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NATURAL GAS VEHICLES AND THE ROLE OF STATE PUBLIC SERVICE COMMISSIONS

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EXECUTIVE SUMMARY

Transportation accounted for about 36 percent of the total net energy consumed in the United States in 1991 with petroleum the overwhelming choice (96 percent) among the various types of fuel. In recent years, the use of petroleum in transportation alone has exceeded domestic petroleum production. Transportation is also a major contributor to the increase in urban air pollution and greenhouse gases. Consequently, the development of vehicles powered by fuels other than petroleum is viewed as a promising approach in enhancing energy security and environmental protection.

The focus of this study is to identify state regulatory actions that are conducive to the extensive use of natural gas as a vehicular fuel. This study concludes that natural gas refueling stations should not be regulated as a public utility, that a local distribution company should be allowed to participate in the refueling market only under strict state oversight, and that ratepayers should be required to provide funding for natural gas vehicle (NGV)-related activities in very limited circumstances.

The most likely candidates for natural gas vehicle conversion are centrally-fueled, centrally-garaged, short-haul fleets such as school buses, delivery trucks, refuse-collection vehicles, and urban transit buses. Certain operational limitations and the lack of an adequate refueling and service infrastructure have raised users' concerns about NGVs' long-term viability. In addition, natural gas vehicles are competing with a dominant incumbent technology--gasoline vehicles--which enjoys significant advantages in consumer acceptance, capital requirement, and political support. Furthermore, the current low price and abundant supply of petroleum have reduced considerably the financial benefits for using natural gas. All these indicate that, in the short run, a rapid increase in the numbers of NGVs and refueling stations is not likely. Over an extended period of time, natural gas vehicles may have the potential to compete with gasoline-powered vehicles if an adequate refueling and service infrastructure is in place.

Government can play a constructive role in the initial stage of the development of natural gas vehicles when potential users and suppliers of NGVs are uncertain about its

long-term viability and the possible imposition of government regulations. A broad range of options such as more stringent emission controls, mandatory vehicle conversions, higher taxes on gasoline, and direct rebates for vehicle purchases have been considered to promote NGVs. But the influence of a state public service commission on these policy options is limited. A commission's role is likely to center around eliminating or reducing regulatory barriers that may hinder the development of NGVs at the present and in the future.

These regulatory barriers are the result of a lack of regulatory experience with the NGV technology, applicable regulatory guidelines, and timely information rather than any substantial conflicts in regulatory principles or among the interests of various market participants. In overcoming these regulatory encumbrances, a state commission needs to define clearly the participants, boundaries, and rules of competition for the natural gas refueling and local distribution markets. No entry restrictions are needed in the gas refueling market. But if the LDC is to own a large number of refueling stations, an unregulated subsidiary may best be required to lessen the possibility of cross-subsidy and anticompetitive behavior. In the local distribution market, the LDC monopoly would be maintained but the refueling stations should be treated no differently from other gas transportation customers. A refueling station should be afforded the opportunity to purchase gas from entities other than the LDC.

There is no need to impose any public utility-type regulation on the NGV refueling market. State commissions can consider codifying the exemption of gas sales to NGVs from state regulation, lifting the prohibition of gas sales for resale to NGV users, and participating in the codification of federal exemption of refueling station owners as utility holding companies and of the FERC's regulation of vehicular gas sales. In terms of funding NGV-related activities, ratepayers should provide funding only for the purchase of natural gas vehicles used by the LDC, the construction of public refueling stations for demonstration purpose in the initial few years when the NGV infrastructure is not fully developed, and when the direct benefits to ratepayers for increased gas sales due to more NGVs in use can be clearly demonstrated.

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FOREWORD

In recent years there has been a growing interest within NARUC and its constituent membership about how state public utility regulation might bear on the emergence of natural gas vehicles (and perhaps vice versa). This report attempts an early assessment of the nature of the issues state regulators may face in this field and provides some guidelines as to what might be a "best stance." Such a stance is characterized as neither gratuitously getting in the way nor actively fostering the development of NGVs and their attendant support facilities.

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Director
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CHAPTER 1

INTRODUCTION

The transportation sector consumed 22 quadrillion BTU (quad), or 36 percent of the total net energy consumption, in the United States in 1991.[1] Among the various types of fuels used in transportation, petroleum was the overwhelming choice at 96 percent (21.4 quad) while natural gas (0.8 quad) and electricity (0.02 quad) accounted for only small portions.[2] This dominance of highway transportation, and consequently petroleum fuel, in the United States transportation sector is not likely to change in the foreseeable future without radical changes in transportation technology, living and working styles, and the mass transit infrastructure.[3]

The dominance of petroleum as a transportation fuel has two important implications: dependence on petroleum imported from foreign countries, and the continued worsening of urban air quality and increase of greenhouse gases. In terms of energy security, transportation accounts for about two-thirds of the total petroleum consumption in this country, and the amount of petroleum used in transportation has already exceeded domestic petroleum production in recent years. Currently, the United States imports half of its petroleum, with a large percentage of the imports coming from politically unstable areas where the possibility of supply interruption is high.[4] This

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[1] Energy Information Administration, *Monthly Energy Review* (Washington, D.C.: Energy Information Administration, April 1992), Table 2.2.

[2] Ibid., Table 2.5.

[3] See U.S. Department of Transportation, *National Transportation Strategic Planning Study* (Washington, D.C.: U.S. Department of Transportation, 1990) for a detailed examination of the long-term needs and costs for developing and maintaining a desirable transportation system for the next twenty-five years.

[4] *Monthly Energy Review*, Table 1.8.

dependence on imported oil is expected to increase as the amount of domestic petroleum production continues to decline.[5]

Turning to environmental protection, petroleum used in transportation contributes to about half of the ozone emissions, 80 percent of the carbon monoxide inventory, more than 60 percent of urban particulate matter emissions, and half of the nitrogen dioxide emissions in the ambient air in the United States.[6] At the same time, many people are concerned with the increase in greenhouse gases and their possible effects on global warming. Furthermore, the production, transportation, distribution, and storage of petroleum products can create significant environmental risks such as soil and ground water contaminations. All these have intensified the search for ways to expand the use of alternative transportation fuels with less environmental damage.

Not surprisingly, improved transportation energy efficiency is viewed by some as the key to reducing the dependence on imported petroleum and stem the deterioration of the environment.[7] A broad range of options is available to improve the energy efficiency of the transportation sector. They include improving gasoline vehicle fuel efficiency, increasing the use of alternative-fueled vehicles, promoting mass transit and ride sharing, developing high-speed rail/magnetic levitation technology, reforming transportation pricing, and constructing "intelligent" vehicle highway systems.[8]

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[5] "EIA Announces U.S. Energy Intensity Is Expected to Decline As Energy Consumption and Oil Imports Continue Upward," *NARUC Bulletin* (February 10, 1992): 10-11.

[6] Rob Klausmeier, *Assessment of Environmental, Health, and Safety Issues Related to the Use of Alternative Transportation Fuels*, GRI-89/0249 (Chicago: Gas Research Institute, 1989), 3-1 to 3-76.

[7] The term "transportation energy efficiency" used here refers to the amount of energy consumed per unit of transportation service provided. It can be expressed in various forms depending on the kind of transportation service. For example, miles per gallon is typically used to measure the energy efficiency of motor vehicles.

[8] Discussions on the policy alternatives in improving transportation energy efficiency can be found in *National Energy Strategy, First Edition 1991/1992* (Washington, D.C.: U.S. Government Printing Office, 1991), 60-72; and David Howard, "Energy and Transport: Problems and Solutions," *Energy World* (March 1991): 6-10.

At the present time, highway transportation accounts for about 70 percent of the total energy used in transportation.[9] As a result, improved motor vehicle fuel efficiency and increased use of fuels other than petroleum have considerable potential to reduce the amount of petroleum used in transportation. Between these two options, the increased use of alternative fuels seems to be the more promising approach for the future even though it has been imperfectly understood and less emphasized in the past.[10]

The improvement in vehicle fuel efficiency (typically expressed as miles traveled per gallon of gasoline) has been quite impressive. For example, the fuel efficiency of new cars increased 80 percent while light-duty trucks improved 55 percent between 1975 and 1988.[11] One study indicates that further improvement in vehicle fuel efficiency may still be possible; but its overall potential in reducing petroleum consumption is probably limited unless the government mandates much more stringent vehicle fuel efficiency standards and imposes substantial taxes on low fuel efficiency vehicles.[12] It is also viewed by some that further emission reduction through better emission control technology for gasoline or diesel vehicles may be increasingly difficult to achieve.[13] Obviously, these two options--further improvement of gasoline-powered vehicles and

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[9] U.S. Department of Transportation, *National Transportation Strategic Planning Study*, 3-7.

[10] There are still some debates about the relative magnitudes of environmental protection and energy security benefits that can be achieved by the further improvement in vehicle fuel efficiency and the increased use of alternative fuels. For example, some argue that substantial improvement in fuel efficiency is still possible and this approach faces less market constraints and consequently it will be a more effective policy than the promotion of alternative transportation fuels. See Deborah L. Bleviss, "The Role of Energy Efficiency in Making the Transition to Nonpetroleum Transportation Fuels," in *Alternative Transportation Fuels*, 293-308.

[11] U.S. Department of Transportation, *National Transportation Strategic Planning Study*, 3-9.

[12] Frank von Hippel, "Automobile Fuel Economy," *Energy* 12 (1987): 1063-71.

[13] Klausmeier, *Assessment of Environmental. Health, and Safety Issues*, 5-1.

increased use of alternative-fueled vehicles--are not in conflict with each other, and may be complementary due to their unique strengths and weaknesses.[14] The focus of this study is on the development and use of alternative-fueled vehicles.

There has been a flurry of activity in the development and use of alternative-fueled vehicles in the last two years. For example, the Clean Air Act Amendments of 1990 requires, among many other things, that starting in 1998 fleets of ten or more cars and light-to-medium trucks need to meet more stringent emission standards in twenty-two urban areas. The 1991 National Energy Strategy proposes removing current caps on corporate average fuel economy credits given to automobile manufacturers to stimulate further development and production of flexible and dual-fuel vehicles. The National Association of Regulatory Utility Commissioners (NARUC) passed resolutions in 1988 and 1990 urging its members to eliminate ambiguities in utility-type regulation on the sale and use of natural gas for vehicles and to adopt a natural gas vehicle commercialization development program in their states.

One example of a state's initiative is Pacific Gas and Electric Company's Natural Gas Vehicle Program approved by the California Public Utilities Commission in 1991. This program, among other things, intends to offer incentives of up to $1,250 per vehicle to a maximum of 50 percent of the conversion costs to fleet vehicle owners for compressed natural gas (CNG) vehicle conversion, and to install twenty-five additional CNG refueling stations within its service territory. In addition, major vehicle and engine manufacturers such as General Motors Corporation, Ford Motor Company, Chrysler Corporation, Cummins Engine Company, Detroit Diesel Corporation, and The Flxible Corporation, as well as energy research organizations such as the Gas Research Institute

[14] It has been argued that the continued pursuit of vehicle fuel efficiency would have to play a major role in *the transportation sector's transition* from petroleum to alternative fuels. See Bleviss, "The Role of Energy Efficiency in Making the Transition to Nonpetroleum Transportation Fuels."

(GRI) and the Electric Power Research Institute (EPRI) are actively engaged in the research and development of alternative-fueled vehicles.[15]

Problem Definition

As we know, different kinds of alternative fuels such as natural gas, electricity, methanol, ethanol, propane, and reformulated gas can be used to power a motor vehicle. This study concentrates on the use of compressed natural gas as a transportation fuel. There are two basic types of natural gas vehicles (NGVs): a dedicated-fuel vehicle in which the engine is optimized for burning natural gas, or a dual-fuel vehicle which can burn both natural gas and gasoline. Either a conversion kit with necessary engineering modifications can be installed on a gasoline-powered vehicle or the vehicle can be designed and assembled by the original equipment manufacturers (OEMs). In the following analysis, references to natural gas vehicles imply primarily a dedicated-fuel OEM vehicle. In the long run, this type of natural gas vehicle with its energy efficiency, capital cost and environmental advantages is considered to have the largest potential for market penetration and the largest impact on energy security and environmental protection. In the short-run, a dual-fuel vehicle may face fewer obstacles in market development and user acceptance since it can extend the vehicle driving range and reduce the need for more refueling stations. Therefore, it is viewed as a more promising vehicle than a dedicated-fuel vehicle *in the transition period* from petroleum to alternative fuels.[16]

The government's efforts to promote natural gas vehicles up to now have been less than successful. In reviewing the progress of the Department of Energy in

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[15] A review of recent automobile industry activities in developing new natural gas vehicle technology can be found in Rebecca L. Busby, "NGV Technology Staying On The Fast Track," *Gas Research Institute Digest* (Spring 1990): 13-23.

[16] See Kenneth Koyama and Carl B. Moyer, "The Transition to Alternative Transportation Fuels in California," in *Alternative Transportation Fuels*, 263-72.

implementing the Alternative Motor Fuel Act of 1988, the General Accounting Office (GAO) concluded that:

> . . .progress has been slower than anticipated since the program was initially funded in October 1989. . ., and while [GAO] agree that federal leadership in the procurement of alternative-fueled vehicles is desirable, a gradual approach, coupled with performance and emission data collection and incentives for developing a fueling infrastructure, might provide a more balanced and less risky strategy. In the final analysis, the extent to which alternative fuels are competitively priced with gasoline will determine their use.[17]

The private sector's experience with natural gas vehicles up to now has not been encouraging either. For example, Southern California Gas Company decommissioned its fleet of 2,500 compressed natural gas vehicles for economic reasons in the early 1980s.[18] More recent data indicate that the Company has some natural gas vehicles in use, but they amount to less than 1 percent of its current fleet of 5,000 vehicles.[19]

There are many explanations for the lack of progress on the development and use of NGVs.[20] They include the inherent limitations of certain operational characteristics such as cruising range and refueling time, uncertainty about the long-term prospect of natural gas supply and cost, insufficient consumer interest and knowledge, lack of an infrastructure that can adequately provide the refueling, maintenance, and repair services, and ambiguities regarding the regulation of NGV-related services and products.

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[17] General Accounting Office, *Alternative-Fueled Vehicles*, GAO/RCED-91-169, (Washington, D.C.: General Accounting Office, 1991).

[18] R. Hull, *Environmental Benefits of CNG-fueled Vehicles*, GRI-87/0265 (Chicago: Gas Research Institute, 1987), 7.

[19] American Gas Association, "Natural Gas as An Alternative Transportation Fuel: Clean Air Strategy for State and Local Officials," *Planning & Analysis Issues*, 1990-14 (October 29, 1990).

[20] See, for example, Barry McNutt, "Alternative Fuels Market Development: Elements of a Transition Strategy," in *Alternative Transportation Fuels,* 263-72.

Another commonly cited explanation is that the current low price of petroleum simply makes alternative fuels less attractive to motor vehicle users.

In addition, the lack of progress in the development and use of natural gas vehicles can be viewed as resulting from the divergence between the costs and benefits perceived by individual vehicle owners and the costs and benefits for society as a whole. One study concludes that the public interests (such as energy supply security and diversification, and environmental protection) associated with natural gas vehicles have no influential constituencies because the benefits of natural gas are diffused and difficult to measure, while the private interests (such as the sunk-cost investments already made in petroleum production and distribution facilities, inconvenience in refueling and service, and reduction in vehicle speed and range experienced by users) are concentrated and obvious.[21] No government actions can eliminate completely the divergence between public and private interests without creating distortions in other parts of the economy.

Obviously, the past ineffectiveness of certain natural gas vehicle programs though discouraging does not necessarily mean natural gas vehicles cannot compete successfully with gasoline-powered vehicles in the future, or that the government cannot play a constructive role in the development and use of NGVs. But the use of one particular type of fuel in transportation (whether natural gas or another alternative fuel) itself should not be the goal of government action. Instead, obtaining the benefits of environmental protection and energy security associated with the expanded use of alternative-fueled vehicles in the most efficient manner should be the goal of government actions.[22] In other words, government initiatives should concentrate less on creating artificial conditions that either mandate the use of natural gas vehicles or severely distort

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[21] Ibid.

[22] A commonly-cited industry goal is to increase the demand for natural gas and consequently raises the gas price in the current extremely depressed gas market. It has been argued that a "stable and reasonable" price is essential to the long-term viability of the domestic natural gas industry.

the benefits and costs of doing so, and more on eliminating barriers that inhibit the development of natural gas vehicles to a level justified by its true energy and environmental advantages and limitations.

Purpose of the Study

A whole range of technical, environmental, economic, and regulatory issues is involved in the development and use of natural gas vehicles. The objective of this study is more narrowly defined. This study, mainly from the perspective of a state public service commission, intends to identify: the prospect of natural gas in the transportation fuel market; the major issues facing the state commission in formulating NGV-related policies; the regulatory barriers that may inhibit the full development of natural gas vehicles; and the appropriate state policies that can overcome these barriers. Specifically, the regulatory issues to be addressed are:

(1) the entry of various entities into the natural gas vehicle market;

(2) the jurisdiction and regulation of NGV-related services and products; and

(3) the funding of NGV-related activities initiated by a local distribution company.

