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Authors
Nesbitt, Kevin
Sperling, Daniel

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MYTHS REGARDING ALTERNATIVE FUEL VEHICLE DEMAND BY LIGHT-DUTY VEHICLE FLEETS

KEVIN NESBITT* and DANIEL SPERLING
Institute of Transportation Studies, University of California, Davis, CA 95616, U.S.A.

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Abstract—Public and private vehicle fleets have long been targeted as an ideal initial market for alternative fuel vehicles (AFVs). We examine seven widely accepted hypotheses regarding the potential fleet market for AFVs. The hypotheses are tested using data and information collected from focus group sessions, one-on-one interviews with fleet operators, and a large two-part survey administered to over 2700 California fleets, as well as secondary sources. We find a large number of misconceptions by both fleet operators and policymakers that lead to distorted expectations and ineffective policies regarding the purchase and use of AFVs by fleets.

Keywords: Alternative fuel vehicles (AFVs), fleet, market, alternative fuels

1. INTRODUCTION

Vehicle fleets operated by businesses and government agencies are a tantalizing market for alternative fuel vehicles (AFVs). Widescale use of AFVs in fleet applications could provide the critical mass necessary to initiate development of a widespread refueling infrastructure and mass production of AFVS. Purchase patterns and vehicle operating practices make fleets a favorite target for policymakers who wish to use AFVs as a means to reduce transportation emissions and petroleum consumption. Below are a few of the reasons why policymakers perceive fleets to be an attractive initial market for alternative fuel vehicles:

- Fleet vehicles are, on average, driven twice as far as household vehicles on an annual basis (Federal Highway Administration, 1992; Miau *et al*., 1992; U. S. Department of Energy, 1993; Davis, 1995). Therefore, the energy and emissions benefits of using an AFV are greater than if a household vehicle were supplanted with the same AFV. Furthermore, most fleet mileage is typically accumulated in urban areas where emission reductions are most needed.
- Fleet vehicles constitute approximately one quarter of all light-duty vehicle sales in the U.S. each year, even though they represent only 6% of all registered light-duty vehicles (Miau *et al*., 1992; Bobit, 1997). High vehicle turnover facilitates rapid penetration of AFVs into the vehicle market. Fleets also provide a conduit to the household vehicle market since most fleet vehicles are eventually sold to households.
- A significant number of fleet vehicle purchases are by government agencies or regulated companies, which are politically more compliant than other market sectors. Besides being accustomed to government rules and regulations, these organizations expect to play a key leadership role by demonstrating practical applications for AFVs.
- Targeting fleets is very efficient because relatively few decision makers control a disproportionately large number of vehicles. Less than 2% of fleets account for approximately 35% of all light-duty fleet vehicles (Bobit, 1997).
- Many fleet vehicles have fixed daily routes and are regularly fueled at a one location. These operating parameters are conducive to using AFVs in the absence of a public refueling station network.

*Author for correspondence (presently at CALSTART 3601 Empire Avenue, Burbank, CA 91505).

Based on these facile observations, federal, state and local governments in the U.S. have adopted rules that require public and private organizations to incorporate low-emission alternative fuel vehicles into their fleets. The 1992 Energy Policy Act (EPAct) and the 1990 Clean Air Act Amendments (CAAA) both have provisions requiring fleets throughout the nation to purchase an increasing number of alternative fuel or clean fuel vehicles over the next several years. The CAAA Clean Fuel Fleet Program targets fleets of 10 or more vehicles in air quality non-attainment areas while the EPAct Fleet Requirement Program—aimed at reducing petroleum consumption—affects fleets in 122 cities that operate at least 20 light-duty vehicles (both laws apply only to vehicles that are 'capable of central refueling'). It has been estimated that these purchase requirements could put over 1 million clean vehicles in fleet applications by the year 2000 (U. S. Environmental Protection Agency, 1991; Hu and Wang, 1996; Hu *et al*., 1996; Vyas and Wang, 1996; U. S. Department of Energy, 1997). In addition to the federal requirements, 25 states have legislative mandates or executive directives requiring the conversion or purchase of alternative fuel vehicles for state government fleets. Many U.S. cities also have purchase requirements for their municipal fleets.

