used
- 38% were 1985-1989 models
- 32% were 1990-1994 models
- 70% of consumers were very/extremely satisfied with this vehicle
- 61% were used by someone in the household to commute to work
- 44% were used to make overnight trips

## Vehicle Preference Questions

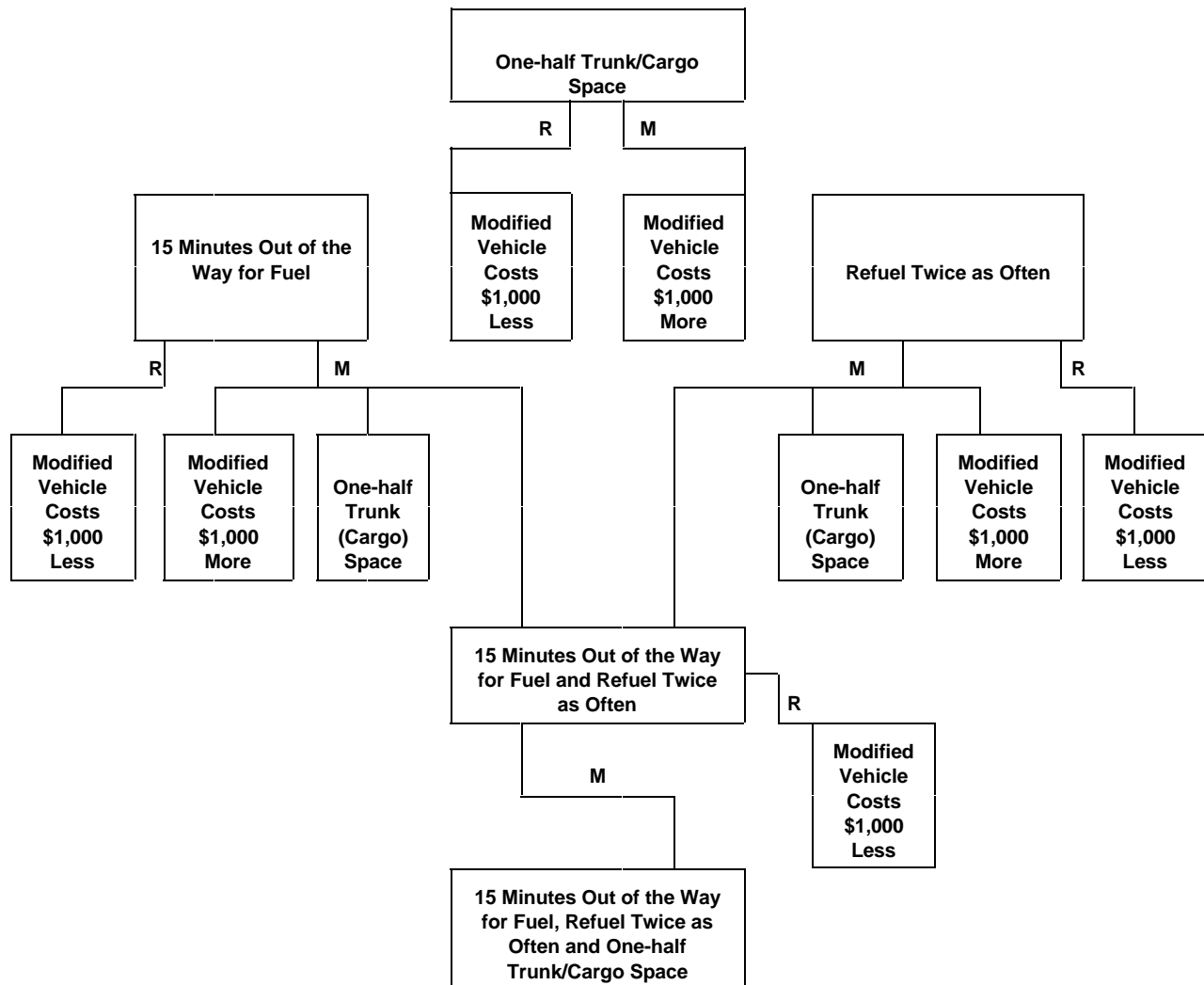
The respondent was asked a series of hypothetical choice questions between a new model of the household's least-used vehicle and a less-polluting modified vehicle that was identical to the regular vehicle except for certain limitations or "penalty" characteristics. The limitations of the modified vehicle are similar to those currently associated with alternative-fuel vehicles (AFV) and imply behavioral changes for the operator. The questionnaire contained three scenarios:

1. The modified vehicle has only one-half the trunk (cargo) space of the regular vehicle.
2. The respondent must drive 15 minutes out of the way to buy fuel for the modified vehicle.
3. The modified vehicle must be refueled twice as often as the regular vehicle.

Respondents were asked to choose which vehicle they would purchase, given each limitation individually and in combination.