The influence a state public service commission can have on the development and use of natural gas vehicles is limited. Many factors, such as the technical design of motor vehicles, current and future vehicle emission standards, fuel and road taxes, and prices of most competing fuels, are outside the purview of a state public service commission. Furthermore, the policies advocated by a commission need to conform to the legal and regulatory framework imposed by the federal government as well as the nonenergy policies and regulation developed by other state agencies. A detailed and complete analysis of the numerous constraints facing a state public service commission in setting NGV-related policies is beyond the scope of this study. This study assumes that: the principal features of current and proposed federal energy and environmental legislation will be enacted; the supplies of various transportation fuels will be sufficient while the prices may be more volatile with more competition in these markets; and no

fundamental technological breakthroughs in primary transportation modes, energy production, and emission control will occur.

In addition to the intended goals stated above, this study can be further characterized by what it does not intend to do. This study does not engage in experimental or laboratory work. It does not independently verify or construct the technical, environmental, and cost parameters associated with various transportation fuels and vehicles. All technical data used in this report are derived from secondary sources. This study does not estimate the future prices of various fuels and the eventual market penetration of natural gas vehicles. It does not predict the eventual success, failure, or effectiveness of various government and private programs regarding natural gas vehicles. Nor does this study consider policy options outside the purview of a state public service commission or options not directly related to the use of alternative fuels.

Organization of the Report

This report consists of five chapters. Chapter 2 discusses the advantages and limitations of natural gas as a transportation fuel in comparison with gasoline and other alternative fuels. The main regulatory issues facing the states regarding the development and use of natural gas vehicles is the subject of Chapter 3. The regulatory barriers and the actions that a state public service commission can consider to reduce or eliminate them are addressed in Chapter 4. Chapter 5 provides some concluding comments. A synopsis of the important past and current federal and state initiatives on alternative-fueled vehicles, in particular the natural gas vehicles, is contained in Appendix A. Appendix B is a summary of the experience of three countries--Brazil, Canada, and New Zealand--in promoting alternative transportation fuels.

CHAPTER 2

NATURAL GAS AS A TRANSPORTATION FUEL

At the present time and for the foreseeable future, highway transportation (and consequently motor vehicles) are expected to remain the dominant form of transportation. Most highway transportation vehicles are powered by gasoline. A small portion of the vehicle fleet is powered by alternative fuels such as methanol, compressed natural gas, ethanol, propane, and electricity. In the following sections, a comparison of natural gas and gasoline as motor fuels is presented followed by a discussion of some special considerations associated with other alternative fuels.

Vehicle purchase and usage decisions are different from most other decisions about durable-good purchases. On the one hand, motor vehicles are private goods (with the exception of mass transit systems which remain only a small part of the U.S. vehicle fleet) with the decision to purchase and operate one largely an individual decision. On the other hand, the use of a motor vehicle depends on the provision of adequate "infrastructure" goods such as highways, bridges, roads, refueling stations, fuel production and transportation facilities, and vehicle service and repair shops. Without these "infrastructure goods," a motor vehicle cannot provide anyone with travel or freight service. This infrastructure is supplied through public and private (but multiple) efforts over an extended period of time.

In the case of natural gas vehicles, under current technical and economic conditions natural gas is transported through existing transmission and distribution pipelines to the dedicated or add-on (to existing gasoline stations) natural gas refueling stations. Natural gas is compressed at the refueling station and is added to the vehicle in a way similar to refueling a gasoline-powered vehicle. Natural gas is held in a pressurized tank on the vehicle.

Individual and corporate vehicle owners have the greatest influence over the types of vehicle and fuels used for meeting their transportation needs. Other parties play critical roles, however: vehicle and engine manufacturers decide the number and type of

NGVs available and their performance, local gas distribution companies (LDCs) set the costs and conditions for delivering gas to refueling stations, pipelines and producers help determine the cost and quantity of gas available to LDCs, gas refueling station owners decide the availability and convenience of refueling, and maintenance and repair shops keep vehicles running.

The decision to buy and use a natural gas vehicle can be analyzed from two perspectives. One takes the perspective of an individual vehicle owner while the other adopts the perspective of the general public.[1] Different results as to what constitutes the "best" NGV purchase and usage decisions can be expected given the differences in these two perspectives. A distinction between these two perspectives is essential since no government intervention is required if individual and societal perspectives converge.

From the viewpoint of an individual vehicle owner (whether a person, a corporation, or a government agency), critical factors are the cost of owning and operating the vehicle, its operational performance, the convenience of obtaining fuel, maintenance, and repair services, and any altruistic goals an individual may have. From the policymaker's viewpoint, the factors to be considered in promoting a particular type of fuel and vehicle are the environmental effect, the diversification and assurance of energy supply sources, the effects on energy price stability, and other social goals if any.

Unique Characteristics of the Transportation Vehicle Market

The transportation vehicle market has some unique characteristics which have profoundly influenced the market development of natural gas vehicles and are likely to

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[1] Other private entities such as vehicle manufacturers, oil companies, and refueling station owners may have different perspectives from the vehicle owners. But their behaviors are assumed to be primarily responses to the decisions of the vehicle owners. Their perspectives on the development and use of NGVs are not discussed here. Discussion on the incentives and behaviors of other participants of the NGV-related markets can be found in Albert J. Sobey, "A Global Fuels Strategy: An Automotive Industry Perspective," in *Alternative Transportation Fuels: An Environmental and Energy Solution*, ed. Daniel Sperling (New York: Quorum Books, 1989), 205-20.

continue doing so. These characteristics are the importance of an established infrastructure, the sunk-cost nature of the capital investments associated with gasoline-powered vehicles, and the lack of active political support for emerging technology. Recognizing the significant advantages of an incumbent technology is important. Natural gas vehicles are not competing in a market where every type of vehicle and fuel is starting from scratch. More specifically, successfully converting to a natural gas vehicle depends not only on a demonstration of economic, environmental, and energy advantages of NGV over gasoline-powered vehicles, but also on persuading users who have purchased, operated, and repaired a gasoline-powered vehicle to discontinue their past practice in favor of another, unfamiliar type of motor vehicle.

Necessity of an Infrastructure

The mobile nature of a motor vehicle means it is usually used over a large geographic area rather than at a fixed point such as the home or a factory typically associated with most energy-using technologies such as gas heaters and industrial boilers. In view of the large geographic area of operation, a well-developed infrastructure that can refuel, maintain, and service motor vehicles over an extended area is of critical importance to the vehicle's acceptance by the users. An infrastructure must be in place before the general public will consider purchasing a special type of motor vehicle. Natural gas vehicles are no exception. In one study evaluating the progress of federal procurement of alternative fuel vehicles, the great difficulty in placing these vehicles in desirable locations where they can conveniently access refueling and repair stations was identified as the key barrier to their use.[2]

To a considerable extent, elements of the natural gas vehicle infrastructure are in place. This is evidenced by the presence and successful operation of a large number of gas production fields, gas transportation and distribution pipelines, and the developed

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[2] General Accounting Office, *Alternative-Fueled Vehicles*, GAO/RCED-91-169 (Washington, D.C.: General Accounting Office, 1991).

technology of NGV manufacture, repair, and maintenance. The only missing part of the NGV infrastructure is natural gas refueling and service stations operating over an extended geographic area. Unfortunately, this is also the most critical place where the NGV infrastructure interfaces directly with vehicle users. A vehicle user may not be concerned with supply interruption in a remote gas field, but can experience firsthand the difficulty and inconvenience of being unable to find a refueling station. Currently, there are more than 110,000 gasoline filling stations nationwide.[3] On the other hand, there are less than 350 natural gas refueling stations, more than 60 percent of which are limited-access stations which serve only particular users and are unavailable to the general public.[4] The lack of refueling stations has severely limited the length and route of trips a natural gas vehicle owner can take. A distribution of existing NGV refueling stations is shown in Table 2-1.

Sunk-Cost Capital Investment of Gasoline-Powered Vehicles

Even though a large part of the NGV infrastructure is already in place, a substantial amount of capital is still required in the purchase of natural gas vehicles and the construction of a reasonable number of refueling stations. It has been estimated that the incremental cost for an original equipment manufacturer (OEM) light-duty natural gas vehicle was approximately $300 to $500 (in 1989 dollars) while the conversion from a gasoline-powered to a natural gas vehicle would cost $1,750.[5] The capital investment

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[3] Rayola S. Dougher and Thomas F. Hogarty, *Structure and Performance in Motor Gasoline Manufacturing and Marketing* (Washington, D.C.: American Petroleum Institute, 1991), 4-5. The figure used here does not include the numerous convenience food stores that also sell gasoline and the "mom and pop" stations with no paid employees.

[4] Mark S. Bononi, "The Natural Gas Industry and Natural Gas Vehicle Infrastructure," *AGA Gas Energy Review* (April 1991): 14-15.

[5] It should be noted that there are considerable variations on the cost figures for NGVs and NGV refueling stations. The figures used here are drawn from American Gas Association, "An Analysis of the Economic and Environmental Effects of Natural Gas as an Alternative Fuel," *Energy Analysis*, 1989-10 (December 15, 1989).

TABLE 2-1

EXISTING NATURAL GAS VEHICLE REFUELING STATIONS

State	Total	Public*
Alabama	6	0
Arizona	8	4
Arkansas	6	0
California	23	17
Colorado	19	10
Connecticut	2	0
District of Columbia	1	0
Florida	17	3
Georgia	17	0
Illinois	14	1
Indiana	23	23
Iowa	2	0
Kansas	4	0
Kentucky	1	0
Louisiana	1	1
Maryland	3	0
Massachusetts	3	1
Michigan	3	1
Minnesota	9	1
Montana	1	0
Nebraska	9	2
Nevada	2	1
New Jersey	6	4
New Mexico	3	3
New York	16	6
North Carolina	1	0
North Dakota	3	1
Ohio	27	20
Oklahoma	13	0
Oregon	4	0
Pennsylvania	19	12
Rhode Island	1	0
South Dakota	2	0
Tennessee	4	0
Texas	7	1
Utah	4	0
Virginia	3	1
Washington	18	2
West Virginia	1	0
Wisconsin	20	8
Wyoming	2	0
Total	328	123

Source: Bononi, "The Natural Gas Industry and Natural Gas Vehicle Infrastructure."

*Either open to the public or available through special arrangement with the operator.

required for two add-on double-nozzle natural gas dispensers to an existing gasoline service station was estimated to be $297,700.[6] The total capital investment required to build an infrastructure that could displace one quadrillion BTU of petroleum used in transportation annually (about one-half million barrels of oil a day) was estimated at $18.5 billion by the U.S. Department of Energy and $11.2 billion by the American Gas Association.[7]

More important than the sheer amount of capital required is the distinct nature of the capital investments required to maintain an existing infrastructure compared with the capital investments required to establish a new infrastructure. For gasoline-powered vehicles, a large portion of the capital investments for building gasoline refueling stations and buying vehicles has been spent already. For natural gas vehicles, the capital investments have yet to be made. In most instances, when an individual, corporation, or society as a whole face the decision of whether to own and operate natural gas vehicles and refueling stations, each essentially is comparing the full cost (including both capital and operating costs) of owning and operating NGVs and refueling stations with the incremental cost (which does not include the cost of capital investment already made) of owning and operating gasoline-powered vehicles and refueling stations. The sunk-cost nature of the capital investments in gasoline vehicle infrastructure does not prevent the purchase and use of natural gas vehicles completely, but it certainly raises the cost and performance threshold that such a vehicle must surpass in competing with a gasoline-powered vehicle.

Political Support for NGVs

Because of the enormous amount of capital, technical expertise, and human resources already invested in the gasoline-dominated transportation sector by oil

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[6] Ibid.

[7] American Gas Association, "Infrastructure Costs for Natural Gas vs. Methanol for Vehicular Use," *Planning & Analysis Issues*, 1991-9 (July 3, 1991).

companies, service stations, and vehicle manufacturers, it can be expected that these participants have developed strong political support for the continued dominance of gasoline-powered vehicles. There is little evidence to suggest that many of these participants will actively oppose development and use of natural gas vehicles. After all, a majority of these companies and individuals have some involvement in both the gasoline-powered vehicle and NGV markets. The largest suppliers of NGVs are also the firms manufacturing most of the gasoline-powered vehicles, most public-access NGV refueling stations are likely to be add-ons to existing gasoline stations, and many gasoline producers also produce substantial amounts of natural gas.

Nevertheless, as the overall transportation vehicle and fuel market is rather stable, any substantial increase in the use of natural gas vehicles inevitably may lead to a decrease or slower increase in gasoline sale. Some of the vehicle and fuel market participants such as oil producers who do not have natural gas production fields may suffer economic losses and resist the development and use of natural gas vehicles.[8] It has been argued that the relatively slow growth in the retail gasoline market in the United States has induced various affected parties to discourage development of new vehicle technology based on alternative fuels.[9]

Irrespective of whether political opposition exists to the development and use of natural gas vehicles, the key question is not the presence of opposition but the existence of strong political support for NGVs. After all, natural gas vehicles are an emerging technology trying to compete with a dominant incumbent technology. Without strong political support, the speed of NGV market penetration will be slow for various reasons outlined in Chapter One. As the above discussions indicated, most potential participants in the transportation vehicle market are likely to be indifferent to the development and use of NGVs, and seem unlikely to promote NGVs at the expense of their own interests.

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[8] Daniel Sperling and Mark A. Deluchi, "Is Methanol the Transportation Fuel of the Future?," in *Alternative Transportation Fuels*, 273-92.

[9] Barry McNutt, "Alternative Fuels Market Development: Elements of a Transition Strategy," in *Alternative Transportation Fuels*, 263-72.

Obviously, certain government agencies such as the California State Air Resource Board have provided strong political support for the promotion of alternative-fueled vehicles (including NGVs) for environmental considerations. The gas industry trade groups such as the American Gas Association and the Gas Research Institute are also active promoters of NGVs. But there are few indications of any broad-based strong political support at the present time.

This suggests that political support for natural gas vehicles, in addition to gas companies and equipment suppliers, may have to come from parties not directly involved in the transportation vehicle and fuel market such as environmentalists, energy conservationists, and relevant government agencies. However, the environmental and energy security benefits of natural gas vehicles tend to be spread among a large group of people, are implicit, and are difficult to assess. Therefore, the threshold level of strong political support may be difficult to obtain because few vehicle users are certain that they can benefit financially from the development and use of natural gas vehicles. As a result of the diffusion and uncertainty of the benefits, political support for NGVs may be less than what can be justified by the benefits enjoyed by the general public.[10] This does not imply that the lack of strong political support for NGVs is the sole factor contributing to its slow progress. It simply points out a political reality that the advocates of natural gas vehicles need to consider.

Implications

These unique features of the transportation vehicle market have three important implications. First, a particular type of alternative-fueled vehicle that can better utilize

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[10] It has been argued that in a democratic society a small special-interest group tended to have both economic and social incentives to work more effectively toward the achievement of their collective goals while the large latent group (the general public) is not likely to have strong social incentive to be effective in achieving the "public" interest, even though the group of special-interest is clearly outnumbered by the latent public. See Mancur Olson, *The Logic of Collective Action* (Cambridge, MA: Harvard University Press, 1971).

the existing infrastructure of gasoline-powered vehicles has a better chance of success. For such a technology, the need to build and maintain its own fueling and service infrastructure is less, and the barriers associated with the behavioral adjustments, capital investments, and political support are easier to overcome. One argument favoring methanol over natural gas as the main alternative fuel is its high degree of compatibility with existing gasoline vehicle infrastructure and thus less "starting-up" cost is required.[11]

Second, the use of natural gas vehicles is likely to be limited to certain niches in the motor vehicle market while gasoline-powered vehicles will remain the dominant motor vehicle in highway transportation in the foreseeable future. Third, the speed at which the total number of natural gas vehicles can be increased will be restricted by the normal rates of replacement of motor vehicles (about 8 percent each year as measured by the number of new vehicle purchases divided by the total number of vehicles in use) and refueling stations unless there are massive government interventions. Its effects in enhancing energy security and improving the environment for the nation as a whole may not be evident for a number of years even though the effects may be evident for a particular city or region within a short period of time.[12]

The unique features of the transportation vehicle market mean vehicles that place a low demand on new infrastructure or those with the high possibility of establishing their own infrastructure are most likely to succeed. In the case of natural gas vehicles, as will be shown in later sections, this means fleet vehicles such as delivery trucks, refuse trucks, and urban buses with fixed routes, central fueling stations, and central garage facilities are most easily adapted to natural gas.

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[11] Sperling and Deluchi, "Is Methanol the Transportation Fuel of the Future?"

[12] The environmental benefits of an individual natural gas vehicle are evident and impressive. But there are some doubts about the total effects of NGVs in improving the environmental quality of the nation given the slow rate of market penetration of NGV projected by most analysts. More on this can be found in Jeffery A. Alson, Jonathan M. Adler, and Thomas M. Baines, "Motor Vehicle Emission Characteristics and Air Quality Impacts of Methanol and Compressed Natural Gas," in *Alternative Transportation Fuels*, 109-44.

Individualistic Evaluation of Natural Gas Vehicles

This section evaluates NGVs from the perspective of a vehicle owner. The perspectives of other entities such as vehicle manufacturers, natural gas refueling station owners, gas producers and pipelines, and local distribution companies are not presented in detail. This does not mean other perspectives are not important to the development and use of natural gas vehicles; indeed they are of significance to establishing an adequate NGV infrastructure. Nevertheless, individual vehicle owners ultimately decide whether to use a particular vehicle and fuel, and the actions of other entities are more in the way of responses to their decisions.