Several misconceptions regarding fleet behavior could diminish the effectiveness of AFV purchase mandates. This paper explores these misconceptions by examining several important issues regarding the fleet market for AFVs. These issues are structured around seven hypotheses which we test using data and information collected from focus group sessions, one-on-one interviews with fleet operators, and a large two-part survey administered to over 2700 California fleets, as well as other secondary sources (Nesbitt, 1996).

2. RESEARCH METHODS AND DATA COLLECTION

Aggregate descriptive data for fleets are poor because fleets have no standardized reporting requirements, are highly diverse, and not represented by any single trade organization. Behavioral data, indicating how and why fleets purchase and use vehicles, is even more fragmented and unreliable. In 1993, we undertook a 3-year study to improve our understanding of the purchase behavior of light-duty vehicle fleets with respect to alternative fuels. This paper examines broad misconceptions we discovered; a subsequent paper will provide a detailed analysis of fleet purchase and usage behavior.

First we conducted 39 one-on-one interviews and seven focus groups with 59 individuals who played major roles in the fleet management and purchase decisions of their organizations. They were specifically recruited from a variety of organizations and management positions. We had hypothesized, and it was confirmed in the interviews and focus groups, that most previous AFV fleet market studies were flawed in assuming that the fleet manager alone would make all decisions pertaining to the acquisition of alternative fuel vehicles. Because of the importance of such purchase decisions, in terms of the number of people affected, the resources involved, and the precedents set, we found that several individuals from the same organization generally play substantive roles in the AFV purchase decision, especially in the initial purchases.

Interviewees and participants in the focus groups represented a wide cross-section of businesses, government agencies, utility companies, and nonprofit organizations. Fleets varied in size, type, and function. Small business fleets (less than 10 vehicles) are often ignored in fleet data and market studies, but were specifically included here since they account for an estimated 14% of all fleet-operated vehicles and are the fastest growing segment of the fleet population (Energy Information Administration, 1996a; Bobit, 1997). Interviews and focus groups were conducted in the Sacramento and Los Angeles regions, the two metropolitan areas in California most aggressively introducing AFVs into fleets. (Videotapes of several other AFV fleet focus group sessions conducted by the San Diego Gas and Electric Company were also reviewed.)

Building upon insights gained in the focus groups and interviews, we helped design a two-part survey administered by the University of California, Irvine (Golob *et al*., 1997). The first part of the survey comprised a computer-aided telephone interview (CATI) administered to 2715 organizations throughout California that operated at least 10 light-duty vehicles. Of these organizations, 2131 completed a follow-up mail questionnaire that included detailed questions regarding the purchase and use of alternative fuel vehicles. This equates to a response rate of 78%, which is extraordinarily high for mail surveys administered to fleets.

3. FINDINGS

Seven widely-accepted hypotheses regarding the near-term market for AFVs are specified below. We find them all to be largely mistaken—and thus myths. Rejection of the first four implies that the fleet market for AFVs has been overstated, while rejection of the latter three suggests that purchase decisions will be different and possibly more positive than otherwise expected . The net effect is uncertain, except to indicate that a better understanding of fleet behavior is needed in order to design and implement effective public policy regarding the use of AFVs in fleet applications.

3.1. Hypothesis 1: Refueling practices reflect a fleet's ability to use alternative fuel vehicles

One of the most frequently cited rationales for targeting fleets is that they often refuel their vehicles at one location. Central refueling could potentially mitigate the 'chicken-or-egg' quandary of marketing AFVs before a fuels infrastructure is established. Policymakers commonly use central fueling as a proxy for a fleet's ability to use AFVs. Most clean-fuel fleet mandates cover only fleet vehicles that are 'capable of central refueling.'

In reality, the capacity for central refueling gives little indication of a fleet's ability to use AFVs. In fact, central fueling may signal a fleet's inability to purchase certain types of alternative fuel vehicles. Light-duty fleets that centrally refuel on-site typically do so because they have high travel demands and, therefore, can significantly reduce fuel costs by purchasing petroleum in bulk. But high travel demands preclude the use of most AFVs, which have shorter ranges and limited refueling opportunities.

Moreover, of the fleets that do centrally refuel—34% of the business fleets and 78% of the public fleets in our mail survey—few do so exclusively (Easton Consultants, 1991; Runzheimer International, 1993a,b,c; Energy Information Administration, 1995, 1996b). Of the organizations participating in our focus groups and interviews, none had even one vehicle that was refueled at a single location 100% of the time. Most fleets that centrally refuel rely on outside sources for at least 15% of their refueling needs (Easton Consultants, 1991; Runzheimer International, 1991). Even an occasional need to refuel off-site could render certain types of AFVs impractical for many fleets.