Within each individual scenario, respondents who said they would choose the modified vehicle were asked which they would choose if the modified vehicle cost \$1,000 more than the regular vehicle. Respondents who chose the regular vehicle were asked which they would choose if the modified vehicle was \$1,000 less than the regular vehicle. Figure 4.1.1 illustrates the flow of the vehicle preference section of the questionnaire. In the figure, "M" means that the respondent chose the modified vehicle. "R" means that they chose the regular vehicle.

Figure 4.1.1. Flow Chart of the Questionnaire



Source: Energy Information Administration, Office of Energy Markets and End Use, Joint Program in Survey Methodology Consumer Vehicle Preference Survey.

Additionally, for a random half-sample, the modified vehicle was described as producing half as much air pollution as a regular vehicle; for the other half, the modified vehicle was described as producing no air pollution. Although the two categories were general, the modified vehicle that produced no air pollution was intended to represent electric-powered vehicles. The vehicle that produced half as much air pollution as a regular vehicle represented other alternative-fuel vehicles, such as those powered by natural gas, propane, and other non-petroleum fuels.

### Attitudinal Questions

The final section of the questionnaire measured respondent awareness of AFV's and attitudes about air pollution and environmentalism. Questions included ascertained: (1) whether and to what extent respondents had heard of alternative-fuel vehicles, (2) respondents' perception of the relative safety of alternative fuels to gasoline, (3) respondents' concerns about air pollution in their area, and (4) whether and to what extent respondents considered themselves environmentalists.

## **Organization of this Report**

Sections 4.2 and 4.3 address three general topics: (1) consumer characteristics and their general attitudes and concerns about air pollution, (2) prospective vehicle purchasers' receptiveness to behavioral changes they might have to make to operate an alternative-fuel vehicle, and (3) price differentials between conventional vehicles and alternative-fuel vehicles that consumers will accept in making purchasing decisions. The detailed tables for the survey are found in section 4.4. Section 4.5 contains the relative standard errors for the estimates found throughout this section of the report. Data quality and methodology issues are briefly discussed in section 4.6.

## 4.2. Consumer Characteristics, Awareness, and Concerns

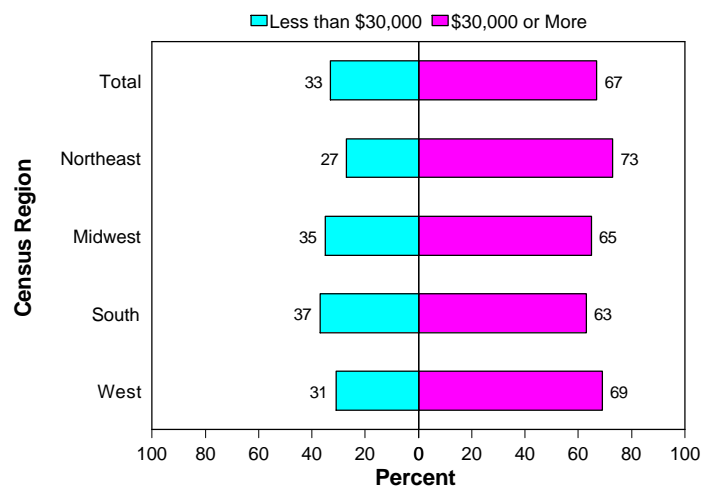
The Consumer Preference Survey contained questions to learn respondent demographic characteristics, consumer knowledge of alternative-fuel vehicles, perception of the relative safety of alternative fuels, and general concerns for the environment.

### Consumer Characteristics

The Consumer Preference Survey found that 39 percent of the telephone household population has one household vehicle, 42 percent has two, 12 percent has three, and 7 percent has four or more. Sixty-seven percent of the population has an average annual household income of \$30,000 or more. For these households, nearly 75 percent owned two or more vehicles. In contrast, 64 percent of households with annual income of less than \$30,000 owned only one vehicle.

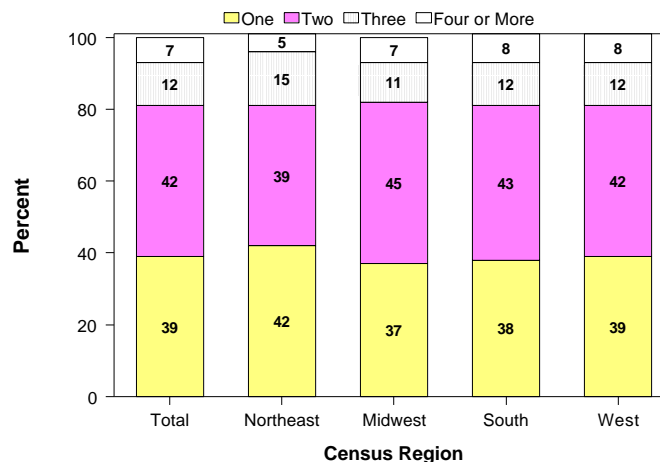
Nineteen percent of the population lives in the Northeast, 25 percent in the Midwest, 35 percent in the South, and 21 percent in the West. Within each Census Region the household annual income is distributed as shown in Figure 4.2.1. The Northeast has the highest percentage of people earning \$30,000 or more annually, and the South has the highest percentage of people who earn less than \$30,000. Most households have one or two vehicles (about 80 percent). The distribution of the number of vehicles is shown in Figure 4.2.2.