Operational Characteristics

The common operational characteristics of a motor vehicle consist of its top speed, acceleration, cruising range after a full refueling, time required for a full refueling, and payload. A natural gas vehicle has an advantage in certain operational characteristics such as a higher compression ratio leading to greater energy efficiency, reduced engine knocks associated with a higher octane rating, and excellent cold weather starting capability and hot weather driveability due to the elimination of vapor lock. As for top speed, acceleration, cargo space, and payload, natural gas vehicles now are generally less satisfactory, although these differences are not viewed as significant drawbacks. A comparison of current performance characteristics is shown in Table 2-2.

The most significant performance disadvantages of an NGV are its cruising range after a full refueling and the time required for refueling. According to various estimates, the cruising range of an NGV is less than 40 percent of a gasoline-powered vehicle: about 100 miles as compared with 300 miles. This means the frequency of refueling for NGV is about *three times* that of a gasoline vehicle. This drastic difference is due to the large difference in energy content in a fixed volume of gasoline and natural gas (even if

TABLE 2-2

A COMPARISON OF OPERATIONAL CHARACTERISTICS OF NGVs AND GASOLINE AND ELECTRIC VEHICLES

Operational	NGV	Gasoline Vehicle	Electric Vehicle
Top speed (mph)	50-75	80-120	50-75
Acceleration (seconds to reach 60 mph)	12-16	9-12	14-16
Cruising range (miles)	100-150	250-400	60-100

Source: Authors' construct based on various sources cited in this report. Because of differences in vehicle types and operating conditions, these figures should be viewed only as estimates rather than actual test results.

the gas is compressed.)[13] Since basically the same amount of energy is required to travel a fixed distance by comparable vehicles, the lower energy content of natural gas in a fixed volume of fuel inevitably leads to a shorter driving distance. A larger natural gas fuel tank can be installed to increase the driving range, but this increases the vehicle's weight, reducing fuel efficiency and lowering the driving range, cargo space, and payload.

The limited range of NGVs, and consequently the increased demand for refueling frequency, is further complicated by its long refueling time. A complete refueling by the

[13] It is estimated that the potential heat energy in a cubic foot of natural gas at atmospheric pressure is equivalent only to one- to two-tenths of 1 percent of that contained in a cubic foot of gasoline or other liquid fuels. See Congressional Research Service and The National Regulatory Research Institute, *Natural Gas Regulation Study* (Washington, D.C.: U.S. Government Printing Office, 1982), 96-105.

more commonly used "time-feed" method may take up to fourteen hours. This is no problem for vehicle fleets having central-garage and central-fueling facilities where NGVs are left overnight for refueling. This method, however, apparently is not feasible for most individual vehicle owners who must rely on public refueling stations. The only viable option for refueling at public stations is the "quick-feed" method that takes two to ten minutes. While comparable to the time required for refueling a gasoline-powered vehicle, the method requires more expensive equipment (such as a more powerful compressor, a backup compressor, and a cascade of gas storage vessels). The configuration of a typical natural gas refueling stations with both time-feed and quick-feed dispensers is shown in Figure 2-1.

Capital Cost of Vehicle Purchase and Conversion

As discussed before, a vehicle owner can either convert his gasoline powered vehicle into an NGV or purchase an NGV designed and assembled by an original equipment manufacturer (OEM). In most instances, the total cost of buying a gasoline-powered vehicle and then converting it to natural gas is more than purchasing an OEM natural gas vehicle. However, the incremental cost for a conversion is less than the full cost of buying an OEM natural gas vehicle since the gasoline-powered vehicle is already paid for leaving only the conversion cost to the vehicle owner.

Natural gas vehicles' higher capital cost can be attributed to three factors. One is the additional equipment required such as on-board gas storage tanks, mounting brackets, regulators, gas air mixers, fuel gauges, switch assemblies, and carburetor adapters. Their cost can be offset in part by eliminating other equipment such as fuel injectors, gasoline tanks, and catalytic converters that are not used in an OEM natural gas vehicle. A second contributing factor is the limited scale of production by all NGV manufacturers. As a result, the unit cost of each vehicle is certainly higher than it would be under full-scale production. At the same time, the size of natural gas vehicles available from OEM manufacturers may not match the need of potential users. A larger and generally more costly type of vehicle may have to be used, instead, potentially

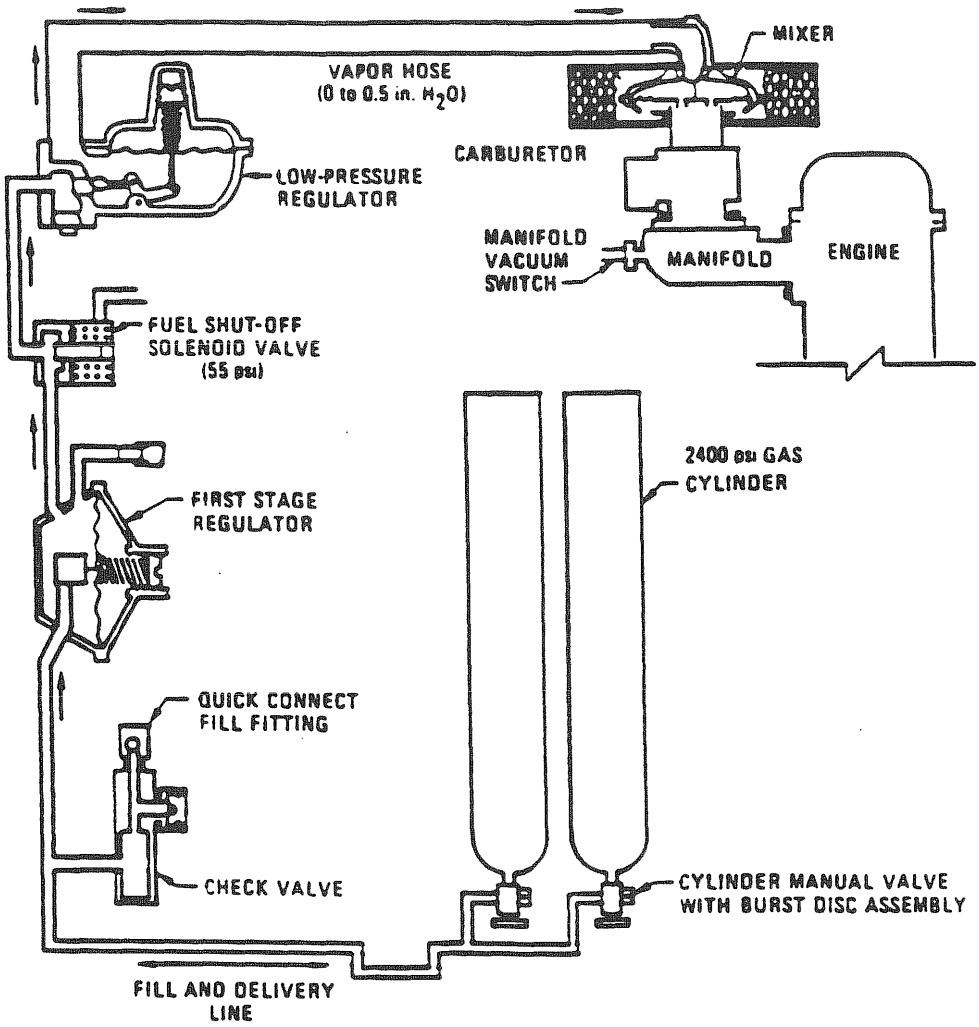

Fig. 2-1. The configuration of a typical natural gas refueling station as depicted in U.S. Department of Energy, *Assessment of Costs and Benefits of Flexible and Alternative Fuel Use*, 33.

raising the capital cost of a natural gas vehicle. In examining the federal light-duty vehicle demonstration program mandated by the Alternative Motor Fuels Act of 1988, the Department of Energy estimated that the capital cost for alternative-fueled vehicles increased about $4,150 a vehicle because the automobile manufacturer could only supply midsized vehicles which could not be purchased with a volume discount rather than the volume-discounted compact vehicles currently making up the bulk of government purchases.[14]

Even though the additional capital cost required for NGV may be substantial, when vehicle manufacturers start full production of NGVs, its capital cost difference with gasoline-powered vehicles should be expected to shrink considerably. Even if the cost difference persists in the future it is not likely to be a significant hinderance to the development and use of NGV. After all, the capital cost difference (for example, $500 for an OEM vehicle) will be a relatively small percentage of the total capital cost ($15,000) of buying a motor vehicle, and an even smaller percentage of the full cost of owning and operating a motor vehicle ($4,000 to $5,000 per year).

Operational Cost

Operational costs include such expenses as fuel and vehicle maintenance and repair. In general, maintenance and repair requirements are less for a natural gas vehicle. Compared to gasoline vehicles, NGVs have reduced engine wear, longer periods between oil changes, and longer spark plug life.[15] However, the difference in maintenance and repair costs between these two types of vehicles is not significant in most instances. The cost of fuel is the more important factor in determining a vehicle's

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[14] See General Accounting Office, *Alternative-Fueled Vehicles.*

[15] Paul McArdle, "Comparison of Alternative Vehicular Fuels with Conventional Gasoline," *AGA Gas Energy Review* (October 1991), 9-13.

operational cost. Owing to a depressed market at the present time, natural gas may have some cost advantage over petroleum.[16] Whether this condition will continue is uncertain.

Certain factors can complicate the projection of future natural gas prices. One is the projected expanded use of natural gas by transportation vehicles and electric utilities. There is some concern that competition for natural gas will drive its price much higher than its current level. The U.S. Department of Energy (DOE) indicates that most future gas usage increases will come from the utility (electricity generation) sector as a result of anticipated increases in combined-cycle generating units and the increased utilization of existing gas-fired plants in compliance with the emission standards of the Clean Air Act.[17] The increase in gas usage due to NGVs is more modest.

In addition to world energy demand and supply, natural gas prices are also affected by government regulation. As discussed in more detail in later chapters, while there seems no reason to regulate the natural gas refueling market, the availability and price of gas to this market (which determines the cost of gas to refueling stations) is affected by local distribution companies, which remain subject to state regulation. Depending on the nature of state regulation, if any, there may be considerable differences between the prices paid by ordinary distribution customers and NGV users.

In summary, the effects of the difference in motor vehicles' operational costs may not be a significant factor either hindering or accelerating the development and use of

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[16] Even though the retail gasoline price and natural gas price paid by users are readily available from government publications such as the *Monthly Energy Review* published by the Energy Information Administration, the computation of price paid by NGV users at the refueling stations is a complicated task. It depends on how the gas was obtained, the rate charged for transportation service, the capital cost and the utilization of refueling stations and the regulation, if any, by the state public service commission on the natural gas refueling service.

[17] Energy Information Administration, *Annual Outlook for Oil and Gas 1990* (Washington, D.C.: Energy Information Administration, 1990).

natural gas vehicles. This is not because there are no significant operational cost differences between these two types of vehicles. In fact, significant differences in fuel costs are quite likely. However, because motor vehicle owners are uncertain about the permanency of the cost advantages of either type of vehicle caused by fluctuating fuel prices, other factors such as convenience in refueling and maintenance must be relied upon in making a choice. After all, any current cost advantage of natural gas may last no more than one or two years while a lower rate of vehicle utilization due to a lack of refueling stations may last over the life of the vehicle (seven to ten years) if the NGV infrastructure is not developed within a short period of time. Combined with the discussion of vehicle capital costs, it seems that cost factors alone may not be very effective in promoting the purchase and use of natural gas vehicles.

Convenience and Safety

Evidence on the extended years of use in some foreign countries such as Canada, Italy, and New Zealand and the several years of fleet vehicle use in the United States indicates that natural gas vehicles appear to pose no safety problems.[18] Despite the public perception about the safety of compressed natural gas, most experts agree that natural gas vehicles are likely to be safer than vehicles using gasoline or other alternative fuels.[19] The on-board fuel storage tanks (cylinders) must meet the standards for transporting industrial gases set by the U.S. Department of Transportation. A typical schematic of a compressed natural gas vehicle fueling system is shown in Figure 2-2.

Furthermore, the ignition temperature for gas is higher than for other alternative fuels, and about twice as high as that of gasoline. Natural gas also has a relatively narrow range of flammability so that specific amounts of gas and air are required before

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[18] R. Hull, *Environmental Benefits of CNG-Fueled Vehicles*, GRI-87/0265 (Chicago: Gas Research Institute, 1987), 44.

[19] Rebecca L. Busby, "NGVs--Now on the Fast Track," *Gas Research Institute Digest* 13 no. 1 (Spring 1990), 2-11.

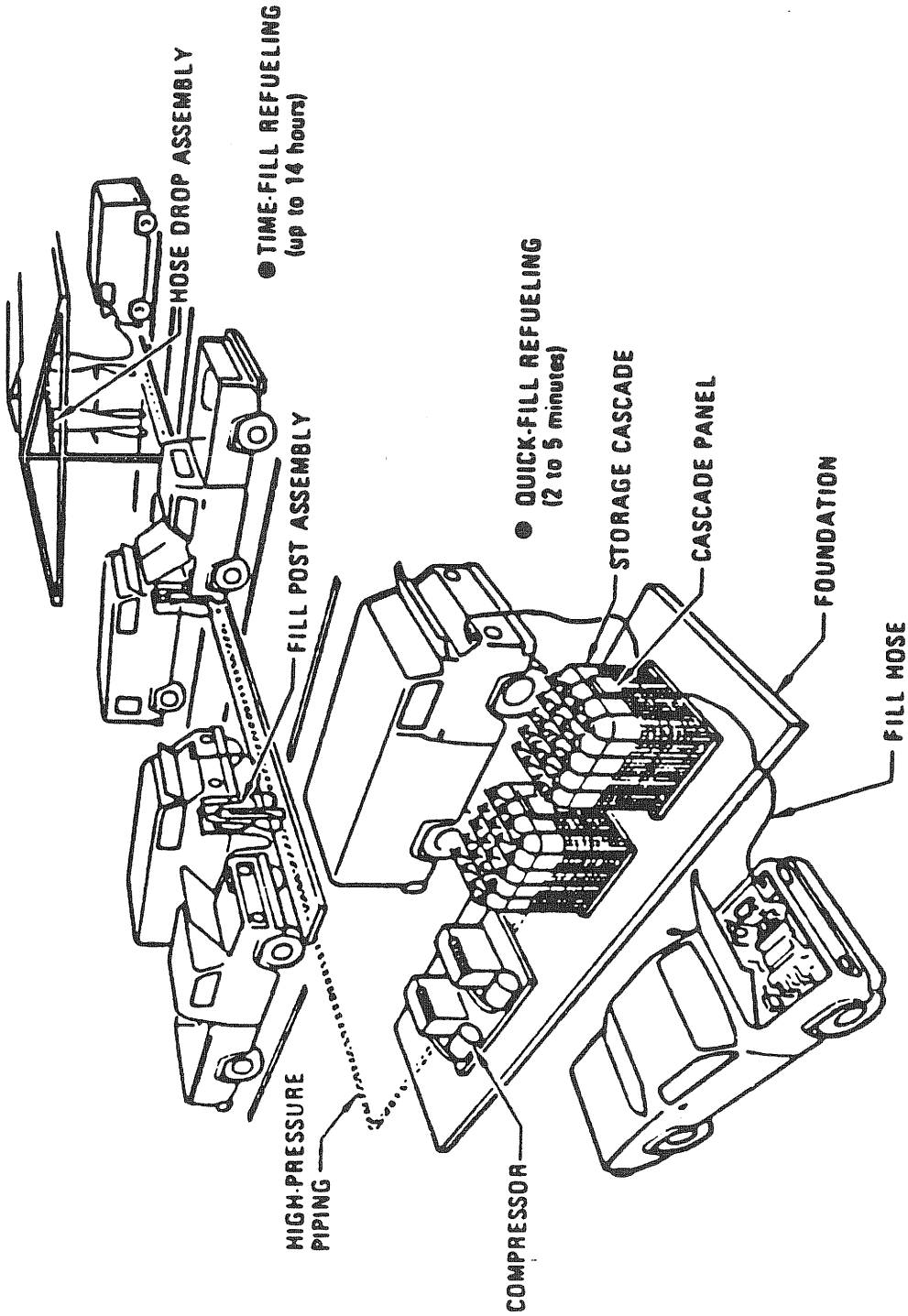

Fig. 2-2. Typical schematic of a compressed natural gas vehicle fuel system as depicted in U.S. Department of Energy, *Assessment of Costs and Benefits of Flexible and Alternative Fuel Use* (Washington, D.C.: U.S. Department of Energy, 1990) 25.

the mixture can be burned. The operation of gasoline-powered vehicles is also quite safe with the continued improvement in gasoline tank design and other safety features. Thus, both NGVs and gasoline-powered vehicles are relatively safe and easy to operate.

Not surprisingly, there are significant differences in term of the convenience of refueling and maintenance. Currently, the number of natural gas refueling stations (350) is less one half of 1 percent that of gasoline stations (110,000) nationwide. The issue of vehicle refueling is further complicated by the limited range (100 miles) of the natural gas vehicle after a full refueling. Essentially, in operating the vehicle NGV owners need more frequent refueling and it takes considerably more time and travel to find a natural gas refueling station. The NGV owners are also likely to experience more difficulties in obtaining maintenance and repair services.

A monetary value on the convenience of obtaining refueling, maintenance, and repair services can be established and included as a part of the total cost of owning and operating the NGV. This value is real although difficult to estimate with certainty. For example, it may be reasonably assumed that an NGV owner on average may have to spend one additional hour each week in refueling because of the increased frequency of refueling and the time required to travel to a natural gas refueling station. There is definitely a cost associated with the additional hour spent in refueling. An NGV owner may also need to rent a gasoline-powered car from time to time for an out-of-town vacation or leisure trip because of the uncertainty over refueling the natural gas vehicle during the trip. The incremental cost of renting a car should be considered a part of the cost of owning and operating a natural gas vehicle.