Therefore, neither central refueling nor average daily vehicle mileage are sufficient criteria for determining a fleet's ability to use a dedicated AFV. Other factors need to be taken into consideration, such as whether or not the fleet vehicles operate on fixed daily routes, whether another fleet vehicle with a longer range can be substituted for occasional high mileage needs, and whether fleet operators would be willing to make those substitutions. Unfortunately, no such data are available.

Furthermore, it is not likely that more fleets will adopt central refueling practices. Twenty-four percent of the fleets in our mail survey which currently do not have on-site refueling stated that it was not physically possible to install such facilities, mainly because of space constraints. In fact, it was explained in our focus groups and interviews that many fleets let company employees drive vehicles home at night because available parking space is limited. Surveys show that well over half of all business fleets send at least some vehicles home with employees (Runzheimer International, 1993b; Energy Information Administration, 1995).

The central refueling criterion specified in AFV fleet mandates may, in fact, expedite a growing trend away from central refueling. Underground fuel storage tanks have decreased in number by almost 50% since 1989 due to U.S. Environmental Protection Agency regulations and liability issues concerning fuel leakage (Wiegler, 1997). These federal regulations require fleets to purchase insurance against tank leakage and take costly measures to protect against spillage, overfill, and tank corrosion. The last of these measures goes into effect 22 December, 1998 at which time fleets will have to decide whether to comply or remove their underground fuel tanks. Alternative fuel vehicle purchase mandates will likely expedite this trend away from on-site central refueling as fleets look for ways to circumvent AFV purchase requirements by reducing the number of vehicles 'capable of central refueling'. This strategy was brought up several times in our focus group sessions. In fact, 9% of the fleets in our CATI survey had already removed their on-site refueling facility.

3.2. Hypothesis 2: Fleets are better suited to use AFVs because of in-house maintenance capabilities

Although not stipulated by fleet mandates, in-house maintenance is another common argument for targeting fleets. Indeed, a large share of fleets do perform their own maintenance and repairs: 39% of the business fleets (with 10+ vehicles) and 78% of the local government fleets, in our mail survey. [Other studies find that state and federal government fleets are comparable to local fleets in performing in-house maintenance and repairs (Miau *et al.*, 1992; Runzheimer International, 1993a,c)]. It is reasoned that these fleets are more capable of dealing with special AFV maintenance needs, and that vehicle downtime can be minimized because spare parts can be stockpiled for quick repair and they need not depend on outside AFV repair services. In fact, standardization—buying all the same vehicle model—is a common fleet strategy for reducing vehicle downtime and cost because parts can be interchanged between vehicles and purchased and stocked in large quantities for quick repairs.

However, like central refueling, there is a trend away from in-house maintenance (Runzheimer International, 1991Runzheimer International, 1993c). This trend is due largely to better manufacturer warranties that have reduced the need for in-house services. Although only 10% of business fleets currently purchase extended warranties for gasoline vehicles (Runzheimer International, 1993c), 63% of our mail survey respondents felt such warranties would be 'very important' in the AFV purchase decision.

Fleet operators anticipate some vehicle repair needs. Only 14% of our mail survey respondents believe compressed natural gas vehicles are as reliable as gasoline vehicles and 38% believe EVs are as reliable. But they are more concerned about the length of time the vehicle is out of service. They are looking to form a 'partnership' with AFV manufacturers and dealers in order to develop a strong AFV support network and minimize downtime. Emergency roadside service and free loaner vehicles during breakdowns are two examples of services fleet operators expect from dealers, manufacturers and leasing companies.

Even organizations with in-house maintenance facilities typically send their AFVs and specialty vehicles elsewhere to be serviced. The primary function of most in-house service facilities is to render routine maintenance and perform minor services. In fact, only 23% of fleets with in-house facilities are currently authorized to do manufacturer warranty work (Runzheimer International, 1993c). Repair work performed by uncertified company mechanics can invalidate manufacturer warranties. We conclude that in-house maintenance capabilities are not an important motivation nor justification for introducing alternative fuels into fleets.