**Figure 4.2.1. Household Annual Income by Census Region**



Source: Energy Information Administration, Office of Energy Markets and End Use, Joint Program in Survey Methodology Consumer Vehicle Preference Survey.

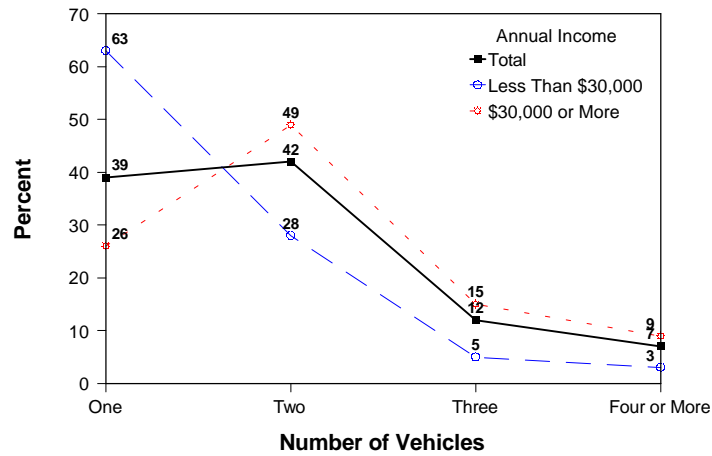
**Figure 4.2.2. Number of Vehicles by Census Region**



Note: Percents may not sum to 100 due to rounding.  
Source: Energy Information Administration, Office of Energy Markets and End Use, Joint Program in Survey Methodology Consumer Vehicle Preference Survey.

The relationship between the number of vehicles and annual income in households is shown in Figure 4.2.3.

**Figure 4.2.3. Household Annual Income by Number of Vehicles**



Source: Energy Information Administration, Office of Energy Markets and End Use, Joint Program in Survey Methodology Consumer Vehicle Preference Survey.

Other consumer characteristic estimates are given below.

### Consumer Characteristics

- 87% used personal vehicles as their main type of transportation
- 67% had household income greater than \$30,000
- 69% lived in single-family detached homes
- 86% had high school or college education
- 59% belonged to household with two persons over 18 years of age
- 85% were white

## Consumer Awareness

Most consumers (85 percent) had heard of alternative-fuel vehicles, although only slightly more than one-half of the population knew more than “just a little” about them. By far, the perception of fuel safety of alternative fuels was strongest for electricity, with 62 percent stating it was a safer vehicle fuel than gasoline. The following summarizes consumers’ awareness of alternative-fuel vehicles and opinions of the relative safety of alternative fuels.

### Consumer Awareness and Opinions

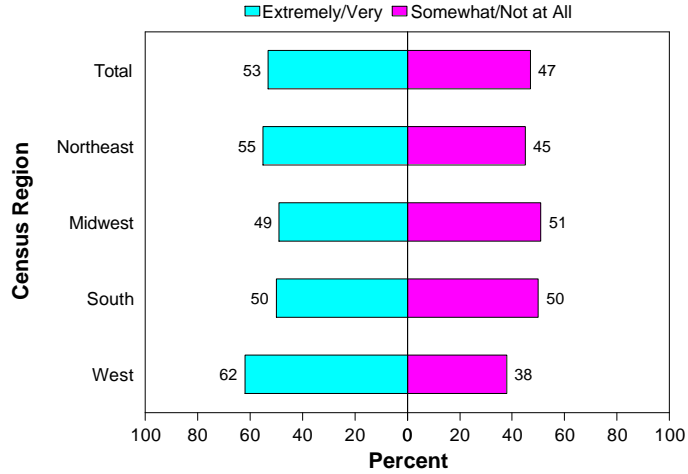
- 85% had heard of alternative-fuel vehicles
- 18% felt that natural gas was a safer vehicle fuel than gasoline
- 29% felt that gasoline was a safer vehicle fuel than natural gas
- 11% felt that propane was a safer vehicle fuel than gasoline
- 41% felt that gasoline was a safer vehicle fuel than propane
- 62% felt that electricity was a safer vehicle fuel than gasoline
- 12% felt that gasoline was a safer vehicle fuel than electricity



## Consumer Concern

Concern for the environment was greatest in the Northeast and West Census regions (Figure 4.2.4).

**Figure 4.2.4. Level of Concern for the Environment by Census Region**



Source: Energy Information Administration, Office of Energy Markets and End Use, Joint Program in Survey Methodology Consumer Vehicle Preference Survey.

Overall, consumers are concerned about the environment and consider themselves environmentalists; however, of the 48 percent who consider themselves environmentalists, only 22 percent are members of any environmental organization.