The cost of inconvenience can vary significantly among different NGV owners. For a business owner with a large fleet of natural gas vehicles used mostly for fixed-route and short-haul delivery, and that are centrally garaged and fueled, the lack of fueling and service stations may not impose any inconvenience or costs. On the other hand, for an individual having only one car that needs to perform a variety of functions, the costs of inconvenience associated with NGV may be prohibitively high. At the present time, no study on the costs of inconvenience associated with natural gas vehicles has been conducted or is included in comparing the costs of NGVs and gasoline-powered vehicles.

Societal Evaluation of Natural Gas Vehicles

In addition to the factors being considered by an individual vehicle owner, the development and use of natural gas vehicles also has societal impacts. A societal impact is characterized by the following three features: first, the impact is not exclusively attributed to the individual NGV users; second, the effect has not been completely internalized and reflected in the costs of purchasing and fueling a motor vehicle facing the individual NGV users; and third, the effect will not be evident through the action of one individual NGV user. The effect will become pronounced only when many people take the same action at the same time. Using these standards, the more prominent societal factors in evaluating NGV are the environmental effect, the fuel source diversification effect, and the fuel price stability effect.

Environmental Effects

Reducing urban air pollution and greenhouse gases may be the most important impetus for promoting natural gas vehicles. Few controversies exist over the environmental advantage of a single natural gas vehicle in comparison with a gasoline-powered vehicle. But the impact on overall environmental quality is less certain due to the significant variations in projecting future NGV market penetration and utilization. The environmental effect of using natural gas as a transportation fuel can be evaluated in the following areas: attainment of the National Ambient Air Quality Standards (NAAQS) for ozone, carbon monoxide, nitrogen dioxide, particulate matter, sulfur dioxide, and lead; maintenance of the NAAQS; air toxic emissions; acid deposition; global warming; and groundwater and soil contaminations.[20] Selected air pollution emissions for various fuels is presented in Table 2-3.

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[20] See Rob Klausmeier, *Assessment of Environmental, Health, and Safety Issues Related to the Use of Alternative Transportation Fuels*, GRI-89/0249 (Chicago: Gas Research Institute, 1989), 3-1 to 3-76. The following presentation in this section is based mostly on this report. Additional discussions on the environmental impact of natural gas vehicles can be found in Hull, *Environmental Benefits of CNG-Fueled Vehicles;* and Alson et al., "Motor Vehicle Emission Characteristics."

TABLE 2-3

SELECTIVE AIR POLLUTION EMISSIONS OF MOTOR VEHICLES BY VARIOUS FUELS*
(grams per mile)

Pollutants	Natural Gas	Gasoline	Electric
Nonmethane hydrocarbons	.08	.55	.02
Carbon monoxide	.36	3.57	.07
Nitrogen oxide	.55	.64	1.00
Sulfur dioxide	n	.16	2.29
Carbon dioxide	273	400	454

Source: Paul Wilkinson, "Natural Gas and Electric Vehicles--An Economic and Environmental Comparison with Gasoline Vehicles," *AGA Energy Review* (June 1991): 20-26.

* The pollution emissions include not only those resulting from the operation of the vehicle, but also of those generated in fuel production, processing, transportation, and conversion.

n: negligible

Ozone formation is probably the most serious and persistent air pollution problem of this nation. In 1987 approximately 90 million people lived in areas that had not met the ambient ozone standard. Transportation contributed to about half of the ozone-forming emissions such as hydrocarbons and oxides of nitrogen. The use of NGV in comparison with gasoline-powered vehicles can significantly reduce hydrocarbon emissions. The effects of NGVs in reducing nitrogen dioxide emissions are less

pronounced, but significant reductions can be achieved if NGVs are used to replace heavy-duty diesel vehicles.

Carbon monoxide is a less widespread air pollution problem. Mobile sources, mostly light-duty gasoline-powered vehicles, contribute about 80 percent of the nationwide carbon monoxide inventory. Natural gas vehicles can significantly reduce the emission of carbon monoxide, about 80 percent less than that generated by gasoline-powered vehicles. In reducing particulate matter emissions, natural gas vehicles will be effective if they are used to replace heavy-duty diesel-powered vehicles.

Transportation vehicles account for about half the nitrogen dioxide found in the ambient air. The increased use of NGVs will have little effect on compliance with the NAAQS for nitrogen dioxide in most areas since they have already met the standard. Transportation sources do not contribute to the emission of sulfur dioxides and lead (after the phase-out of leaded gasoline in most parts of the nation), and most areas also have met NAAQS.

As for the maintenance of NAAQS, NGVs are more useful in areas with a large number of diesel-powered vehicles. There, the increased use of NGVs means more "increments" of particulate matters and nitrogen dioxides are available for new stationary sources such as industrial plants and utilities, and thus more opportunity for economic growth than otherwise.[21]

The air toxics are pollutants, though specific emission standards do not exist, suspected of carcinogenic or other health effects. Currently, little information is available regarding air toxic emissions from transportation vehicles. It is estimated, however, that an NGV is likely to produce much less benzene, toluene, and polycyclic aromatic hydrocarbons than gasoline-powered vehicles.

Motor vehicles contribute little to sulfur dioxide emissions, so the use of NGVs will have little benefit in reducing sulfur emissions. Greenhouse gases include carbon

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[21] The "increment" of a particular pollutant is established by current environmental regulations, and existing emissions plus emissions from the new sources must not exceed the allowable increment.

dioxide, methane, nitrous oxide, and other air pollutants. Transportation vehicles are major emitters of greenhouse gases. Though NGVs emit more methane they emit considerably less carbon dioxide, so they can reduce overall greenhouse gases by 7 to 22 percent per vehicle mile traveled over a gasoline-powered vehicle.

In addition to reducing air pollution, natural gas has other environmental benefits. Natural gas is nontoxic and noncorrosive, and, since compressed natural gas is never in a liquid form, it poses no risk of ground water and soil contamination from the process of transportation, storage, and distribution.

Any environmental benefits must be measured against the current status of the particular affected region. For example, it makes little economic sense to promote natural gas vehicles based solely on their environmental advantages in a region where no serious air pollution problem exists, or to promote natural gas vehicles as a way to reduce acid rain deposition knowing that transportation vehicles contribute little to the problem of sulfur emissions. Another cautionary note is that in comparing the environmental impact, not only must the direct effect in the vehicle's operation be measured, but the full effect on the various pollutants emitted during the fuels' production, transportation, and distribution must be measured as well.

Energy Source Diversification

The increased use of natural gas has two important energy source diversification implications: a reduction of petroleum imports and a shift from petroleum to natural gas. The continued increase in petroleum consumption is especially alarming considering a recent DOE projection indicating that domestic oil production is likely to decline further in the next twenty years.[22] Petroleum imports, consequently, are expected to increase further in the future. There have been many discussions about the economic, political,

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[22] "EIA Announces U.S. Energy Intensity Is Expected to Decline As Energy Consumption and Oil Imports Continue Upward," *NARUC Bulletin* (February 10, 1992), 10-11.

diplomatic, and even psychological impact of the dependence on petroleum imports, and they are not repeated here.[23]

The increased use of natural gas in transportation will reduce the amount of petroleum used.[24] The extent to which oil imports will be reduced as a result of the development and use of alternative-fueled vehicles is a more complex and uncertain matter. A reduction in total petroleum consumption will not necessarily lead to a proportional decrease in oil imports. The structure of the international petroleum market, the cooperation and competition between oil exporting countries, and the coordination of major oil importing countries all influence the international flow of petroleum. Given the relatively low cost of petroleum produced in the Mideast as well as its vast proven petroleum reserves, dependence on imported oil is not likely to change significantly in the foreseeable future even with a significant reduction in total petroleum consumption. The only direct ways of reducing petroleum imports are to impose substantial oil import fees, set stringent import quotas, or give substantial financial and regulatory incentives to domestic petroleum producers. The use of natural gas vehicles is

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[23] A summary of the economic and national security implications of the dependence on foreign petroleum supply (specifically those produced in the Mideast) can be found in U.S. Department of Energy, *Energy Security, A Report to the President of the United States* (Washington, D.C.: U.S. Department of Energy, 1987), 1-30.

[24] One study estimates that the continued development and use of motor vehicles powered by compressed natural gas and methanol can potentially displace about 2.5 million barrels of gasoline consumption a day by the year 2000. See Michael F. Lawrence and Janis K. Kapler, "Natural Gas, Methanol, and CNG: Projected Supplies and Costs," in *Alternative Transportation Fuels*, 21-50. However, this is a rather optimistic projection in comparison with other studies prepared by the American Gas Association and the U.S. Department of Energy. See, for example, "EIA Sees Gas Demand at 23.9 Tcf in 2005," *Inside F.E.R.C.* (February 3, 1992); and American Gas Association, "Projected Natural Gas Demands from Vehicles Under the Mobile Source Provisions of the Clean Air Act Amendments." This reduction is unlikely to happen considering that the amount of capital required to build an infrastructure able to support the required use of natural gas vehicles implied by the amount of petroleum displaced ranges from $55 billion to $90 billion based on the estimates prepared by the American Gas Association ($11.2 billions) and the U.S. DOE ($18.5 billions) of the NGV infrastructure cost required to displace one half million barrels of petroleum per day.

not directly related to these three options, and the effects of natural gas vehicle on reducing petroleum imports is likely to be indirect and unpredictable. It was concluded in the 1991 National Energy Strategy that no feasible combination of domestic or international energy strategy options can make the country completely invulnerable to oil supply interruptions. Furthermore, it is not in the nation's interest to adopt measures that reduce imports but impose high economic or environmental costs. The promotion of NGVs should take this into consideration.

In addition to reducing petroleum imports, the use of natural gas vehicles replaces a more abundant energy source for an energy source with more restricted supply potential. More than 90 percent of the natural gas consumed in the United States is supplied by domestic producers, in obvious contrast to petroleum's consumption.[25] Most experts seem to agree that the United States has an adequate gas resource base available *if the price is high enough*. It was estimated by the Department of Energy in 1987 that known domestic recoverable natural gas resources could support approximately thirty-five years of consumption.[26]

As for the deliverability of gas (that is the amount of gas made available to endusers after production, processing, transportation, and distribution) its long-term prospect is also encouraging. The Gas Research Institute projects that total U.S. domestic production will increase 14 percent from 18.3 quadrillion BTU (quad) to 20.8 quads between 1990 and 2010.[27] The amount of gas imports will more than double, from 1.5 quads to 3.7 quads, while import's total share of gas supply will increase from 7.7 percent to 14.8 percent. However, a large percentage of those imports will come

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[25] Energy Information Administration, *Monthly Energy Review* (Washington, D.C.: Energy Information Administration, April 1992), Table 4.2.

[26] If unconventional gas supplies such as gas shales, tight gas sands, and gas hydrates are included, the domestic supplies of natural gas might support up to 200 years at the current rate of consumption. See U.S. Department of Energy, *Energy Security*, 116-120.

[27] Thomas J. Woods, *The Long-Term Trends in U.S. Gas Supply and Prices: 1992 Edition of the GRI Baseline Projection of U.S. Energy Supply and Demand to 2010* (Chicago: Gas Research Institute, 1991), 5-10.

from Canada and Mexico where gas prices and supplies may be more predictable and less susceptible to political and strategic manipulations. The risk associated with dependence on gas imports is considerably less than the risk associated with petroleum imports.

Energy Price Stability

It has been argued that the dramatic and unpredictable changes in world petroleum prices are more harmful to the United States and other nations than a persistent but gradual rise in price, even if the average price over the long-run in both sets of circumstances is identical.[28] According to some experts, the presence of creditable alternative transportation fuels such as natural gas can reduce the market power of certain petroleum exporting countries as well as the potential increase and volatility of oil price.[29] It was estimated in 1988 that by substituting alternative fuels for 2 million barrels of gasoline a day the world oil price could be lowered $2 a barrel from $34 a barrel.[30]

However, others argue that the increased use of alternative fuels may put downward pressure on the price of petroleum, but will not reduce the volatility of oil price.[31] This is because the capital investments already spent on the production facilities, refueling stations, and vehicles associated with alternative fuels cannot be reversed or converted to other uses. Consequently, there is only a very narrow range of production and consumption in which the alternative fuel infrastructure can respond to changing oil prices. As discussed before, the complex and dynamic nature of the

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[28] *National Energy Strategy*, First Edition 1991/1992 (Washington, D.C.: U.S. Government Printing Office, 1991), 3-6.

[29] Sperling, "Introduction," in *Alternative Transportation Fuels*, 1-10.

[30] Ibid.

[31] Robert J. Motal, "Synthetic Fuel Costs in the Synfuels Era: A Chevron View," in *Alternative Transportation Fuels*, 51-64.

international petroleum market makes it difficult to estimate the effects of the increased use of NGVs on the reduction and stability of petroleum price. It may be speculation at best to argue that the extensive use of NGVs can definitely and significantly reduce the volatility of petroleum price.

Infrastructure Cost

The extensive use of natural gas vehicles will require some additions to this country's existing gas production and delivery infrastructure. Besides the increased cost of vehicle purchase and conversion, the incremental capital costs for retrofitting existing gasoline stations, the construction of new refueling stations, and the cost of expanding certain distribution pipelines to a large number of refueling stations are important infrastructure costs. The U.S. Department of Energy estimates that the average cost of an add-on NGV refueling station capable of dispensing 220,000 cubic feet of compressed natural gas a day is $320,500.[32] The capital costs for NGV refueling stations can be expected to vary significantly depending on location, method of financing, and other factors. The American Gas Association indicates that the capital cost for a similar NGV refueling station in California may be 10 to 15 percent higher than the DOE figure.[33]

Calculating the investments required in establishing an adequate infrastructure for a particular fuel is important, but it may not provide useful insights about the selection of NGVs or other alternative-fueled vehicles either from the perspective of an individual vehicle owner or government policymakers. The final infrastructure cost figures invariably depend on a broad range of assumptions about fuel production technologies, fuel costs, capital costs, vehicle energy consumption, and displacement. The validity of

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[32] U.S. Department of Energy, *Assessment of Costs and Benefits of Flexible and Alternative Fuel Use in the U.S. Transportation Sector, Technical Report Four: Vehicle and Fuel Distribution Requirements* (Washington, D.C.: U.S. Department of Energy, 1990), 35.

[33] Nelson Hay, "Infrastructure Costs for Natural Gas vs. Methanol for Vehicular Use," *AGA Gas Energy Review* (August 1991), 2-5.

these assumptions remains to be determined and certainly is open to argument. Even if infrastructure costs can be reliably determined, their usefulness in guiding government policies should not be overstated. Does a high infrastructure cost associated with NGVs necessarily indicate that natural gas is a less desirable alternative fuel and that the government should promote other alternative fuels more aggressively? Not necessarily. No matter how large or small the infrastructure cost is, most infrastructure costs eventually will be reflected in the cost of fuels and vehicles paid by users. Users themselves can determine which alternative fuels they want to use, suppliers can determine whether they want to build new fuel production plants, and vehicle manufacturers can determine the number of alternative-fueled vehicles they want to produce.

Special Considerations of Other Alternative Fuels

In addition to natural gas, other fuels have also been considered as possible alternatives to gasoline in powering motor vehicles. For example, indications are that the federal government and the state of California have been inclined to promote methanol since it is easily adapted to existing fueling and vehicle infrastructures.[34] In the following sections, some of the more important considerations surrounding the development and use of alternative fuels are discussed. The intent here is to indicate the competitive position of natural gas in comparison with other alternative transportation fuels in supplementing gasoline.

Methanol

Methanol is produced primarily through the steam reformulation of natural gas. It can be used as a petroleum substitute (such as M-85, a mixture of 85 percent methanol and 15 percent gasoline) or as a substitute for lead-based octane enhancers. Under

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[34] Lawrence and Kapler, "Natural Gas, Methanol, and CNG."

existing economic and technical conditions, it seems likely that methanol would be imported from low-cost producers in the Mideast, Chile, British Columbia, Alaska, and Trinidad. It would be transported by tankers to the U.S., blended with gasoline at portside, distributed by trucks to gasoline retail stations, and sold in the same manner as gasoline. Some modifications to gasoline-powered vehicles are required before using methanol.

The most important advantage of methanol as a transportation fuel is its liquid form. It can be readily mixed with gasoline and used quickly by existing vehicles and refueling stations with only minor modifications. Methanol also needs less infrastructure investment and less disruption to vehicle manufacturers, fuel suppliers, and vehicle users than a gaseous fuel or electricity.[35] Methanol is considered less safe than natural gas because its vapors can accumulate inside the fuel tank and become flammable; it also burns with an invisible flame. Methanol-fueled vehicles can produce formaldehyde in the exhaust, which is a suspected carcinogen that can react with other chemicals in the atmosphere to create smog. Methanol also corrodes fuel tanks and engine parts more severely than gasoline, meaning engines likely would require special lubricants to protect their cylinders.

There are some debates about the amount of capital required to establish the necessary infrastructure allowing for significant use of methanol as a transportation fuel.[36] The American Gas Association estimates that the total infrastructure cost

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[35] McNutt, "Alternative Fuels Market Development." There are other studies with different viewpoints about the relative advantages and limitations of methanol and natural gas such as Sperling and Deluchi, "Is Methanol the Transportation Fuel of the Future?"; and R. F. Webb, Carl B. Moyer, and M. D. Jackson, "Distribution of Natural Gas and Methanol: Cost and Opportunities," in *Alternative Transportation Fuels*, 65-82.