3.3. Hypothesis 3: Detailed cost accounting by fleets favors AFVs in purchase decisions

The principal alternative fuels tend to have lower fuel costs and/or reduced maintenance, but higher vehicle purchase costs. Thus, the use of full life-cycle cost accounting, rather than simple vehicle purchase price comparisons, would tend to favor AFVs. It is widely believed that fleet operators are more cognizant of the full life-cycle costs associated with owning and operating an automobile than are individual buyers, and thus would be more accepting of AFVs than individual consumers.

The presumption that fleets rationally conduct careful life-cycle cost analyses of new vehicles appears overstated. The majority of fleet operators do not perform detailed cost comparisons when purchasing new vehicles and are not fully aware of life-cycle cost differences. A survey by Runzheimer International found that only 24% of business fleets consider full life-cycle costs when selecting a new vehicle (the same number found to use computers to monitor automobile expenses) (Runzheimer International, 1993c), Some firms do keep detailed accounts that allow full life-cycle cost comparisons, but for the most part they are not carefully derived. Many fleets in our study did not understand the concept of full life-cycle cost analysis ('fuel costs are about the same for our vehicles') or did not believe it applies to them ('we do not keep vehicles long enough').

Instead, vehicle selection is often based on past experiences, with fleet operators sometimes being more brand-loyal than cost-conscious. In a survey by Runzheimer International, past experience with a particular vehicle make and model was ranked as the second 'most influential factor in vehicle selection'—second only to capital cost. Fleet operators we interviewed expressed an overwhelming preference for AFVs produced by familiar automobile manufacturers. One study summarizes the importance of past experience in the following way (J. D. Power and Associates, 1989):

"In most cases, maintenance and life cycle costs are not quantified or arrived at scientifically. Businesses rack up experience with vehicle makes and models. They remember the bad transmissions, carburetors, power trains, engine blocks, electrical systems, steering boxes and flimsy bodies. They won't buy Dodges; they only buy Dodges; they're going to Ford, they left Ford..." (p. 31).

It is unlikely that personal experience will give way to detailed cost analyses with the advent of alternative fuel vehicles. In a fleet survey conducted by the Southern California Gas Company, only 24% of the respondents considered operating cost an important AFV purchase consideration (Southern California Gas Company, 1990). In general, the three most important vehicle selection criteria are suitability (whether the vehicle can perform adequately in its intended application), experience with vehicle (and/or manufacturer) and purchase price (J. D. Power and Associates, 1989; Easton Consultants, 1991; Runzheimer International, 1993b,c, 1995; National Association of Fleet Administrators, 1997). The first two criteria are used primarily in forming the final choice set. The final selection is then based largely on the purchase cost, which is usually the largest and easiest cost difference to assess amongst the vehicles in the final choice set.

Fleet operators in our focus groups and interviews that considered buying an AFV but eventually dismissed the notion, were discouraged by the high upfront capital cost. The higher purchase cost of an AFV tends to mask any potential savings resulting from lower operating costs. In order for fleets to recognize the potential economic benefits of using AFVs vis-à-vis conventional vehicles, the operating costs should be explicitly stated along side the purchase price.

The main cost concerns expressed by fleets in this study were not about vehicles or fuels, but uncertainties such as repairs (especially in terms of downtime) and the extra time required to refuel (because of longer and more frequent refuelings and the sparse network of fueling stations). Fleet operators in our interviews and focus groups were concerned about the additional driver wages that would be needed as a result of increased refueling times, Fifty-four percent of our survey respondents indicated refueling time would be an important consideration when selecting an AFV. Other studies have shown that the extra costs associated with AFV refueling can be significant and is a primary concern among fleet operators (San Diego Gas and Electric Company, 1993; Bechtold, 1997; Singh and Mintz, 1997).

In addition to cost, the inconvenience of refueling an AFV is also a concern for fleet operators, although it is difficult to assess. Participants in focus groups held by San Diego Gas and Electric Company indicated they would be willing to travel 3 miles to refuel but a more recent survey of federal fleets suggests a reluctance to travel more than 1/2 mile out of the way (National Renewable Energy Laboratory, 1997a,b).