**Consumer Concern for Environment**

77% were concerned about outdoor air pollution in their area  
 Of these, 53% were extremely/very concerned  
 61% feel that vehicle emissions are extremely/very dangerous  
 48% consider themselves to be environmentalists

## 4.3. Consumer Receptiveness to Behavioral Changes and Price Differentials

Respondents were asked whether they would purchase a new model of the household's least used vehicle, or a less-polluting modified vehicle (AFV) identical to the regular vehicle except for certain limitations that might require respondents to change their normal behavior associated with operating a vehicle. Three simple cases were first addressed: the modified vehicle would have only half the trunk space of the regular vehicle; the modified vehicle would require refueling at a station that was 15 minutes out of the way for the respondent; and, the modified vehicle would need to be refueled twice as often as the regular vehicle. If the respondent answered that they would choose the modified vehicle with the single limitation over the regular vehicle, then they were asked about their vehicle choice if the modified vehicle had any combination of these same three limitations. Additionally, in all the single limitation scenarios, respondents were asked a question regarding the price of the modified vehicle to learn if a \$1,000 difference in price would influence the respondents' original vehicle preference. Respondents who had chosen the regular vehicle were asked their preference if the modified vehicle cost \$1,000 less. Respondents who chose the modified vehicle were asked their preference if the modified vehicle cost \$1,000 more.

### Single Vehicle Limitations

The following table presents consumer vehicle preferences, expressed in percents, when given three possible modified vehicle limitations.

**Table 4.3.1. Overview of Vehicle Preference by Modified Vehicle Limitations, 1994**  
(Percent)

Vehicle Limitation	Modified Vehicle Pollutes Half as Much as Regular Vehicle			Modified Vehicle Does Not Pollute		
	Regular Vehicle	Modified Vehicle	Don't Know	Regular Vehicle	Modified Vehicle	Don't Know
<b>One-half Trunk (Cargo) Space</b> .....	60	33	Q	55	35	Q
<b>15 Minutes Out of the Way to Refuel</b> .....	55	41	Q	44	51	Q
<b>Refuel Twice as Often</b> ...	42	54	Q	37	57	Q

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, Joint Program in Survey Methodology Consumer Vehicle Preference Survey.

Between the two options of giving up one-half of the trunk (cargo) space of a regular vehicle and having to refuel the modified vehicle twice as often, consumers in both pollution level groups were clearly more willing to refuel more often. Twenty-one percent more consumers were willing to refuel twice as often than were willing to give up trunk space when the modified vehicle polluted half as much as a regular vehicle, 22 percent more if the modified vehicle did not pollute at all. Not much can be said, however, concerning consumer willingness to drive 15 minutes out of the way to refuel in comparison to the other two options. The differences were statistically insignificant.

With one exception, within each limitation scenario, differences among the pollution level groups' vehicle choice were statistically insignificant. The exception occurred when the respondent had to drive 15 minutes out of the way to refuel the

modified vehicle. Eleven percent fewer respondents chose the regular vehicle if the modified vehicle did not pollute than if it polluted half as much as a regular vehicle.

The following sections look at the behavioral changes and the effect of price differentials on vehicle choice associated with each of the vehicle limitations.

## Giving Up Trunk Space

Potential vehicle purchasers were most reluctant to give up half the amount of trunk (cargo) space of their current vehicle even if it meant halving or eliminating the pollution produced in operating a vehicle. Vehicle choice was related to the size of the trunk of the consumer's current vehicle (Table 4.3.2).

**Table 4.3.2. Vehicle Preference Regarding Loss of One-Half Trunk Space, by Size of Current Vehicle Trunk, 1994**  
(Percent)

Trunk Size	Modified Vehicle Pollutes Half as Much as Regular Vehicle			Modified Vehicle Does Not Pollute		
	Regular Vehicle	Modified Vehicle	Don't Know	Regular Vehicle	Modified Vehicle	Don't Know
Large .....	58	34	Q	48	40	Q
Medium .....	65	Q	Q	54	Q	Q
Small .....	44	51	Q	Q	60	Q
No Trunk .....	66	29	Q	71	Q	Q

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, Joint Program in Survey Methodology Consumer Vehicle Preference Survey.

As expected, those who currently had large or medium-sized trunks were less willing to replace their vehicle with one with only one-half the trunk space no matter how much pollution was reduced. This result suggests that a large trunk may have been an important factor in the purchasing decision of their current vehicle, and it continued to be a deciding factor in the selection of a new vehicle. Consumers whose current vehicles had small trunks were more likely to choose the modified vehicle, perhaps because trunk space was not as important as other considerations in their vehicle-purchasing decision.