[36] See, for example, Hay, "Infrastructure Costs for Natural Gas vs. Methanol;" and U.S. Department of Energy, *Assessment of Costs and Benefits of Flexible and Alternative Fuel Use in the U.S. Transportation Sector.*

(including the capital costs of methanol production facilities, import terminals, marine shipping, domestic delivery and storage, dispensing, and vehicles) of displacing the first quadrillion BTU of petroleum is $28.6 billion dollars. The U.S. Department of Energy estimates the cost at $10.7 billion dollars. Not surprisingly, these two studies offer different implications about the desirability of using methanol or natural gas as the main alternative transportation fuels to gasoline.

Electricity

Electric vehicles share many of the same advantages and problems as natural gas vehicles. An electric vehicle produces no air pollution and reduces pollutants such as carbon monoxide, carbon dioxide, nitrogen oxides, and volatile organic compounds in its operation. Even if the secondary effects of pollution (that is the emissions produced when the electricity is generated) are included, the total emissions of certain pollutants may still be less than those of gasoline-powered vehicles. Another advantage is that a significant portion of the infrastructure to generate, transmit, and distribute electricity already is in place. In many instances, the user of an electric vehicle can tap existing electric outlets in his garage to recharge the electric vehicle overnight. However, for certain geographic areas considerable upgrades in electricity transmission and distribution facilities may be required, and consequently large amounts of infrastructure capital investment is needed before the widespread use of electric vehicles can occur. The extensive use of electric vehicles also could possibly improve the load factor of existing power plants since most vehicle recharging would occur during off-peak hours.

One disadvantage of electric vehicles is that air pollution at power plants may be increased (depending on the generation mix of the electric utility); for example, the overall emission of sulfur dioxide is likely to increase substantially if coal is used as the fuel in generating electricity. Furthermore, the cruising range (60 to 100 miles on full charge), top speed (50 to 75 miles per hour), and acceleration (0 to 50 mph in 14 seconds) of an electric vehicle each is less than those of a similarly equipped gasoline-powered vehicle, and may never be equal even incorporating more advanced batteries

still to be developed.[37] Also, the time required for a full battery recharge is extremely long, about eight hours. Fumes emitted during recharge and the disposal of used batteries can become serious environmental concerns if electric vehicles are used extensively.

The most critical element in developing and using electric vehicles is advancements in on-board batteries so the range of the vehicle, the time required for battery recharge, and the cost and useful life of the battery can be improved significantly.[38] Chrysler, Ford, and General Motors have formed the U.S. Advanced Battery Consortium to develop the most promising advanced battery technologies for use in electric vehicles. However, similar to the advancement of other technologies, the research and development of advanced batteries is far from certain, and the commercial application of these technology remains a few years away even by the most optimistic projections.

Ethanol

Ethanol in the United States is mainly made from domestically produced corn in the Midwest states. Ethanol is usually mixed with low-grade gasoline to form "gasohol"--a mix of 90 percent gasoline and 10 percent ethanol. Gasohol can be used in all gasoline-powered vehicles with no vehicle modifications required and with no deterioration of vehicle performance and fuel efficiency relative to gasoline-powered vehicles. Some concern exists that using ethanol can cause engine and valve damage due to ethanol-dissolved sediments and impurities in pipelines and tanks. To avoid this problem, ethanol is usually transported by trucks or through dedicated pipelines. The

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[37] A more detailed discussion on the performance of various electric vehicles in production and being design can be found in Taylor Moore, "They're New! They're Clean! They're Electric!" *EPRI Journal* (April/May 1991), 4-15.

[38] A review of the current battery technology and possible future advanced batteries can be found in Taylor Moore, "The Push for Advanced Batteries," *EPRI Journal* (April/May 1991), 16-19.

blending of gasoline and ethanol is usually done at or near the site of ethanol production, and the mixture is transported, distributed, and dispensed just like gasoline.

Like methanol, the extensive use of ethanol would require no substantial modification to existing gasoline infrastructures or behavioral adjustments on the part of vehicle users. The only significant change would be construction of new ethanol production plants if the demand for ethanol were to exceed the current production capacity.

Since ethanol can displace only 10 percent of the petroleum used in transportation, its effects in reducing environmental pollution and petroleum imports would be much less evident than for other alternative fuels unless there was a tremendous increase in its use. Any substantial increase in ethanol consumption, however, would be constrained by demand for corn in the world market (which in turn determines its price), the available ethanol production capacity, and the facilities of transporting ethanol from its production areas to other part of the country.

Reformulated Gasoline

Reformulated gasoline eliminates some of the highest and heaviest ingredients of normal gasoline to reduce sulfur emissions and other compounds. Its most important advantage is that it requires no change in existing vehicle design and manufacture, and current gasoline distribution networks and refueling stations can be used to the fullest extent possible. Similarly, no new fuel transportation and distribution infrastructure, nor driver behavioral adjustments would be required.

However, reformulated gasoline faces some limitations. Current refinery capacity is limited compared to the overall demand for gasoline. A substantial amount of capital investment would be required to modify existing refineries to produce enough fuel to achieve appreciable improvements in air quality. The use of reformulated gasoline will have no effect on reducing the nation's dependence on imported oil since the same amount of petroleum would be required. The environmental benefits are less

pronounced than other alternative fuels, especially for the most severe pollution problem of carbon monoxide and ozone-forming compounds.

Summary

There are about 30,000 natural gas vehicles in use in the United States at the present time, used primarily by government, utility, and private delivery fleets.[39] No readily available nationwide data on the government and private delivery fleets can be found. The following discussion is based on utility fleets data compiled by the American Gas Association. A breakdown of the fleet composition of selected utilities in 1989 and planned purchases for 1990 by vehicle and fuel types is shown in Table 2-4.[40] Though the composition of these fleets may not be similar to fleets owned by entities such as government agencies, there is reason to believe that these utilities are likely to be NGV's more active promoters. An examination of utility NGV purchase decisions may indicate a more optimistic development of natural gas vehicles. Based on the data on selected utility vehicle fleets, some trends can be identified.

First, natural gas vehicles still account for a small percentage of the total utility vehicle fleets despite utilities' transportation needs being short-haul and fixed-route, with vehicles mostly centrally fueled and centrally garaged. Second, vehicles with dual-fuel capacity seem to be the preferred choice of most utilities. For the planned NGV purchases of 1990, for example, the number of dual-fuel NGVs was almost ten times that of dedicated NGVs. Possible explanations for the preference of dual-fuel vehicles are the utilities' concerns about the limited range of a dedicated NGV (especially for emergency situations in remote locations), the future cost and availability of gas (this is clearly a lesser concern at the present time), and the relatively small cost differentials (if

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[39] With the current interest in natural gas vehicles and the many on-going activities in this area, it is not possible to have an exact account of the current number of NGVs in use. However, the number used here seems to be a reasonable figure.

[40] American Gas Association, "Natural Gas as An Alternative Transportation Fuel."

TABLE 2-4

FLEET VEHICLE COMPOSITION AND PLANNED PURCHASES FOR SELECTED UTILITIES IN 1989

	1989 (Actual)					1990 (Planned)				
	Dedicated CNG	Dual-Fuel CNG	Gasoline	Others	Total	Dedicated CNG	Dual-Fuel CNG	Gasoline	Others	Total
Passenger cars										
Compact	1	68	1,602	1	1,672	3	36	1,011	1	1,051
Intermediate	0	47	810	0	857	0	75	763	0	838
Total Cars	1	115	2,412	1	2,529	3	111	1,774	1	1,889
Vans										
MiniVans	2	106	540	0	648	1	73	421	0	495
Standard	6	368	758	31	1,163	62	295	673	47	1,077
10,000-19,500 lbs.	0	15	20	46	81	0	13	20	37	70
Total Vans	8	489	1,318	77	1,892	63	381	1,114	84	1,642
Trucks										
Light	0	383	1,474	1	1,859	16	305	1,304	1	1,626
6,000-10,000 lbs.	0	210	1,542	587	2,339	20	1988	1,296	420	1,934
Medium	0	106	523	212	841	3	88	355	211	657
Heavy	0	44	120	621	785	0	12	96	470	578
Total Trucks	0	743	3,659	1,421	5,824	39	603	3,051	1,101	4,795
Grand Totals	9	1,347	7,389	1,499	10,245	105	1,095	5,939	1,185	8,326

Source: American Gas Association, "Natural Gas as An Alternative Transportation Fuel," 1990.

any) between a dual-fuel vehicle and a dedicated one. A survey of fourteen NGV fleet owners conducted in 1987 showed similar results.[41] Of the 800 natural gas vehicles in use when the survey was conducted, all were dual-fuel (compressed natural gas/gasoline) rather than dedicated CNG vehicles. The fleet owners cited economic factors and the desire to have a backup fuel for gasoline as the primary reasons for converting to dual-fuel vehicles.

There are also various estimations about the future development of NGV, in particular the number of vehicles in use. The federal government has proposed a ten-year program with phased-in introduction of clean-fueled vehicles: 500,000 vehicles in 1995, 750,000 in 1996, and 1 million each year from 1997 to 2004. The Gas Research Institute (GRI) projects that by the end of the 1990s there will be more than 500,000 natural gas vehicles in use, and by the year 2010 the number will exceed one million.[42] (The GRI's projection of market shares of natural gas vehicles in various vehicle market segments is shown in Table 2-5.[43]) The American Gas Association projects that as a result of implementing the mobile source provisions (clean-fuel vehicle fleet program and California pilot program) of the Clean Air Act Amendments of 1990, about 4 million natural gas vehicles will be purchased and put into service between 1995 and 2005.[44] Among the various type of vehicles, NGV is projected to capture a 75 percent market share of all clean-fuel vehicles (methanol, ethanol, propane, electricity, and natural gas) in light-duty and medium-duty fleet trucks, a 40 percent share in fleet cars, a 40 percent share for heavy-duty trucks, and a 45 percent share for buses. A

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[41] Hull, *Environmental Benefits of CNG-fueled Vehicles,* 7, 44.

[42] Stephen D. Ban, presentation at the DOE/NARUC Conference on State Regulation and the Market Potential for Natural Gas: Challenges and Opportunities, February 3, 1992, Phoenix, Arizona.

[43] David Webb's presentation, "Natural Gas Vehicle Update," to the Committee on Gas, NARUC Winter Meeting, February 26, 1991.

[44] Paul Wilkinson and Nelson Hay, "Projected Natural Gas Demand from Vehicles Under the Mobile Source Provisions of the Clean Air Act Amendments," *AGA Gas Energy Review* (April 1991), 9-13.

TABLE 2-5

GRI PROJECTED MARKET POTENTIAL FOR NATURAL GAS VEHICLES BY 2010

Vehicle Type	Market Share (%)	Number of Vehicles (1,000)	Annual Gas Use (Bcf)
Cars	5-10	100-200	15-30
Vans, Pick-ups	10-20	400-800	70-140
School Bus	20-40	75-150	15-30
Medium-Duty Delivery Vehicle	10-20	250-500	100-200
Transit Bus	50-100	25-50	25-50
Refuse Hauler	20-40	40-80	32-64

Source: Gas Research Institute, 1991.

review of past experience in the development of alternative-fueled vehicles indicates that these government and gas industry projections are likely to be too optimistic. Given the gasoline-powered vehicle's long-standing domination in the motor vehicle market, a large-scale conversion to natural gas vehicles is not likely. For example, Pacific Gas and Electric Company (PG&E) estimated in 1990 that of the eight million vehicles in PG&E's service territory only about 6 percent, or about 500,000 vehicles with suitable usage and fueling characteristics, may be considered for conversion to run on compressed

natural gas.[45] Of these possible candidates for conversion, an uncertain percentage of them would actually convert to natural gas even if the problems of inadequate infrastructure, fuel price uncertainty, and operational limitations could be resolved or reduced considerably.

Substantial financial incentives to fleet vehicle owners and potential refueling station owners, or extremely high taxes on gasoline and gasoline vehicles may stimulate the growth of the NGV market considerably. But the economic costs of doing so may be too high to make it politically acceptable. The imposition of much more stringent air pollution regulation (and possibly the mandated conversion to alternative-fueled vehicles) not to mention a prolonged petroleum supply shortage also may spur the development and use of natural gas vehicles. Based on current information, such events are not likely to occur any time soon.

In summary, the short-term potential for natural gas vehicles in reducing foreign oil dependence and enhancing environmental protection is limited. They will be used primarily in centrally fueled, centrally garaged, short-haul vehicle fleets owned by corporations and governments. Individual vehicle owners will consider purchasing natural gas vehicles only as a second car for daily commuting purposes. Over a longer period of time, natural gas vehicles may have the potential to compete with gasoline-powered vehicles if a refueling, service, repair, and manufacturing infrastructure is firmly established.

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[45] California Public Utilities Commission, "Application of Pacific Gas and Electric Company for Authority to Increase Gas Rates and Recover Costs for Implementation of a Natural Gas Vehicle Program," Decision 91-07-018, July 2, 1991.

CHAPTER 3

STATE REGULATORY ISSUES

Though government can affect the development and use of natural gas vehicles through a broad range of policy options, the extent of a state public service commission's influence remains limited. Out of a broad range of policy options aimed at promoting NGV, more stringent environmental regulation, establishment of a refueling and service infrastructure, higher taxes on petroleum fuels and gasoline vehicles, and expanded vehicle demonstration and procurement programs are viewed as most effective.[1] A state public service commission, however, has little direct influence over these policy options. Its influence in many cases is exercised only through its jurisdiction over local gas distribution companies. The focus of this chapter is to identify the main issues a state commission needs to consider to help develop an environment in which natural gas vehicles can compete fairly with other types of vehicles on their own merits.

Local gas distribution companies (LDCs) are the only entity in the natural gas vehicle infrastructure over which a state public service commission has clearly defined jurisdiction. LDCs and refueling stations have the most direct interactions with natural gas vehicle users. An LDC can participate in a broad range of NGV-related activities such as the sale or transportation of gas to refueling stations, construction and operation of refueling stations, vehicle conversion, and the setting and certification of NGV-related design and operational standards. From the perspective of a state commission, three categories of regulatory issues have significant influence on the development and use of natural gas vehicles. They are:

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[1] See, Daniel Sperling, ed., *Alternative Transportation Fuels: An Environmental and Energy Solution* (New York: Quorum Books, 1989); General Accounting Office, *Alternative-Fueled Vehicles* GAO/RCED-91-169 (Washington, D.C.: General Accounting Office, 1991); and Rebecca L. Busby, "NGVs Now on the Fast Track," *Gas Research Institute Digest* (Spring 1990), 2-11.

(1) the entry by LDCs and other entities into NGV-related markets;

(2) the authority to regulate NGV-related services and products; and

(3) the funding of NGV-related activities initiated by the LDCs.

These three categories of issues are closely related and in many instances need to be solved simultaneously. For example, the participation of an oil company in the natural gas refueling market (a market entry issue) may well depend on the clarification of federal and state jurisdiction on the price and quantity of natural gas sold at the refueling station (a jurisdiction issue).

Issues of Market Entry

Since extensive use of natural gas vehicles is a relatively new idea, the structures and participants in the markets for NGV-related products and services are not clearly defined. Whether there should be any restriction on participation in any of these markets is a key issue still to be resolved. For example, some oil companies are reluctant to enter the natural gas refueling market for fear of being regulated as a public utility or a utility holding company. The issue of market entry can be further divided into three considerations. First, which entities other than the local distribution companies should be allowed to participate in a particular market for NGV-related services and products? Second, should the LDC be excluded from a particular market or allowed to participate but under a different set of rules due to its public utility status? Third, if the LDC is allowed to participate in a certain market, should it be operated as a separate unregulated subsidiary or as an integral part of a regulated utility?

An examination of the natural gas vehicle infrastructure indicates there are six main components, and consequently six markets for NGV-related services and products. They are the NGV equipment and conversion market, the NGV repair and maintenance market, the refueling station equipment and construction market, the gas production and transportation market, the local gas distribution market, and the natural gas refueling

market. The relationship of these six markets and the major market participants are shown in Figure 3-1. Several well-established criteria and measurements can be used to determine and characterize the structure and conduct (market power) of participants in a particular market (industry).[2] An incomplete list would include the number of firms, the combined market share of the top four or eight firms, the price-cost margin, and the Herfindahl-Hirschman Index (the sum of the squared market shares of each firm). Since NGV-related markets are in their initial stage of development, there are only scant data available on market shares, sales, and profits. No attempt is made here to empirically measure the concentration indices of these markets. The following discussions of competition and concentration in these markets will be based more on general observations than on actual statistical measurements.

Natural Gas Vehicle Equipment and Conversion Market

At the present time, the original equipment vehicle market consists of a small number of major manufacturers of gasoline and diesel-powered vehicles. This is no surprise in light of the many similarities between gasoline-powered and natural gas vehicles in engineering design, manufacturing, and marketing. Because of the enormous amount of capital, technical expertise, and marketing organization required in the manufacture and marketing of motor vehicles at a commercially sustainable level (the minimum efficient scale),[3] few participants not already involved in vehicle manufacture

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[2] A discussion of the relationship between market structure and behaviors of market participants can be found in F. M. Scherer and David Ross, *Industrial Market Structure and Economic Performance, Third Edition* (Boston: Houghton Mifflin Company, 1990), 1-7. It also addresses the issues related to the measurements of market power and concentration. Ibid., 57-96.