Fleets also expressed concerns about expenses associated with vehicle 'downtime' (the time the vehicle is out of service because of scheduled or unscheduled repairs). This was especially important to small fleets in our focus groups. A vehicle breakdown could have a severe impact on the operations of a small business. Although 86% of our mail survey respondents believe compressed natural gas vehicles are less reliable than gasoline vehicles, fleets actually using these vehicles report no significant difference in total downtime compared to conventional vehicles (National Renewable Energy Laboratory, 1997a,b).

3.4. Hypothesis 4: Fleet operators are well-informed about AFV technology, costs, mandatory purchase requirements, and incentive programs

Fleet operators are usually among the first to be advised of advances in automobile technology. They are kept apprised of changes through manufacturers, colleagues, trade associations, and industry journals. It was hypothesized, therefore, that fleet operators would also be well informed about alternative fuel vehicles, especially since they are the primary target for AFV sales. However, our findings indicate that in the mid-90s (well after many fleet rules were adopted), the majority of fleets were largely misinformed and in many cases uninformed about alternative fuel vehicles.

Our focus groups and interviews revealed much confusion among fleet operators regarding AFV-related legislation and incentive programs, costs and availability of AFVs, and AFV technology, refueling and infrastructure needs. Even the most informed individuals had only fragmentary knowledge of alternative fuel vehicles. Decisionmakers within organizations receive only occasional bits of information about AFVs and from very few sources. As a result, they have limited knowledge of AFV issues and options. Although 65% of our survey respondents had read or seen at least some information about alternative fuel vehicles in the previous 6 months, the

primary source of that information was newspapers and magazines. One California utility company found that, even during an intense natural gas vehicle promotional campaign, 95% of the fleets in their service area had absolutely no knowledge about natural gas vehicles or were aware that there was a natural gas refueling station within 5 miles of their business (San Diego Gas and Electricity Company, 1993).

The most respected sources of information are other fleet operators, which suggests in-use success stories are the best sales tool for AFV marketers. An endorsement from another fleet operator is far more meaningful than anything read or seen in magazines, newspapers, TV or trade journals. On the other hand, negative feedback from fleets can be difficult to counter. Regardless of the number of success stories, fleets are most likely to remember the one bad occurrence that either they experienced or heard about from another fleet operator. This fraternal relationship among fleet operators is maintained through extensive personal networks, which allow news (as well as rumors) to travel quickly.

Although AFV experiences vary considerably depending on the fleet and the fuel, overall reported satisfaction could be improved. One survey found that only 31% of the fleets with AFVs reported having a positive experience (Port, 1997), while another found that only 44% stated they would recommend an AFV to others (National Renewable Energy Laboratory, 1997a).

Fleets are more willing to purchase an AFV if they are aware that such a purchase proved productive for another fleet. Fleets generally have a 'wait and see' attitude hoping someone else will assume the risk of being the first to adopt a new technology. They are afraid a given vehicle or technology will emerge, achieve reasonable acceptance, lose momentum, and fade away. As one focus group member put it, fleets do not want to become 'technology orphans'—stuck with obsolete vehicles.

Our findings also reveal that many fleets have unfounded safety concerns based on inaccurate information. Only 17% of our mail survey respondents believed that compressed natural gas vehicles (CNGVs) were as safe as gasoline vehicles while 13% believed EVs were as safe. The primary CNGV safety concern was the notion that CNG tanks would explode if ruptured in an accident (which is highly unlikely). For electric vehicles the primary safety concerns were accidental electrocution and the danger of battery acid leakage in the case of a crash. Again, these concerns are mostly unwarranted (Corbus *et al.*, 1993). The concerns were not deeply held, however. For instance, focus group participants who had seen an informational video produced and distributed by the CNGV Cylinder Company (located in Long Beach, CA) did not have concerns about CNG tank integrity, and were quick to reassure other focus group participants about the safety of the tanks.

In general, larger fleets, especially those with a full-time fleet manager, are better educated than smaller fleets on matters concerning AFVs. Operators of large fleets generally have more extensive information networks (e.g., belong to more fleet associations), and therefore tend to be more knowledgeable about AFV developments, legislation, and purchase incentives. Full-time fleet managers can remain aware of and respond to changes and opportunities in AFV development. They are also targeted by promotional and educational campaigns conducted by utility companies and AFV manufacturers. However, there is a discernible trend toward eliminating full-time fleet manager positions as a means of reducing costs (Runzheimer International, 1993c; Flesia, 1997). Moreover, fleet managers that are being hired are generally less experienced: over 75% of new fleet managers have no prior fleet experience (Flesia, 1997). The implications of less experience are unclear.