A result that appears surprising is that the majority of respondents who reported that their current vehicle had no trunk at all were unwilling to buy the modified vehicle. The explanation lies in the wording of the trunk size and preference questions. The question concerning current vehicle trunk size was asked about the space contained in the trunk of the vehicle alone, while the vehicle preference question included both trunk space and cargo space. Therefore, a respondent who answered that the current vehicle had no trunk most often had a truck, van, station-wagon, or sport-utility vehicle; all have cargo space but no trunk. In fact, about 70 percent of those who stated that their current vehicle had no trunk were referring to one of these types of vehicles. Since these vehicles are often purchased for their hauling capacity, it makes sense that reducing the cargo space by one-half would not be a compromise many would be willing to make. For those respondents who were not referring to one of these types of vehicles (30 percent), it is feasible that they were referring to an automobile with a hatchback or whose back seat was used for cargo rather than passengers. It could also be that the respondent simply would not purchase another vehicle without a trunk or other cargo space again.

**Price Differential.** In both price cases, trunk (cargo) space seemed more important to consumers than \$1,000. Consumers who were willing to give up trunk (cargo) space were not willing to pay \$1,000 extra to do so. The question of how much pollution was reduced had little impact (Table 4.3.3). Consumers who chose the regular vehicle originally were not swayed

to choose the modified vehicle by \$1,000. The price reduction was little incentive to accept the reduction in trunk space for most people (Table 4.3.3).

**Table 4.3.3. Vehicle Preference Incorporating Price Differential Based on Original Vehicle Choice, 1994 (Percent)**

Differential Cost of Modified Vehicle	Modified Vehicle Pollutes Half as Much as Regular Vehicle			Modified Vehicle Does Not Pollute		
	Regular Vehicle	Modified Vehicle	Don't Know	Regular Vehicle	Modified Vehicle	Don't Know
\$1,000 More . . . . .	68	26	Q	69	27	Q
\$1,000 Less . . . . .	88	Q	Q	79	Q	Q

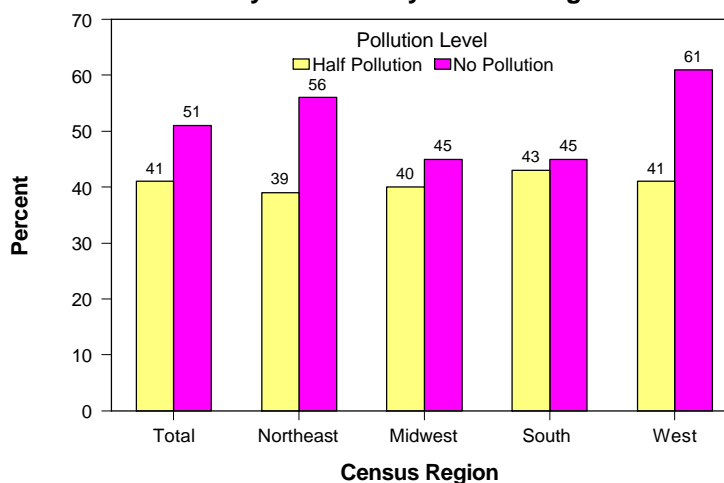
Q = Data withheld either because the Relative Standard Error (RSE) was greater than 50 percent or fewer than 10 households were sampled.

Source: Energy Information Administration, Office of Energy Markets and End Use, Joint Program in Survey Methodology Consumer Vehicle Preference Survey.

### Driving 15 Minutes Out of the Way to Refuel

Respondents were nearly equally divided about whether they were willing to drive a short distance out of their way for fuel in order to drive a vehicle that pollutes less. Unlike giving up trunk space, willingness to purchase the modified vehicle did differ between the two pollution levels of the modified vehicle. Forty-one percent of the group given the half-polluting modified vehicle scenario and 51 percent of the non-polluting vehicle group were willing to travel 15 minutes out of their way. Consumers offered a vehicle that did not pollute at all chose the modified vehicle at a higher rate than those who were offered a vehicle that polluted only half as much. This trend was especially strong among respondents who live in the West or the Northeast. Figure 4.3.1 illustrates the difference between the two groups by Census region.

**Figure 4.3.1. Consumers Willing to Drive 15 Minutes Out of the Way to Refuel by Census Region**



Source: Energy Information Administration, Office of Energy Markets and End Use, Joint Program in Survey Methodology Consumer Vehicle Preference Survey.

Respondents' willingness to drive 15 minutes out of the way to refuel did not appear to be affected by their usual frequency of gas purchase (Table 4.3.4).

**Table 4.3.4. Willingness to Drive 15 Minutes Out of the Way to Refuel by Frequency of Usual Gas Purchase, 1994**  
(Percent)

Frequency of Gas Purchase	Modified Vehicle Pollutes Half as Much as Regular Vehicle			Modified Vehicle Does Not Pollute		
	Regular Vehicle	Modified Vehicle	Don't Know	Regular Vehicle	Modified Vehicle	Don't Know
Less than Once a Week .....	58	38	Q	45	51	Q
Once a Week .....	53	43	Q	42	51	Q
More than Once a Week .....	52	46	Q	45	46	Q

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, Joint Program in Survey Methodology Consumer Vehicle Preference Survey.