[3] The minimum efficient scale (MES) is defined as the smallest scale of production at which minimum units costs are attained. Obviously, the MES can vary significantly among different industries and over time with many factors contributing to its determination. It was estimated that an automobile assembly plant needed to produce about 200,000 vehicles per year on double shift operation to reach the minimum unit cost of production. See Ibid., 95-118.

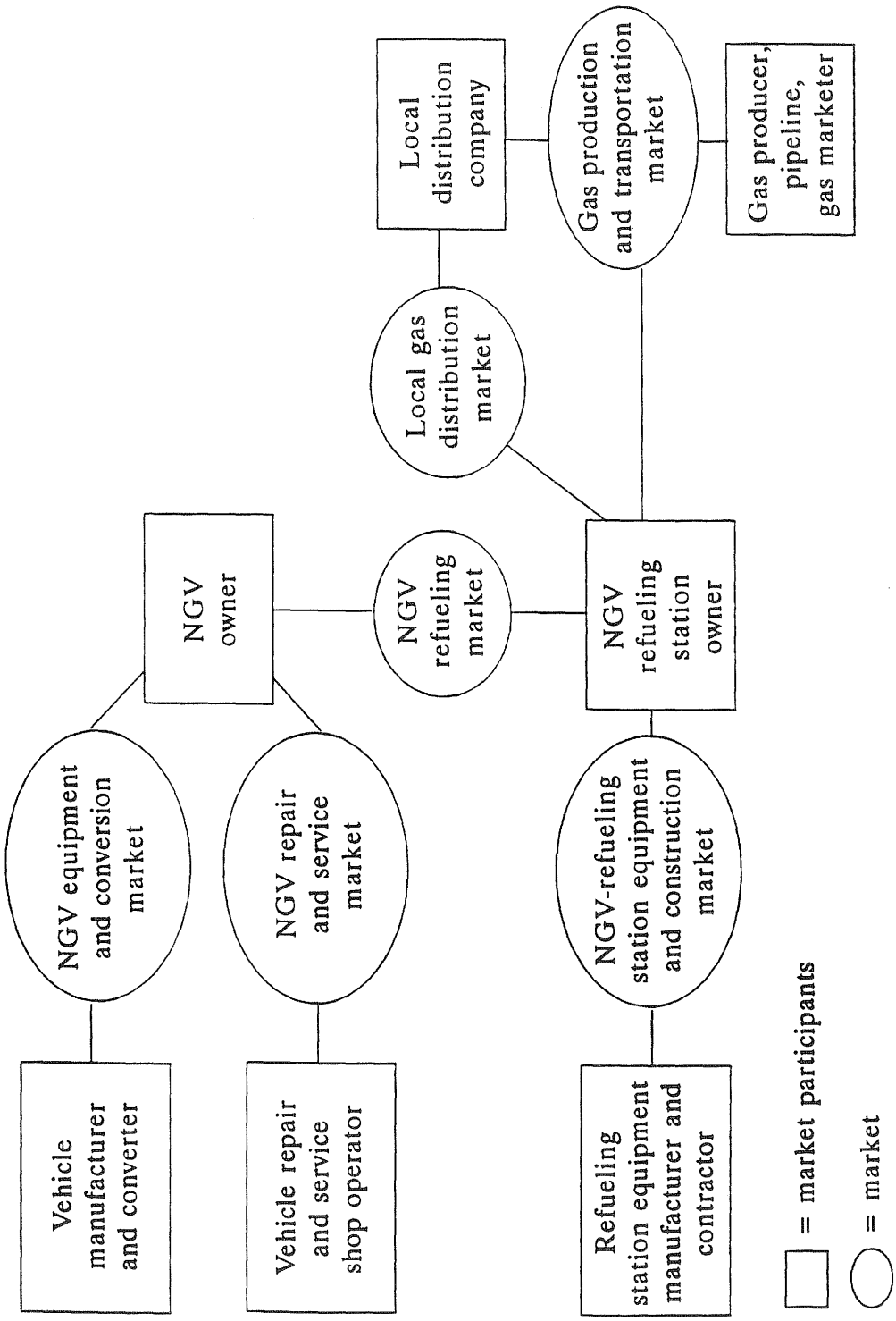

Fig. 3-1. **A schematic of NGV-related markets and participants** (Source: authors' construct.)

are expected to emerge, at least not on a significant scale. The capital, technical expertise, and marketing organization required to produce and market NGV conversion kits are less than those required to produce OEM vehicles. More participants in the NGV conversion equipment market are likely.[4] In any event, the OEM and vehicle conversion markets have not demonstrated the characteristics conducive to a monopoly, and have never been subject to public utility regulation in the past. There is no reason to expect that the technology, cost structure, and competition in the automobile industry will change drastically with the introduction of natural gas vehicles.

No local distribution companies are involved in the NGV equipment and conversion markets at the present time, and seem unlikely to get involved in the future due to their lack of technical expertise and experience in vehicle manufacturing and marketing. Thus, the state public service commission has no direct influence on the structure and competitive nature of this market, and there is no justification for it to intervene, either.

NGV Repair and Maintenance Market

At the present time, most NGV fleet owners have their own in-house garages to perform maintenance and repair services. Individual vehicle owners generally do not have their own NGV repair garages and must rely on gasoline-vehicle repair and service shops. Due to the small number of NGVs in use, few public-access repair shops, if any, can survive by providing services only for natural gas vehicles. If the number of vehicles were to increase significantly, repair shops specializing in servicing natural gas vehicles would likely emerge. Because of the many similarities in vehicle components and powering and fueling technologies between an NGV and a gasoline vehicle, a large

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[4] It is estimated that currently there are about 120 vendors located throughout the country providing vehicle conversions, compressors, cylinders, dispensing equipment, and other NGV-related products and services. See Mark S. Bononi, "The Natural Gas Industry and Natural Gas Vehicle Infrastructure," *AGA Gas Energy Review* (April 1991), 14-15.

number of gasoline-vehicle repair shops can participate in a fully developed NGV repair and maintenance market if they choose to do so. The potentially large number of participants and the high degree of competition that already exists in similar markets imply that the NGV repair and maintenance market is expected to be quite competitive. There is no justification to impose any restriction on participation in this particular market. As for LDC participation, these firms have no particular technical and economic advantages over other potential market participants. Given the limited size of the market at the present time, it is unlikely that many LDCs actually will participate.

Refueling Station Equipment and Construction Market

At the present time, most public-access natural gas refueling stations are an addition to existing gasoline fueling stations, if adequate space is available. For some limited-access refueling stations serving a large fleet of vehicles, an all-gas configuration may be used. The typical equipment installed in a natural gas refueling station is similar to a gasoline refueling station with the exception of different nozzle dispensers, compressors, and storage vessels.[5] Because of the many similarities between a gasoline and a natural gas refueling station, it can be expected that those entities involved in supplying equipment and building gasoline refueling stations can readily enter the market. This market is likely to be similar to the market for gasoline station equipment and construction, so no government restrictions to entry are expected except in the areas of setting and certifying safety, accuracy, and operational standards.

Few local distribution companies are currently involved in the manufacture of equipment such as gas mains, pipelines, and meters and seem unlikely to become active participants in this business with the introduction of NGVs. It is possible that an LDC may get involved initially, to promote and demonstrate equipment installation and

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[5] A brief description of the components of a natural gas refueling station and the typical customer refueling procedure can be found in Todd Bernhardt, "Fill'er Up," *American Gas* (September 1991), 14-19.

personnel training for refueling stations as the NGV infrastructure is still developing. As time goes by, however, there are few justifications for or expectations that LDCs will become active participants in this market. The equipment and services required to build a natural gas refueling station likely will be competitively supplied.

Gas Production and Transportation Market

The fourth market is the natural gas production and transportation market,[6] which determines the price and quantity of gas available to local distribution companies. Traditionally, this market has been under the jurisdiction of the Federal Energy Regulatory Commission (FERC) and the states have had little influence.[7] Dramatic changes in the last ten years in government regulation regarding the production and transportation of gas have seen gas production essentially deregulated, with the Federal Energy Regulatory Commission accelerating its process of restructuring gas transportation.

On April 8, 1992, the FERC issued Order No. 636, requiring fundamental changes in the way natural gas pipelines provide services to their customers. This Order is still

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[6] In the past, a clear distinction between the gas production market (wellhead market) and the gas transportation market (city gate market) can be made. However, as a result of the rapid increase in direct gas purchases and the development of the spot market and futures market, the traditional distinction between the wellhead and the citygate markets may no longer exist. Instead, a new distinction between the gas acquisition service and gas transportation service has emerged. Sometimes, a gas transportation service refers to the transportation of gas both across the states and within a state. Here, the transportation service refers only to interstate gas transportation. In following analysis, the gas production market and the interstate gas transportation market are referred as one gas production and transportation market. More on the evolution of the gas production and transportation market can be found in Daniel J. Duann, "Direct Gas Purchases by Local Distribution Companies: Supply Reliability and Cost Implications," *The Journal of Energy and Development* 15 (Autumn 1989): 61-93.

[7] The natural gas and oil producing states do have certain energy production regulations in place. But these regulations are primarily aimed at better utilization and recovery of natural resources and are unrelated to the market entry issue.

subject to rehearing and judicial review, and it may be too early to predict its eventual impact on the natural gas production and transportation market. It can be expected, however, that its effects on the development and use of NGVs will be indirect and limited. Thus, the natural gas production and transportation market is likely to become more competitive, and the introduction of NGVs will not change the competitive nature of the gas production and transportation market.

Local Gas Distribution Market

The fifth market is the local gas distribution market: the main business of a local distribution company. Local distribution is regulated by state public service commissions except in limited circumstances where the distribution service is provided by municipalities and gas cooperatives.[8] The development of natural gas vehicles will not change the status of an LDC as the local gas distribution monopoly. The LDC will remain as the sole gas supplier to captive customers who have no alternative suppliers and as the provider of transportation and other backup services (such as load balancing and storage) for noncaptive customers with fuel-switching and supplier-switching capability. The only change in the local gas distribution market would be the addition of natural gas refueling stations. Then the entry issue in this market amounts to whether refueling stations should be treated as captive customers of the LDC or as potential gas transportation customers similar to some industrial and commercial firms who only use the LDC's facilities to transport their own gas. Put another way, what entities, if any, besides LDCs should be allowed to supply gas to refueling stations?

Whether to treat natural gas refueling stations as captive customers is best resolved within the framework of existing state policies on unbundled gas services, in particular state gas transportation policy. In general, a natural gas refueling station

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[8] The term "local distribution service" is broadly defined here. It refers to not only the bundled gas service traditionally provided by the LDC but also the unbundled services such as transportation, backup, storage, and load balancing provided to the gas transportation customers.

should be treated no differently than other transportation-only industrial and commercial customers.[9] If current state gas transportation policy allows for direct gas purchases by certain customers, then natural gas refueling stations should be allowed to do so. In allowing refueling stations to use the LDC for transportation purposes, the state public service commission is implicitly allowing entities other than LDCs to supply gas to the refueling stations.

Because any gas supply interruption would affect only a few specific customers and not general NGV users, there is no justification to restrict limited-access refueling stations (which serve only one or few specific customers) to purchase gas only from the LDC. But, the restriction of gas suppliers to public-access refueling stations is a more complicated matter. If a large number of refueling stations already exist within a specific geographic area, NGV users would have many refueling alternatives available making gas supply interruptions to a particular refueling station less of a concern. There is no need to restrict the gas suppliers to the refueling stations. However, if there are only a small number of refueling stations available, NGV users would have few alternatives in obtaining gas. Any supply interruption to these refueling stations could render the NGVs "useless." Consequently, treating refueling stations as "captive" customers of an LDC and imposing certain limitations on gas suppliers to the refueling stations may deserve positive consideration. This does not mean that the owners of the refueling stations are less capable than other transportation customers in obtaining economical and reliable gas supplies. It only indicates the possibility that, given the differences in the amounts of gas procured and the number of gas supply sources, an LDC tends to have a more diversified gas supply portfolio (thus with less possibility of supply interruptions) than a typical refueling station.

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[9] A more detailed discussion of the issues and policy options on gas transportation service within an LDC's service territory can be found in Robert E. Burns, Daniel J. Duann, and Peter A. Nagler, *State Gas Transportation Policies: An Evaluation of Approaches* (Columbus, OH: The National Regulatory Research Institute, 1989).

Natural Gas Refueling Market

This is the most critical market entry issue facing state public service commissions. Before discussing the nature of an NGV refueling market, it is useful to examine how the natural gas vehicle will be operated and refueled. Given current natural gas refueling technology and vehicle performance, a large percentage of NGVs in use at the present time is fleet vehicles with centralized refueling facilities owned and operated by the fleet owners.[10] A smaller percentage may be owned by individuals, who must rely on a small number of public refueling stations. The dominance of limited-access refueling stations seems unavoidable at this stage of NGV development. Fleet owners who have purchased or who want to purchase natural gas vehicles must build their own refueling stations to ensure that their fleets will be fueled when needed.

Most public refueling stations at the present time are owned by gas utilities and large oil companies with strong financial resources to enter a market having uncertain prospects. As the actual market for natural gas vehicles becomes clearer, other entities such as gas producers, petroleum marketing companies, and independent gas station owners may join the gas refueling market. The local distribution companies may also expand their presence in this market. For example, Southern California Gas Company has announced plans to construct fifty-one NGV refueling stations within its service territory by the end of 1993 and to have a network of 1,300 refueling stations serving about 80,000 customers in place by 2000.[11]

The ownership and operation of natural gas refueling stations appear to have no overwhelming economies of scale and scope to justify creating a regulated monopoly to serve a specific geographic area. Certain marketing and financing advantages may exist for an entity that owns a large number of refueling stations. Such advantages are quite

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[10] A recent American Gas Association directory lists 328 NGV refueling stations nationwide with only 123 of them accessible to the general public. See Bononi, "The Natural Gas Industry and Natural Gas Vehicle Infrastructure."

[11] Bernhardt, "Fill'er Up?"

different, however, from the inherent technical advantages typically associated with a public utility.[12] Similarly, there is no indication of significant economic advantages stemming from the vertical integration that exists between the local distribution company and the refueling stations.

Besides the economies of scale and scope, another consideration in deciding whether to allow a public utility to provide service is the necessity of that service to NGV users. Obviously, the refueling service provided by all public refueling stations is essential to NGV users who have no access to other stations. But the refueling service provided by one particular refueling station is not essential to an NGV user since he can obtain natural gas from other refueling stations. So the idea of providing an essential service as a justification for creating a regulated monopoly is also voided by the potentially large number of refueling stations in this market. There is no need for public service commissions to limit entry into the NGV refueling market, or to impose any type of public utility regulation on the refueling stations to ensure that natural gas will be available to NGV users.

Nevertheless, entry to the natural gas refueling market is not without government restrictions as refueling station owners still need to obtain permission from zoning, environmental protection, and fire safety agencies before building. The process of opening an NGV refueling station may take anywhere from six to nine months, although the actual time of construction may be closer to three to six weeks.[13]

Once the free market entry by local distribution companies is set, the next question is in what form the local distribution company should be allowed to participate in the natural gas refueling market. Should refueling stations be an integral part of the

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[12] Three factors are commonly associated with the establishment of a monopoly to provide goods and services: a decreasing long-term cost structure, the requirement of high entry costs and immobile capital investments, and the small number of technically-feasible operators. See Congressional Research Service and The National Regulatory Research Institute, *Natural Gas Regulatory Study* (Washington, D.C.: U.S. Government Printing Office, 1982), 219-52.

[13] Bernhardt, "Fill'er Up?"

LDC or organized as a separate unregulated subsidiary? The creation of a separate subsidiary to handle the refueling business is more desirable for several reasons. First, the imposition of regulation on a significant part of the natural gas refueling market may create substantial distortions in a competitive market as other entities' decisions are restricted or protected by the regulated price set on the LDC-owned refueling stations. Second, if the LDC-owned refueling stations are not owned by a separate subsidiary or if proper financial safeguards are not instituted, an LDC's ratepayers may have to shoulder losses suffered unexpectedly in a competitive and unregulated refueling market.

The third concern is the so-called anticompetitive consideration. An LDC may use its monopoly position in gas distribution or its significant market presence to dominate or even inhibit other entities in the NGV refueling market. Examples of these potentially anticompetitive behaviors include, but are not limited to, the refusal to transport gas for refueling stations and the imposition of difficult terms for transportation service. The case of Southern California Gas Company (SoCal Gas) cited previously would seem to have the potential for this. This is not at all to suggest, however, that SoCal Gas engages in such behaviors, only to point out the generic problem of a dominant supplier in a particular market.

Though it is difficult to predict the number of gas refueling stations in the SoCal Gas service territory by the year 2000, the projected number is still substantial (about three times the number of NGV stations in use at the present time nationwide). It is hard to imagine that any other single entity will own as many refueling stations as SoCal Gas in its service territory. Undoubtedly, SoCal Gas will be a major player in the market if this projected number does materialize. The expected large market share of SoCal Gas may raise concerns of potential anticompetitive behavior. On the other hand, it is also difficult to imagine that other potent competitors such as Chevron, Arco, and Shell will remain on the sideline and not expand their NGV refueling business if demand for NGV refueling service justifies it. These major oil companies already have thousands of gasoline stations in desirable locations and have sufficient financial resources and technical expertise to compete with SoCal Gas in marketing their products. Only when

there are substantial barriers to accessing the transportation and distribution facilities owned by SoCal Gas will these competitors' entries be inhibited.