3.5. Hypothesis 5: Fleets will almost exclusively buy domestically-produced alternative fuel vehicles

Previous surveys have found that American fleet operators prefer domestic automobiles (National Association Fleet Administrators, 1991; Runzheimer International, 1993c). In a survey of U.S. fleet operators, 89% of respondents said they do not buy vehicles with traditionally 'foreign' nameplates; of these, 69% cited a "perceived or written 'buy American' company policy" as the reason (National Association of Fleet Administrators, 1991). When asked in the same survey about their vehicle purchase intentions, less than 3% of the respondents planned to purchase any foreign vehicles in the coming year. Similarly, 65% of the business fleets surveyed by Runzheimer International stated they have a "definite 'buy American' plan" (Runzheimer International, 1993c).

Although generally true, there is some evidence that this 'buy American' sentiment is overstated and receding, and will prove less important in the AFV purchase decision. The percentage of imported light-duty vehicles in U.S. fleets has been slowly increasing and was about 15% in 1995 (Bobit, 1995). In our mail survey 49% of the respondents felt it was important that their AFVs be purchased from a U.S. manufacturer.

Many of the fleets in our study with formal or informal 'buy American' policies felt that foreign-made AFVs would be acceptable, especially in the absence of a comparable American product. They felt that public interest concerns for clean air and energy security would justify the purchase of a foreign-made AFV. Moreover, fleet operators in this study suggested (accurately) that the meaning of 'American-made' has lost significance. They gave examples of vehicles that are touted as American products even though most of the components are produced or assembled elsewhere.

3.6. Hypothesis 6: AFV purchase decisions will be influenced by fleet mechanics. Corollary: Mechanics will generally discourage the purchase and use of AFVs

We, as well as many others, have hypothesized that in-house mechanics would be influential in AFV purchase decisions and that they would generally oppose such purchases. It was reasoned that mechanics would be reluctant to undergo the training necessary to work on AFVs and would generally be reluctant to adopt unfamiliar technologies.

We found little evidence to support this hypothesis. The fleet mechanics we interviewed were remarkably receptive to AFV purchases. Those who train AFV mechanics reported to us similar findings. Mechanics, regardless of age, background, and experience seemed to welcome new innovations, viewing them as a means of getting ahead in their profession. As was pointed out to us by mechanics we interviewed, they are accustomed to change because technologies have become increasingly sophisticated in recent years. One company conducting training classes found that mechanics prefer to work on electric vehicles because there are fewer moving parts (that often get replaced instead of repaired), no oil changes, no exhaust systems, and no fumes in the work environment (Thideman, 1997). Even the mechanics in our study who were not receptive to AFVs indicated they would likely adapt rather than resist AFV purchases.

Regardless of their opinions, it is unlikely that mechanics will be influential enough to affect initial AFV purchase decisions. As part of this overall fleet study, we found that the AFV purchase decision will be made relatively high in the organizational structure (Nesbitt, 1996). Decision-makers may give consideration to the concerns of mechanics when deciding which type of AFV to purchase, but mechanics by themselves rarely play a pivotal role in at least the first AFV purchase decision. However, it should be noted that mechanics could be influential in succeeding AFV purchase decisions, especially if their initial experiences are negative.

3.7. Hypothesis 7: Expectations of low resale value will discourage fleets from purchasing AFVs

Fleets tend to buy new vehicles and replace them more quickly than individuals. Thus resale value plays a large role in the economics of fleet vehicle purchases. It is therefore widely believed that fleet operators will be disinclined to purchase AFVs until a used vehicle market is established.

This hypothesis is accurate for some fleets but is not a valid generalization. Resale calculus is complex and sensitive to fleet practices and vehicle usage. Fleets with high vehicle replacement rates and those that dispose of vehicles on a regular basis, indeed do place great importance on projected resale value at the time of purchase. Managers of these fleets seem to take considerable pride in reselling vehicles at high prices. One study participant even described himself as a 'manufacturer of used cars.' At the other extreme are most public fleets. They generally keep vehicles longer and vehicle sales revenue is usually deposited in a general fund, rather than returned to the fleet. Consequently, public fleets tend to be less concerned with resale value.