**Price Differential.** Nearly one-third of respondents who chose the regular vehicle over the modified vehicle that has to be driven 15 minutes out of the way to refuel said they would choose the modified vehicle if it cost \$1,000 less. There was practically no difference among the pollution-reduction level groups (Table 4.3.5).

On the other hand, when those who originally chose the modified vehicle were asked if they would pay an additional \$1,000 for the vehicle, over one-third said they would not. A larger percentage of potential consumers was “lost” because of a price increase than was “gained” from a price decrease (Table 4.3.5).

**Table 4.3.5. Vehicle Preference Incorporating Price Differential Based on Original Vehicle Choice, 1994**  
(Percent)

Differential Cost of Modified Vehicle	Modified Vehicle Pollutes Half as Much as Regular Vehicle			Modified Vehicle Does Not Pollute		
	Regular Vehicle	Modified Vehicle	Don't Know	Regular Vehicle	Modified Vehicle	Don't Know
\$1,000 More .....	40	54	Q	33	61	Q
\$1,000 Less .....	68	29	Q	68	26	Q

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, Joint Program in Survey Methodology Consumer Vehicle Preference Survey.

## Refueling Twice as Often

Of the limitations specified in this study for the modified vehicle, the one that respondents seemed most willing to accept in order to reduce the amount of pollution emitted was refueling twice as often. More than half chose the modified vehicle, 54 percent among those offered a vehicle polluting half as much, and 57 percent among those offered the choice of a nonpolluting vehicle. Frequency of regular fuel purchases affected willingness to purchase the modified vehicle only minimally (Table 4.3.6). In the non-polluting modified vehicle cases, people who fueled once a week or more were more willing to refuel twice as often than those who refueled less than once a week.

**Table 4.3.6. Willingness Refuel Twice as Often by Frequency of Usual Gas Purchase, 1994**  
(Percent)

Frequency of Gas Purchase	Modified Vehicle Pollutes Half as Much as Regular Vehicle			Modified Vehicle Does Not Pollute		
	Regular Vehicle	Modified Vehicle	Don't Know	Regular Vehicle	Modified Vehicle	Don't Know
Less than Once a Week .....	40	55	Q	39	53	Q
Once a Week .....	41	54	Q	33	61	Q
More than Once a Week .....	47	52	Q	40	56	Q

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, Joint Program in Survey Methodology Consumer Vehicle Preference Survey.

**Price Differential.** The price differential affected the original purchasing decision in much the same way as it affected the scenario requiring drivers to drive 15 minutes out of the way to refuel. The \$1,000 price increase persuaded more people to change their choice from the modified vehicle to the regular one than the \$1,000 price decrease persuaded people to choose the modified vehicle after choosing the regular one (Table 4.3.7).

**Table 4.3.7. Vehicle Preference Incorporating Price Differential Based on Original Vehicle Choice, 1994**  
(Percent)

Differential Cost of Modified Vehicle	Modified Vehicle Pollutes Half as Much as Regular Vehicle			Modified Vehicle Does Not Pollute		
	Regular Vehicle	Modified Vehicle	Don't Know	Regular Vehicle	Modified Vehicle	Don't Know
\$1,000 More .....	37	56	Q	31	63	Q
\$1,000 Less .....	67	25	Q	72	22	Q

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, Joint Program in Survey Methodology Consumer Vehicle Preference Survey.

## Combinations of Vehicle Limitations

Table 4.3.8 presents vehicle preference estimates given different combinations of vehicle limitations. Only those who responded that they would choose the modified vehicle given the single limitation were asked about combinations of limitations. Therefore, the populations these estimates represent are depleted populations of the total (Figure 4.1.1).

**Table 4.3.8. Overview of Vehicle Preference by Combinations of Modified Vehicle Limitations for Depleted Populations, 1994**  
(Percent)

Vehicle Limitation	Modified Vehicle Pollutes Half as Much as Regular Vehicle			Modified Vehicle Does Not Pollute		
	Regular Vehicle	Modified Vehicle	Don't Know	Regular Vehicle	Modified Vehicle	Don't Know
15 Minutes Out of the Way and One-half Trunk (Cargo) Space	49	48	Q	52	45	Q
Refuel Twice as Often and One-half Trunk (Cargo) Space . . . .	51	47	Q	46	52	Q
15 Minutes Out of the Way and Refuel Twice as Often . . . . .	24	75	Q	20	76	Q
15 Minutes Out of the Way, Refuel Twice as Often and One-half Trunk (Cargo) Space . . . .	38	61	Q	34	62	Q

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, Joint Program in Survey Methodology Consumer Vehicle Preference Survey.

The addition of limited trunk or cargo space in the modified vehicle lost, by far, the largest proportion of consumers willing to purchase a modified vehicle. How much pollution reduction the modified vehicle attained seemed to make little difference in vehicle choice.

Consumers who were willing to drive 15 minutes out of the way and refuel twice as often individually, were usually willing to do so in combination (75 percent and 76 percent). Of these, the addition of the loss of trunk (cargo) space lost a somewhat smaller proportion of people willing to buy the modified vehicle than in the double combinations involving trunk (cargo) space.