But, as the interests of other entities in entering the market are restrained at the present time, it is possible some LDCs may choose to open refueling stations to expand the availability of refueling service to encourage use of NGVs and to demonstrate the technical feasibility and economic viability of NGV technology. Furthermore, the LDC's involvements in owning and operating refueling stations may only last a short period of time (such as three years) and in limited scale. Under this circumstance, the requirement of establishing a separate subsidiary may be viewed by the LDC as too burdensome and too costly to justify its participation in the refueling market, and the development of the NGV infrastructure would be slowed accordingly. The state public service commission may consider allowing the LDCs to directly own and operate a small number of refueling stations for a limited time period. If this is the case, the state commission only has to regulate the price and conditions of refueling service provided to LDC-owned stations.

In summary, the emphasis of state public utility regulation, if any, in the natural gas refueling market should not be to impose entry restrictions or price regulation, but to assure equitable and open access to the gas transportation and distribution facilities so that interested parties can participate if they choose.

Issues of Jurisdiction

Once the participants and structure of a market are decided, the next question is jurisdiction; that is whether any activities within NGV-related markets should be regulated and, if so, by which government agencies. As discussed in previous sections, the only markets where a state public service commission can have some influence are the gas distribution market where gas is supplied to refueling stations, and the natural gas refueling market where gas is dispensed to vehicle users. It has also been pointed out that there is probably no need to restrict participation in these two markets except when a local distribution company is participating directly, or when the number of

refueling stations is so small that NGV users are essentially captive customers to those few refueling stations. This section delineates the jurisdictional issues associated with these two markets. In addition, issues related to jurisdiction by the Federal Energy Regulatory Commission and the Securities and Exchange Commission also are discussed.

Regulation of Gas Sales to Refueling Stations

The local distribution company will remain the sole supplier of gas to captive customers within its service territory with or without the introduction of natural gas vehicles. If a natural gas refueling station (whether it be a public or limited-access station) chooses to be served in the same way as a firm customer, then the transaction between the LDC and the refueling station should be regulated by the state in the same fashion.

The more complicated situation is where the refueling station chooses to be served as an interruptible customer or to purchase gas from sources other than the LDC, but still uses the LDC for transportation and backup purposes. In the case of interruptible service, the transaction still may be subject to state regulation, though tariff and service conditions would be different. In the case of purchasing from sources other than LDCs, the state public service commission has no jurisdiction over the cost of gas paid by the refueling station though it still has jurisdiction over the terms and prices of transportation and backup services provided by the LDC.[14] In short, the prices and conditions under which the gas merchant and transportation service provided by the LDC to the refueling stations should not differ from those imposed on transactions between the LDC and similarly situated customers.

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[14] A detailed discussion of the principles and methodologies used in pricing transportation service provided by an LDC can be found in Burns et al., *State Gas Transportation Policies.*

Regulation of Gas Sales to NGV Users

This issue deals with the regulation of gas sales between a public-access refueling station and NGV users. Since gas sales to natural gas vehicle users can be viewed as a retail gas sale and may be subject to state regulation, the possibility of coming under state public utility regulation has been cited as a significant hindrance to the participation of some entities in the natural gas refueling market. The following sections will show that because of the existence and potential entry of many viable competitors, refueling stations owned by LDCs do not enjoy unfair advantages associated with an LDC's monopoly power in gas distribution, unless the LDC-owned stations receive preferential treatment in gas transportation and backup services. Thus, the most important jurisdictional question is to assure equal access to the LDC's gas transportation facilities, rather than the regulation of gas refueling service itself.

A number of criteria can be used to determine whether a particular service (such as gas sales to NGVs) should be subjected to public utility regulation.[15] Two of the most widely used criteria are whether a single firm can supply the entire market at a lower cost than two or more suppliers, and whether the services and goods are essential and exhibit inelastic demand. The concept of a public utility is highly complicated and the above two tests can only be viewed as part of the guidance needed to decide whether a particular service should be regulated or not.[16]

At the present time, no definite empirical studies are available to indicate any significant economies of scale and scope in the ownership and operation of natural gas refueling stations. One useful way to examine the validity of applying utility regulation to natural gas refueling stations is to view the transaction mechanism for closely related products, in this case the gasoline retail market. This market is characterized by a large

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[15] James C. Bonbright, Albert L. Danielsen, and David R. Kamerschen, *Principles of Public Utility Rates, Second Edition* (Arlington, VA: Public Utilities Reports, Inc. 1988), 8-10.

[16] Ibid., 14-25.

number of firms and extremely low level of concentration. According to 1987 Census Bureau estimates, the four-firm concentration ratio (the combined market share of the largest four firms) was 7.1 percent, and the net entry (as measured by the difference between service stations in business anytime during the year and stations in business at the end of the year) was in the range of 5 to 10 percent.[17] The gasoline retail market is not under public utility regulation nor does it enjoy any privileges such as eminent domain. Similar conclusions may be drawn for the natural gas refueling market.

There is one important distinction between the retail gasoline market and the retail gas market. Gasoline is transported to retail stations primarily by trucks whose operation exhibits no significant economies of scale. On the other hand, natural gas is delivered to refueling stations mainly through pipelines, whose construction and operation do exhibit significant economies of scale. The presence of significant economies of scale in gas distribution operation may be the most important justification for creating a franchised monopoly for gas distribution service.

However, the natural gas refueling station is an extension of the existing gas distribution infrastructure rather than a separate entity. So no matter how many potential natural gas refueling station owners there are in a given geographic area, these refueling stations will use the existing gas distribution network, which is owned by the local distribution company, for transporting gas except for a limited number of end-of-the-line distribution extensions. The problem of installing duplicate facilities commonly associated with imposing a competitive industry structure on a "natural monopoly" product does not exist. The use by many refueling stations of a common gas transportation and distribution system owned and operated by one entity does not necessarily mean many refueling stations should be owned by the same entity.

To prevent the unnecessary regulation of natural gas sales to NGV users, some states have enacted laws or regulations that exempt the retail sale of natural gas for

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[17] Rayola S. Dougher and Thomas F. Hogarty, *Structure and Performance in Motor Gasoline Manufacturing and Marketing* (Washington, D.C.: American Petroleum Institute, 1991), 4-6.

transportation purposes from state public utility regulation.[18] A summary of the state regulatory status of vehicular gas sales is shown in Table 3-1. Up to now, no concerted effort to oppose such exemptions has appeared. The concerns of certain entities about the potential for state public utility regulation are real, but there do not appear to be many controversies about how to overcome this concern. The key task is to quickly clarify and codify the intention of the state public service commission in not imposing any kind of utility-type regulation in this market. Also, pending federal legislation--S.2166, the National Energy Security Act of 1992--has provisions that would specifically prohibit states from regulating the sale or transportation of vehicular natural gas as a utility activity, provided that the entity is not otherwise primarily engaged in the business of a public utility.[19]

Regulation of Gas Refueling Station Owner as a Utility Holding Company

Under the Public Utility Holding Company Act of 1935, if a business has a 10 percent ownership interest in a public utility, it is viewed as a utility holding company and becomes subject to the regulation by the Securities and Exchange Commission (SEC). As indicated in previous sections, there is no justification to define the natural gas refueling station as a public utility. If natural gas refueling stations are not defined as such, then the entities (such as oil companies) that own these refueling stations, and which are not otherwise engaged in providing utility services, are neither public utility holding companies nor subject to SEC regulation. Where some ambiguity may still exist about the public utility status of a natural gas refueling station, two approaches can be taken to remove the concern of refueling station owners. Pending federal legislation

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[18] See Appendix B for more detailed discussion on this subject.

[19] See Section 11108 of the pending legislation. The Senate this passed legislation in February 1992. The House of Representative also passed similar legislation in May 1992. The enactment of this legislation is expected later this year.

TABLE 3-1

STATE REGULATORY STATUS OF RETAIL SALES OF NATURAL GAS AS A VEHICLE FUEL

State	Regulation of Retail Sale of NG as a Vehicle Fuel
California	Deregulated
Colorado	Deregulated
Kentucky	Exemptions being requested
Louisiana	Deregulated
Minnesota	Deregulated
New York	Refrain from regulation on a case-by-case basis
Oklahoma	Deregulated
Pennsylvania	Exemptions being requested
Texas	Deregulated
Utah*	Considering deregulation
Virginia	Refrain from regulation on a case-by-case basis
West Virginia*	Deregulation of nonutility gas
Wisconsin	Deregulated

Source: Columbia Gas of Ohio, "Natural Gas Vehicle Infrastructure Development Issues," presented to the Public Utilities Commission of Ohio, July 18, 1991.

*These two states are added based on additional information available.

proposes to exempt the natural gas refueling station from the definition of a public utility under the Public Utility Holding Company Act.[20] Alternatively, the business entity can ask the SEC for a letter of no action.

Prohibition of Gas Sale for Resale

A number of states prohibit the sale of gas for resale by local distribution companies. Some business entities have expressed concern that this can be interpreted as prohibiting the sale of gas to public natural gas refueling stations because the refueling stations in turn resell the gas to NGV users. This prohibition was originally intended to protect the "franchised monopoly" status of the local distribution company.[21] As discussed before, most evidence up to now has suggested that natural gas sales to NGVs can be competitively provided by many suppliers and should not be viewed as a utility service similar to gas distribution service provided by the LDC to captive customers. Then the rationale for protecting the public utility status of the LDC is no longer applicable in term of gas sales to refueling stations. Maintaining such a prohibition of sales for resale is not warranted, and this issue may be resolved through the introduction of state legislation exempting transportation gas sales or changes in utility tariffs.

Regulation of Sale for Resale by the FERC

The Natural Gas Act (NGA) exempts natural gas consumed within the state where it is purchased (intrastate gas transaction) from the jurisdiction of the Federal Energy Regulatory Commission. But there is some uncertainty about how this provision would apply to the sale of natural gas to refueling stations for resale to the general

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[20] Ibid.

[21] The sale-for-resale prohibitions were enacted in the 1930s to prevent the landlords in multifamily buildings from submetering natural gas to the residents.

public, and the sale of gas being used in a vehicle that may cross a state line (thus becoming an interstate gas sale). If gas sales to natural gas refueling stations are viewed as a sale-for-resale, then under the Federal Power Act the entities selling gas to the refueling station will come under FERC regulation. The FERC has taken action on this subject, and issued a Notice of Proposed Rulemaking (NOPR) on March 19, 1992.[22] The proposed rule provides for the generic issuance of a blanket certificate of public convenience and necessity authorizing sales of vehicular natural gas for resale by any local distribution company that does not qualify for an exemption under the Natural Gas Act and any other person (including interstate pipelines, gas marketers, and others) that would not otherwise be natural gas companies for the purpose of the Natural Gas Act.

If the sale of natural gas to motor vehicles is deemed an interstate transaction, the entities selling the gas could be viewed as engaged in interstate commerce and subject to FERC regulation. However, it can be argued (and the FERC has apparently agreed) that the natural gas should be deemed consumed at the point of sale (thus becoming a transaction within a state) and not subject to FERC regulation at all. The FERC NOPR on vehicular natural gas has provided such a determination.[23]

Issues of Funding

The next set of questions relates to the funding of NGV-related activities initiated by LDCs. Specifically, the issue involves whether a state public service commission should allow or encourage local distribution companies to promote natural gas vehicles through financial incentives, and who should pay their costs. Before addressing the funding of specific NGV-related activities, some general guidelines may be considered.

The first consideration is the distinction between short-run transitory NGV funding programs and long-run permanent programs. With natural gas vehicles in their

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[22] Federal Energy Regulatory Commission, *Vehicular Natural Gas*, Docket No. RM92-2-000, 57FR 9515, March 19, 1992.

[23] Ibid.

initial stage of development and with local distribution companies, being most closely interfaced with the users of NGV, having some particular "responsibilities" in establishing the NGV infrastructure, within a short transition period of a few years or so the LDCs may want to actively promote natural gas vehicles and the infrastructure to serve them. Such a large number of refueling stations and natural gas vehicles are required to establish a self-sustaining NGV infrastructure, any funding programs initiated by the LDCs will account for only a portion of the investment required to establish the NGV infrastructure. Consequently, any NGV activities initiated by the LDC will serve more as a catalyst for development and demonstration purposes and less as a permanent involvement in the NGV market.

Over a longer period of time as the NGV market becomes better developed, few specific LDC-led funding initiatives will be required. Some LDCs have expressed reservations over their long-term involvement in markets for NGV-related products and services. For example, Pacific Gas and Electric Company has indicated that it does not want to be involved in constructing NGV refueling stations in the long run and that its NGV program would serve only as a bridge between the current situation and a mature NGV market.[24] The state commission can set specific dates to review the progress of the LDC rather than granting any permanent funding mechanisms.

The second consideration is defining, as a matter of policy, an LDC's role and ultimately that of the ratepayers (assuming the full cost incurred by the LDC is passed through) in providing public goods such as protecting the environment and enhancing energy security. An LDC's ratepayers can benefit from a cleaner environment and more secure energy supply, and should contribute a fair share of the cost of achieving these goals. But, many members of the general public who are not LDC ratepayers and consequently are not contributing to its costs in providing public goods, also enjoy these benefits. Thus, ratepayers essentially are subsidizing the general public. Arguably,

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[24] California Public Utilities Commission, *Application of Pacific Gas and Electric Company for Authority to Increase Gas Rates and Recover Costs for Implementation of a Natural Gas Vehicle Program*, Decision 91-07-018, July 2, 1991.

taxpayers rather than ratepayers should bear the burden of providing desirable public goods such as a clean environment and energy security.

The third consideration is the necessity and effectiveness of financial incentives to NGV users or refueling station owners. The debate on this subject is similar to the one over financial incentives provided for energy conservation programs. The provision of such financial incentives essentially asks ratepayers as a group to subsidize a subset of ratepayers who are NGV users. This subsidy may be justified on the grounds that the increased use of gas by NGV users can benefit other ratepayers through a higher utilization of existing utility facilities, and produce social benefits that may not be properly reflected in the marketplace. On the other hand, it is possible that the cost of providing these financial incentives can drive up the price paid by other gas users whose use of natural gas may decrease. This actually could make the net social benefit of NGVs less than expected.

Procurement of LDC-Owned Natural Gas Vehicles

Once these general considerations are delineated, specific NGV funding issues can be resolved more easily. In general, natural gas vehicles owned and used by the LDC are viewed as assets required for providing utility service. Their purchase cost should be funded by ratepayers subject to the typical prudence and reasonableness oversight by the state public service commission. The only question is whether the additional capital cost associated with NGVs can be justified by the sum of fuel cost reduction and the environmental protection and energy security benefits associated with lower petroleum consumption. The incremental cost for owning and operating an NGV depends on the individual LDC's ability and experience in vehicle and fuel procurement. For some, the incremental costs of NGV may be small while for others the costs may be quite high. In the initial stage of NGV development, the higher incremental cost of NGVs owned by an LDC may be justified by the additional benefit of demonstrating the technical feasibility and economic viability of the NGV technology to potential users.

This issue can be divided into two aspects. One is whether financial incentives such as tax incentives, rebates, and low-interest loans should be provided to potential users of natural gas vehicles to reduce their financial risk in investing in an emerging transportation technology. The second is who should pay for these incentives.

There is some uncertainty about the effectiveness of financial incentives to enhance NGV market penetration. Incremental capital cost only accounts for a very small portion of the total cost of vehicle ownership and operation. The assurance of a long-term operational cost advantage of NGVs (mostly determined by the price of gasoline and natural gas) and the high rate of vehicle utilization (mostly decided by a reasonable number of refueling and service stations that can provide convenient NGV services and products) are likely to be more important considerations.

Energy security and environmental protection effects of the extensive use of NGVs can be felt by the general public, not just LDC ratepayers. For this reason, the cost of financial incentives may be best funded though petroleum or road taxes rather than through gas rates charged by the LDC. Another argument against ratepayers funding NGVs is that natural gas users do not contribute as much to air pollution or energy supply vulnerability as other energy users. It is not fair to ask them to contribute to solving a problem they do not cause. More importantly, the increase in natural gas price as a result of the financial incentives may reduce the consumption of gas for nontransportation use, and the intended effects of the promotion of NGVs may be reduced instead.

It is possible that the promotion of NGVs and consequently the increase in gas sales can benefit an LDC's ratepayers through better utilization of existing gas transportation and distribution systems, and better contract terms in gas procurement.[25] Apparently, some ratepayer funding of these financial incentives for vehicle equipment

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[25] Nelson E. Hay and Paul F. McArdle, "Regulated Utilities in the Vehicular Fuel Market: Toward a Level Playing Field," in *Alternative Transportation Fuels*, 221-34.

purchase may be considered if the direct benefits (as illustrated above) to ratepayers can be demonstrated. In general, ratepayer funding for the financial incentives provided for NGV vehicle purchase and conversion does not appear to be a good public policy even if the social effects of NGVs are considered.

Building NGV Refueling Stations

This issue is concerned with funding the construction of NGV refueling stations and can be divided into two parts: financing public-access gas refueling stations, and financing limited-access refueling stations at or near a fleet owner's premises. As already noted, the establishment of an NGV infrastructure consisting of a large number of public refueling stations is essential to the continued development and use of natural gas vehicles. So until the NGV market is developed to a self-sustaining level, the LDC may have to take a lead in building more refueling stations. The most effective way to encourage this is through ratepayer funding which minimizes the financial risk to the LDC. The arguments presented above on ratepayer funding of NGV vehicle purchase and conversion can also be applied here. But the justification for ratepayer funding in building refueling stations is probably stronger because the addition of refueling stations will benefit current NGV and future NGV users, while the purchase of vehicles will only benefit the vehicle owners themselves.