In our mail survey 44% of the respondents felt it was 'very important' that AFV resale value be comparable to a gasoline vehicle. However, there were no biases in responses between large and small fleets, public and private fleets, or between fleets with low vehicle turnover rates and those with high turnover rates. Resale value was not a major AFV purchase criterion for the majority of fleets in our focus groups and interviews. They were not overly concerned about AFV resale values because they did not expect to sell first-generation AFVs. Instead, they intended to 'run them into the ground' and then 'cannibalize them for parts'. This was true even for fleets with high vehicle turnover rates.

The main resale concern expressed by fleet operators in this study had to do with company reputations and potential litigation. Many fleets worried that their reputation within the used car market would be tarnished—that just a few unsatisfied customers could significantly impact future vehicle sales. Similarly, legal concerns make fleet operators hesitant to sell AFVs to the public. One fleet manager explained that he converts compressed natural gas vehicles back to gasoline before resale—at significant expense—in order to avoid potential legal problems.

4. IMAGE AND HIERARCHY: TOWARDS A BETTER UNDERSTANDING OF BUSINESS FLEETS

In business fleets, initial AFV purchases will likely be top-down decisions motivated largely by corporate image benefits. Despite the fact that nearly all efforts to sell AFVs to fleets take place at the fleet level, AFV purchase decisions will generally be made at a much higher level within the organization, at least for the near term. In fact only about 15% of businesses allow the fleet manager to set fleet policy (Runzheimer International, 1993c). Ninety percent of our surveyed fleets indicated that AFV purchase decisions would be made at the upper management level and in 58% of those fleets the decision would likely be made by just one or two individuals. This decision-making structure was also reported by fleet managers who had already invested in alternative fuel vehicles. In each case, a high-level decisionmaker(s) in the organization had conveyed a strong commitment to AFVs. This commitment helped foster a positive attitude towards the AFV program, from those who serviced the vehicles to those who drove them.

These high-level decisionmakers gave various reasons for purchasing an AFV but economic reasons were often not among them. Instead, they expressed a desire to "help reduce air pollution", "use domestic fuels" and "give something back to the community". Such considerations were voiced by owners of small businesses as well as managers of large corporations (and government fleet managers). In a separate survey, fleet operators using or considering using AFVs stated "environmental concerns", "corporate image" and the desire to be a "good corporate citizen" among their top motivations (Port, 1997). In our interviews, the most important and frequently cited inducements for purchasing an AFV were company image enhancement and public relations benefits.

Company image—an important selection factor in purchases of conventional vehicles (Runzheimer International, 1991, 1993b,c; National Association of Fleet Administrators, 1997)—is especially salient for AFVs. It was one of the top purchase considerations expressed by the vast majority of our interviewees that had already purchased an AFV. Overall, 71% of our survey respondents stated that image benefits will be a "very important" AFV purchase consideration. As AFVs become more common, the purchase decision will likely slide down the company hierarchy and image enhancement will play a lessening role. Economics and operating characteristics will likely become the primary decision criteria.

The first AFV fleet purchase decisions will likely be the outcome of an organizational decision-making process. Therefore, the AFV purchase decision should be viewed within an organizational context. The lesson one draws is that, in addition to targeting fleet managers (the person in charge of daily fleet activities), successful AFV marketing efforts should focus on key decisionmakers higher in the organizational structure. Upper level management may have different motivations for purchasing AFVs (e.g., corporate image enhancement) than those at the lower levels.

5. EARLY ADOPTER FLEETS

The first fleets to purchase AFVs have mostly been government agencies and regulated utility companies (J. D. Power and Associates, 1989; Southern California Gas Company, 1990; San Diego Gas and Electric Company, 1993; Davis, 1995; Runzheimer International, 1995; Vyas and Wang, 1996; National Association of Fleet Administrators, 1997; Wiegler, 1997). In our 1995 mail survey, 28% of the local government fleets already had purchased at least one AFV compared to 4% of the business fleets. Moreover, 36% of the surveyed government fleets (government fleets constituted 19% of the total sample) are "likely to acquire an AFV within the next year or two" compared to 9% of the business fleets. Although not included in our survey, federal and state government fleets show similar AFV purchase patterns and intentions due largely to executive orders and regulatory mandates (Miau *et al.*, 1992; Runzheimer International, 1993a, 1995;

Hu and Wang, 1996; U. S. Department of Energy, 1997; National Renewable Energy Laboratory, 1997a,b; Port, 1997). In an effort to promote the development of AFV markets, electric and natural gas utility companies have also been leaders in purchasing AFVs. Twenty-six percent of the energy utility companies in our survey operated AFVs and 24% expected to purchase additional AFVs within the next 2 years. Government fleets and utility companies are expected to continue purchasing AFVs at an increasing rate because of rules already adopted as part of the Energy Policy Act of 1992 and the Clean Air Act Amendments of 1990, as well as various state and local rules.