## Conclusions

Overall, consumers seem fairly willing to accept vehicles with characteristics of alternative-fuel vehicles. The scenarios of having to drive 15 minutes out of the way to fuel the modified vehicle and having to refuel the modified vehicle twice as often gained wider acceptance than the scenario in which trunk (cargo) space was reduced. Perhaps, this suggests that particular attention should be paid to solving the problem of limited trunk (cargo) space associated with those AFV's that require a great amount of space for fuel storage. There seemed to be a difference in vehicle preference when a price differential was introduced. More respondents were dissuaded from purchasing the modified vehicle if it cost \$1,000 more than were persuaded to purchase the modified vehicle if it cost \$1,000 less. For the most part, consumer preferences were not affected by how much pollution was reduced.

## 4.6. Data Quality

Most of the information concerning the sample selection and sample weights found in the following pages is excerpted from “Methods Report for Joint Program in Survey Methodology Study of Public Attitudes About Alternative Fuel Vehicles” provided to EIA by the University of Maryland.

### Sample Selection

The eligible population for the study consisted of telephone households in the continental United States that owned or leased one or more motor vehicles driven on a regular basis. The respondent was the adult in the household most knowledgeable about the use of the household’s vehicles.

The sample was selected using the Brick-Waksberg (1991)<sup>1</sup> modification of the Mitofsky-Waksberg (Waksberg 1978)<sup>2</sup> Random Digit dialing two-stage cluster design. A frame of all possible clusters, defined as banks of 100 telephone numbers, was generated (stratified by Census Region) from the January 1994 Bellcore Master Data File, a listing of all area code exchange combinations in the United States. A systematic selection of clusters was then made from this frame. One telephone number was randomly generated in each selected cluster and called. If it was a household, the cluster was retained; if not, the cluster was excluded.

A total of 543 clusters was retained and eight telephone numbers sampled within each. Since clusters are selected with probabilities proportionate to size and the number of second-stage households (households contained within the retained clusters) can vary by cluster, the Brick-Waksberg design does not produce an equal probability sample. The design requires weighting to adjust for these unequal probabilities.

Although the method does not achieve an equal probability sample, it has operational advantages. Unlike the Mitofsky-Waksberg design, the Brick-Waksberg method does not require sequential replacement of nonresidential telephone numbers. Instead, the total sample is generated and released based on estimates of nonresidential telephone numbers and the anticipated response rate. In this way, the cluster size is achieved without the cost of replacing non-households and nonworking numbers as they are identified.

### Response Rate

A total of 4,344 telephone numbers was selected from the 543 clusters. The disposition of these numbers is summarized in Table 4.6.1.

<sup>1</sup> Michael J. Brick and Joseph Waksberg, “Avoiding Sequential Sampling with Random Digit Dialing,” *Survey Methodology* (1991), pp. 17, 27-41.

<sup>2</sup> Joseph Waksberg, “Sampling Methods for Random Digit Dialing,” *Journal of the American Statistical Association* (1978), pp. 73, 40-46.



**Table 4.6.1. Disposition of Selected Telephone Numbers**

Phone Numbers		Households		Known Eligible	
Non-households	1,638	Known Ineligible	219	Interviews	1,712
Never Answered	90	Unknown Eligibility	493	Refusals	111
Households	2,616	Known Eligible	1,904	Not-at-homes	60
Total	4,344	Total	2,616	Misc. Problems <sup>a</sup>	21
				Total	1,904

<sup>a</sup>Language, illness, or hearing problems.

Of the 4,344 numbers, 1,638 were non-households (businesses and non-working numbers). In addition, 90 numbers were never answered after at least 20 dialings and were assumed to be non-households.

Of the 2,616 identified households, eligibility (whether the household owned or leased a vehicle) was determined for 2,123, of which 1,904 were eligible and 219 were ineligible. For 493 cases, eligibility could not be determined mainly because of refusals. The response rate is the total number of interviews divided by the number of eligible cases. The unknown eligibility category can be treated in various ways. The most conservative approach, treating 100 percent of such cases as eligible, gives a response rate of 71.4 percent. A more realistic response rate can be calculated by assuming the same proportion of these households had a vehicle (89.7 percent) as for the 2,123 households for which eligibility was determined. This response rate is 73.0 percent.

## Sample Weights

Two design weights were used to adjust for unequal probabilities of selection: (1) the inverse of the number of telephone numbers in the household and (2) the ratio of the mean number of households per cluster to the number of households in the particular cluster. (In eight cases, this weight was trimmed so that it did not exceed three times the mean weight.)

There are also two post-stratification weights: (1) a geographic weight to adjust the sample distribution by major Census region to the distribution of all households with cars and (2) a cluster weight that is the ratio of households with cars (in the cluster) to households with cars that meet the regular use screening criterion. (Most often, this weight equals 1.)