Another reason government agencies and regulated utilities are more inclined to purchase AFVs is public scrutiny. Government agencies participating in our focus groups sessions and interviews felt that their high profile made it their responsibility to 'set an example' or be 'pioneers' in the fight against air pollution, global warming, and reliance on energy imports. Government fleet operators, though sensitive about spending public moneys, often feel that AFVs merit additional expenditures. Regulated energy utility companies (especially natural gas and electricity) exhibit similar behavior and are subject to similar government mandates, plus they are motivated by the desire to create new markets for natural gas and electricity. Government agencies and utility companies play a vital role in disseminating AFV information within the fleet sector.

Large companies with high profiles, especially those that conduct business with the government, are also more likely to purchase AFVs. In general, these companies are the first to comply with regulatory requirements (Pfeffer and Salancik, 1978). In the specific case of AFVs, several factors are key. In addition to potential corporate image benefits and access to more and better information (including first-hand accounts from other fleet managers), large corporations are better suited than smaller ones to assume the financial risks associated with investments in nascent technologies. Their larger fleets are also generally more amenable to substituting vehicles with different attributes for specific tasks. Of the fleets in our survey 'likely to acquire' an AFV in the next year or two, 32% were large organizations (over 500 employees) and 50% were government agencies.

6. POLICY IMPLICATIONS AND LESSONS

Available knowledge about vehicle fleets is insufficient for producing reliable estimates of the near-term AFV fleet market. Studies attempting to assess the potential fleet market for AFVs have focused on mapping AFV attributes to fleet travel demand and operating needs (Wagner, 1979 1980; Berg, 1985; Wachs and Levin, 1985; Mader *et al*., 1988; ETFUCTI, 1990; Marshment, 1991; California Energy Commission, 1992; Runzheimer International, 1993b; Energy Information Administration, 1995, 1996a; CALSTART, 1996; National Renewable Energy Laboratory, 1997b), forecasting AFV market size based on regulatory requirements (U. S. Environmental Protection Agency, 1991; Hu and Wang, 1996; Hu *et al*., 1996; Vyas and Wang, 1996; U. S. Department of Energy, 1997), and predicting AFV market penetration rates based on fleet purchase patterns and stated preferences (J. D. Power and Associates, 1989; Southern California Gas Company, 1990; Easton Consultants, 1991; San Diego Gas and Electric Company, 1993; Runzheimer International, 1995; Golob *et al*., 1997). Although necessary and useful, these studies generally have many shortcomings, including incomplete sampling frames, low response rates, failure to identify key decision makers, poor grasp of organizational decision making behavior, and poor understanding of purchase behavior of new products and attributes. Furthermore, they provide little insight regarding which fleets will actually purchase AFVs, under what conditions they will purchase AFVs, and for what reasons.

The findings reported here suggest that AFV regulations are difficult to implement largely because of the diverse nature of the fleets. The only commonality is that they operate vehicles: they do not make the same product, provide the same service, or even operate their vehicles in the same manner. As a result, proposed and adopted AFV implementation strategies may produce unexpected and, in some cases, undesired outcomes. One such outcome is the likelihood that AFV fleet rules will expedite the removal of on-site fuel storage facilities (probably reducing toxic leakage but possibly increasing emissions and energy use through increased travel to off-site fueling facilities). Furthermore, AFV fleet regulations do not provide incentive to use AFVs that have already been purchased (e.g., a fleet that purchases a bi-fuel AFV for image benefits might operate it using only gasoline).

Given fleet diversity and our rather poor understanding of fleet decision making, it seems desirable that public policy aimed at accelerating fleet adoption of AFVs should tilt more toward flexibility, market instruments, and assuring positive experiences. Where regulatory mandates apply, marketable credits might be seriously considered. A better understanding of fleet behavior will go a long way in helping formulate more effective AFV implementation strategies.

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