Finally, an additional factor sets the weighted sample size equal to the unweighted sample size. All weights and the adjustment factor are combined into one variable (variable name = WEIGHT) and attached to the record for each case in the data set.

## Nonsampling and Sampling Error

The statistics in this report are estimates of population values. These estimates are based upon a randomly chosen subset of the entire population of households with vehicles in the contiguous United States. As a result, estimates always differ from the true population values. The differences between estimated values and the actual population values are of two types, nonsampling errors and sampling errors. Nonsampling errors are errors of the survey process that can result from difficulties such as unit nonresponse or item nonresponse, inaccuracies in data collection, or incomplete coverage in the design of the sampling frame. Sampling error is a result of the survey design, due to the fact that data are obtained from a subset of the population of interest, rather than all members.

## Nonsampling Errors / Adjustment for Item Nonresponse

Item nonresponse occurs when an item (or several items) is missing in an otherwise completed questionnaire, possibly because the respondent does not know or, less frequently, refuses to give the answer to a particular question. Item nonresponse is also recorded when the interviewer does not ask the question or does not record the answer during the interview. For eight respondent demographic characteristics and 15 vehicle characteristic variables, values were imputed for nonresponse. No imputations were made for missing preference or attitudinal items. Imputations were made using a technique known as “hot-deck” imputation. In hot-decking, when a certain response is missing for a given respondent, another respondent, called a “donor,” is randomly chosen to furnish its reported value for that missing item. That value is then assigned to the respondent with item nonresponse.

To serve as a donor, the respondent has to be similar to the nonrespondent in characteristics correlated with the missing item. This procedure was used to reduce the bias caused by different nonresponse rates for a particular item among different types of respondents. Characteristics used to define “similar” depended on the nature of the item to be imputed. The most frequently used characteristics were: Census region, State, age of the respondent, household income, type of home, and education of the respondent. This analysis used a vector hot-deck procedure. With this procedure, the respondent that donated a particular item to a receiver also donated certain related items if any of these were missing. Thus, a vector of values, rather than a single value, is copied from the donor to the receiver. This helps to keep the hot-decked values internally consistent, avoiding the generation of implausible combinations of respondent or vehicle characteristics.

## Sampling Error

Sampling error occurs because the selected sample represents only one of the possible samples that could be selected under the same survey specifications. The estimated values are developed from one of the many possible samples that could be drawn and, therefore, will differ from true population values that would be obtained from a complete enumeration. Each possible sample yields its own estimate of the true population values, with the differences attributable to the particular set of cases selected in each sample.

One measure of the variability of a survey estimate due to the sampling process is the average magnitude of the difference between the values of the estimate for individual samples and the average value of the estimate over all samples of the same size based on the same design. In other words, sampling error is a measure of the variability of an estimate over all comparable samples, one of which was drawn. The average magnitude of the sampling error is measured by the standard error of an estimate. The standard error is the root-mean-square measure of average difference over all possible samples.

Most statistical packages assume simple random sampling. This study employed a more complex design. Therefore, in estimating sampling errors, a method is needed to take account of the sample design and the use of weights. SUDAAN (Survey Data Analysis) was used to compute the design effect (the ratio of the variance reflecting design complexities to the variance of a simple random sample of the same size) on 21 variables (five demographic, six attitudinal, and ten behavioral). The design effect was estimated at 1.13. Standard errors were computed by multiplying the standard error associated with a simple random sample design by the design effect as follows:

$$DE \times \sqrt{\frac{PCT \times (1 - PCT)}{n}} = S_{PCT}$$

where DE is the design effect, PCT is the estimate (in the form of a percent of the total), and  $S_{PCT}$  is the standard error of the estimate.

In this report, standard errors were expressed as relative standard errors (RSE). The relative standard error (RSE) is the standard error expressed as a percent of the estimate, that is, for an estimate PCT:

$$\frac{S_{PCT}}{PCT} = RSE_{PCT}$$

Estimates with RSE greater than 50 percent were withheld from the published tables due to their lack of precision. Estimates were also withheld if the number of observations was less than 10.

**Using the RSE.** To determine the standard error for an estimate, multiply the RSE for the estimate, shown in the tables in this appendix, by the estimate. The standard error can be used to construct confidence intervals and to perform hypothesis tests by using standard statistical methods.

### Calculating the Confidence Range

To calculate the 95-percent confidence range (that range which covers the true value of the estimate with 95 percent confidence):

1. Multiply the standard error by 1.96
2. Subtract the result of Step 1 from the given estimate to determine the bottom of the range
3. Add the result of Step 1 to the given estimate to determine the top of the range.

### Measuring Statistical Significance

To determine if the difference between any two estimates in this report are statistically significant:

1. Calculate the standard error of each estimate
2. Square the standard error of each estimate
3. Add the two values from Step 2
4. Take the square root of the value in Step 3
5. Multiply the value in Step 4 by 1.96

If the value in Step 5 is less than the difference in the estimates, the difference between the estimates is statistically significant.