The funding of limited-access refueling stations for vehicle fleet owners is more an issue of designing proper financial arrangements between the LDC and its customers. The justifications for ratepayer funding for this kind of refueling station are rather weak. Only specific NGV users can benefit from the construction of this kind of refueling stations. The increase in the number of limited-access refueling stations may contribute significantly to the popularity of NGVs as the number of vehicles owned by fleet owners is usually rather large. But its effect on the provision of an NGV infrastructure is probably less than that of building public-access refueling stations.

For some fleet owners who are not quite certain about the economics and technical feasibility of NGVs, the LDC may have to build dedicated limited-access

refueling stations in the fleet owners' premises to demonstrate the benefits. Other fleet owners may lack the financial resources to build their own dedicated refueling stations. In such cases, a leasing arrangement under which the LDCs pay for the costs of refueling station equipment and construction while the customers lease the refueling stations from the LDCs may be considered by the state commission.

CHAPTER 4

STATE REGULATORY BARRIERS AND POLICIES

The Sources and Nature of Regulatory Barriers

Before discussing the specific regulatory barriers to the development and use of natural gas vehicles, it is useful to examine their sources and fundamental nature. A regulatory barrier can be defined as the presence or absence of a particular legal or institutional mechanism that can inhibit the socially-beneficial development and use of natural gas vehicles. The presence of regulatory barriers may well inhibit the development of natural gas vehicles, but their effects are likely to be less than other barriers more technical or financial in nature.

Several factors may contribute to the regulatory barriers at the state level. First, the extensive use of natural gas vehicle is a relatively new phenomena even though the technical features of NGVs are well-developed. Many participants in NGV-related markets, including vehicle owners, fuel suppliers, fuel transporters, vehicle manufacturers, and most important, government regulatory agencies are "newcomers" facing a learning curve to climb. A period of time will have to pass before these participants can develop some consensus on the issues to be addressed, the objectives to be achieved, the regulatory principles to be applied, and the information required to resolve these issues. There is no easy and quick way to overcome the lack of information, experience, action, and consensus under the current regulatory and political framework.

Second, the fueling of natural gas vehicles is closely related to a regulated business--the local gas distribution company--but does not exhibit the same characteristics as a regulated utility. On the one hand, the use of natural gas in transportation may be viewed as an extension of gas distribution service. On the other hand, the manufacture of NGV and refueling station equipment and their installation show many similarities with gasoline-powered vehicles whose markets are characterized by many competitive suppliers. Some confusion and uncertainty about the nature of the NGV refueling

market are unavoidable. In the absence of a clearly defined and agreed-upon mechanism to facilitate the transaction in a newly developed market, regulatory guidelines and practices used in the state regulation of gas distribution business are transferred to the NGV-related markets as a temporary or permanent proxy. The application of public utility-type regulations in competitive markets will invariably lead to some unintended results.

Third, full NGV market development is a long process. Markets may exhibit different structures from one another during different periods of their development. For example, in the initial stage of NGV development, there may be only a small number of LDC-owned refueling stations available, perhaps requiring some kind of state regulation. Over time, however, the number of refueling stations could increase substantially, making it a workably competitive market and requiring minimum, if any, state regulation. Consequently, the policy options for a short-term transition period may be quite different from long-term policy options, although this distinction may not always be recognized by market participants and state commissions.

Fourth, the extensive use of natural gas vehicles can have significant implications for environmental protection and energy security. These goals are important policy considerations, but most public utility-type statutes and regulations are concerned primarily with the availability and price of services and goods provided by regulated utilities. They may not be adequately designed to address environmental and energy-security issues effectively. Consequently, some conflicts between the goals of protecting an LDC's ratepayers and shareholders and enhancing the general public's environmental protection and energy security may arise.

Thus, it seems that most of the regulatory barriers associated with the development and use of natural gas vehicles are different from those associated with other regulatory proceedings such as state gas transportation policy and the pricing and access of electric transmission facilities. In those regulatory proceedings, barriers and impasses are derived mostly from conflicts of interest involving the various parties or in the regulatory principles adopted by different regulatory agencies. For example, the imposition of a federal electric transmission policy mandating open access almost

certainly will be challenged by some electric utilities fearing the lost of native-load customers to other electricity generators inside or outside its service territory.

As for natural gas vehicles, regulatory barriers are mainly the result of a lack of relevant information and a high degree of uncertainty that are inherently unavoidable in the initial stage of a new technology. As discussed in previous chapters, while there are few "natural" constituents for NGVs due to the diffusion of its benefits, few parties are actively contesting its development and use either.

This does not mean that there are no real conflicts among the interests of various parties (such as the allocation of costs for NGV-related activities among NGV users, ratepayers, and the general public) or that the presence of regulatory barriers is not an important issue requiring no action on the part of a state public service commission. It is fair to say, however, that most NGV-related regulatory barriers are not "real" and are likely to diminish with time.

An example can be provided here to illustrate why an NGV-related regulatory barrier is actually an unresolved confusion in the application of certain regulatory principles. Most state commissions do not envision regulating a business entity (in this case, a natural gas refueling station) which does not exhibit the characteristics commonly associated with a public utility. However, because of the existence of statutes defining retail gas sales as a regulated utility service, sales to NGV users arguably are also a retail gas sale that should be regulated like other types of retail gas sales. Clearly, the question here is not the validity of the principle of regulating gas sales, but the applicability of this particular regulatory principle to a new type of service and technology whose provision does not exhibit significant economies of scale and where the users of this service are mobile and have alternative suppliers available.

A Summary of Major Regulatory Barriers

An extensive discussion of the major issues facing the state public service commission in developing appropriate policies to promote the development and use of

natural gas vehicle already was presented in Chapter 3. This section summarizes the major regulatory barriers.

Regulatory Barriers Related to Market Entry

There are several regulatory barriers related to the entry into various NGV-related markets. One is the possible limitation of gas suppliers to the refueling stations. The state commission may view the NGV refueling stations as captive customers of the LDC and consequently limit them from buying gas from entities other than the LDC. This is an especially important concern where state gas transportation policies are not yet developed or promulgated. If state gas transportation policies are in place, the refueling stations can be treated similarly to those transportation-only industrial and commercial customers.

The second barrier is the uncertainty regarding the participation of an LDC in the refueling market. Although an LDC has no significant technical, economic, or marketing advantages over other entities in selling natural gas to NGV users if open access to the LDC's distribution facilities is assured, many states have encouraged the participation of LDCs to spur the participation of other entities, at least in the initial stage of NGV infrastructure development. This raises the possibilities, however, of cross-subsidization between the regulated gas distribution business and the unregulated natural gas refueling businesses, and unfair competition if the LDC is allowed to directly control a large number of refueling stations in its service territory.

Regulatory Barriers Related to Jurisdiction Over NGV-Related Markets

The jurisdictional uncertainty over various NGV-related markets may be the most common concern expressed by potential market participants. One concern is that different states act differently in regulating or deregulating these markets. A major oil company may actively participate in the gas refueling market in one state that exempts

this particular type of service from state regulation, but may be reluctant to offer the same service in another state where the exemption issue has not yet resolved.

Another concern is the lack of clear guidance on the possible imposition of regulations on several NGV-related markets that can be characterized as competitive in nature. Regulation or the lack of it in various NGV-related markets has been discussed in some detail in a previous chapter and will not be repeated here. Instances of unnecessary government regulation would presumably include the regulation of gas sales between a public-access refueling station and the general public using natural gas vehicles, and the prohibition against reselling gas sold by the local distribution companies.

Regulatory Barriers Related to the Funding of NGV Activities

Once the regulatory barriers related to market entry and state jurisdiction are identified and resolved, there would appear to be little need for an LDC to provide funds for NGV-related activities except for short-term temporary programs aimed mostly at information dissemination, technology demonstration, and expansion of the NGV infrastructure. Consequently, the main focus of a state public service commission may better be guarding against unnecessarily funding NGV-related activities by the LDC and hence the ratepayers rather than the removal of "barriers" that prevent funding of justifiable NGV-related activities. This does not mean that no financial or economic incentives should be provided by the government to spur the development and use of natural gas vehicles. It simply says that few if any justifications exist for ratepayers of the local distribution companies alone to shoulder the financial burden of supplying public goods that benefit the general public.

Principles of Developing State Regulatory Policies

As discussed before, the regulatory barriers to the development and use of natural gas vehicles are mainly the result of inadequate information and uncertainty in applying

specific regulatory principles. These barriers, commonly associated with the introduction of a new technology, are likely to disappear over time. Most importantly, a state public service commission can lessen the confusion and uncertainty related to the entry and jurisdiction of various NGV-related markets. The task at hand is to reflect on the role of a state public service commission and to develop some principles useful in developing specific policy options. These regulatory principles can be applied in many aspects of the development of natural gas vehicles.

The first principle is to limit the role of government to one of facilitator rather than initiator. Government alone can not be responsible for the development of natural gas vehicles and their infrastructure. The amount of capital required is large. Also, the establishment and operation of the NGV infrastructure involve a large number of decisions made by many decisionmakers, mostly private enterprises with vastly different objectives. Few government regulatory policies, if any, can have immediate, simultaneous, and substantial effects on the behaviors of so many diverse parties.

The second principle is to recognize the distinction between short-term transitory and long-term permanent policies, and to limit the state commission's involvements to short-term transitory policies. Motor vehicles and refueling stations are durable goods with extended years of service. Likewise, the development of natural gas vehicles and their infrastructure is a long and slow process. Consequently, the policy objectives of a state commission over the short term may be different from its objectives ten years from now. This is especially important since the characterization about the competitive nature of the various NGV-related markets is predicated on the assumption that these markets will be fully developed with a sufficiently large number of suppliers. It is quite possible that some of these markets may not exhibit the competitive structure required for total deregulation within a short period of time. A different set of regulatory policies in this transition period to facilitate the development of natural gas vehicle may be warranted.[1]

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[1] These short-term regulatory policies include ratepayer funding of NGV refueling stations and the restriction on LDCs as the only gas supplier to refueling stations. A detailed discussion appears in Chapter 3.

The third principle is to clarify the LDC's responsibility (ultimately the responsibility of the ratepayers assuming the cost incurred by the LDC will be recovered eventually) in providing public goods such as environmental protection and energy security. For some NGV-related activities initiated by the LDC, the ratepayers can clearly benefit. But for many of these activities, benefits will accrue not only to ratepayers but also the general public. In this instance, there is some concern over whether ratepayers alone should bear the full burden of providing these public goods.

Regulatory Policy Guidelines

Since most state regulatory policies have already been discussed elsewhere, this section will only summarize some of the more important ones. These guidelines can be grouped by the two goals they intend to achieve: increasing the number of refueling stations and maintaining a competitive NGV refueling market. Certain policy guidelines can affect the achievement of more than one goal, and are classified by the main effect they can generate.

The regulatory policy guidelines that can increase the number of refueling stations include:

(1) Codifying the exemption of gas sales to NGVs from state public utility regulation;

(2) Codifying the exemption of gas sales to NGVs from state prohibition against gas sale for resale;

(3) Codifying the status of a natural gas refueling station as a nonutility; and

(4) Actively participating in federal legislative and regulatory proceedings to assure that no unnecessary federal regulations are imposed on the ownership and operation of refueling stations.

Regulatory policy guidelines that can assure and maintain the competitive nature of the NGV refueling market are as follows:

(1) Establishing state gas transportation service that allows a refueling station, similar to other gas transportation customers, to bypass the local distribution company for gas supplies if it so desires; and

(2) Establishing the ratepayer funding mechanism, corporate structure, specific time period for market participation, and property disposal mechanism for LDC-owned refueling stations if such a ownership arrangement is desirable and allowed in a transition period.

CHAPTER 5

CONCLUSIONS

This study has examined the prospect of natural gas as a vehicular fuel, the characteristics of vehicle purchase and usage decisions, state regulatory barriers to the extensive use of natural gas vehicles, and preferred state regulatory actions to overcome these barriers. Despite the substantial energy and environmental advantages of a natural gas vehicle over a gasoline-powered vehicle, the prospect for a significant increase in the number and use of NGVs as well as its overall contribution in reducing dependence on foreign oil and improving air quality seems far from certain.

This study further concludes that a state public service commission neither can, nor should, do very much regarding the development and use of natural gas vehicles. Its most useful role is likely to be as a facilitator rather than as an initiator, except in some limited circumstances. Though the prospect of natural gas vehicles has improved considerably and is probably at its best position in a long time, the development of a natural gas vehicle market is and will be at a slow and somewhat restrained pace in the foreseeable future with or without the active intervention of a state public service commission.

The short-term market potential of natural gas vehicles is limited in light of their considerably shorter driving range, small number of refueling stations available, the stable supply and low price of gasoline, and inherently low rates of motor vehicle and refueling station replacement. Initially, a dual-fuel vehicle conversion that can use both natural gas and gasoline is likely to be the choice of most vehicle owners. The adoption of NGVs will also be limited to centrally fueled, centrally garaged, short-haul fleets owned by corporations and government.

Over a longer period of time, a dedicated natural gas vehicle may be more economical, energy-efficient, and cleaner than a dual-fueled vehicle. Such a vehicle has the potential to compete if an adequate refueling and service infrastructure is in place. Given the large amount of capital required to establish this and the great number of

individual actions required in terms of purchasing vehicles and opening natural gas refueling stations, government actions will have only limited effects on the establishment of the NGV infrastructure. After all, the refueling stations, repair shops, and vehicle manufacturers have to be economically viable to stay in business. They will be viable only if large numbers of natural gas vehicles are in use and further growth of the NGV market can be reasonably assured.

Nevertheless, the government can play a constructive role in the initial stage of developing natural gas vehicles and their infrastructure when potential users and suppliers are uncertain about NGV's long-term viability and the possible imposition of government regulation on NGV-related markets. A broad range of state policy options such as vehicle procurement, vehicle fuel efficiency and emission standards, reductions in fuel and road taxes, rebates and low-interest loans, and technology demonstration projects can be implemented. A large part of these actions, however, are outside the purview of state public service commissions.

The focus of a state public service commission should be to eliminate or reduce regulatory barriers to NGV development. These barriers are the result of a lack of relevant information, experience, and applicable regulatory guidelines, which probably are unavoidable in the introductory stages of a new technology and probably are not real conflicts in the regulatory principles or the interests of various market participants. The three areas where a state public service commission needs to pay special attention are entry to NGV-related markets, jurisdiction over these markets, and funding NGV-related activities initiated by the local distribution companies.

A state public service commission needs to define the participants, boundaries, and rules of competition of various NGV-related markets, in particular the gas refueling and local gas distribution markets. Other markets such as NGV equipment and conversion, NGV repair and maintenance, gas production and transportation, and gas refueling station equipment and construction markets are characterized either by a large number of competitive suppliers or are regulated by the Federal Energy Regulatory Commission. A state commission has little or no influence on them. In the local distribution market, the gas refueling station should not be treated differently than other

gas transportation customers. Only when there is a small number of refueling stations available in the LDC's service area, can the gas refueling stations be viewed as "captive" customers of the LDC (since NGV users have few alternatives available and therefore, can be considered as captive customers of the refueling stations). Then, some restriction on the supplier to the refueling station may be considered. As for the gas refueling market, there is no need to restrict entry or impose any public-utility type regulation. If the LDC is to own a substantial number of refueling stations in its service territory, however, these are better off under the ownership of a separate unregulated subsidiary than within the LDC itself to avoid the possibility of cross-subsidy or anticompetitive behavior.

State public service commissions also need to clarify the jurisdiction of these two markets. They could codify the deregulation of gas sales to NGV users (which most states have no intention of regulating anyway), lift the prohibition of gas sales for resale for transportation purpose, and seek federal exemption of refueling station owners as a utility holding company and FERC regulation of gas sales for resale.

As for the funding of NGV-related activities initiated by the local distribution companies, three guidelines can be used to determine the funding of specific activities. They include making a distinction between short-run funding programs aimed at spurring the development of NGV initially and permanent funding programs, defining an LDC's role in the provision of public goods such as environmental protection and energy security, and assessing the necessity and effectiveness of providing financial incentives to NGV and refueling station owners. In general, LDC ratepayers should fund only NGVs owned and actually used by the LDC in its gas distribution operation, and possibly a small number of public refueling stations when the NGV infrastructure is in its initial stage of development. In other instances, either the provision of financial incentives are ineffective or the benefits of NGV-related activities are so diffuse that taxpayers (as a proxy of the general public depending on the types of tax used), rather than ratepayers, should bear the financial burden.

There are several areas for further study that can be beneficial to the formulation of NGV-related public policies. One is the decisionmaking process of other participants

in NGV-related markets, in particular the owners of natural gas refueling stations. Given the importance of establishing a refueling and service infrastructure and the fact that refueling stations (due to their direct interactions with the NGV users) are the most critical link in the NGV infrastructure, a closer examination of the behavior of the refueling station owner is justified. Another area for further study is the estimation of the full technical and economic potential of NGV based on a more detailed analysis of projected transportation vehicle market. A realistic assessment of the potential of NGV will serve as the basis for determining the extent of government intervention in the NGV market. The third area for future study is the exact relationship between the use of natural gas vehicles and the enhancement of energy security and environmental protection. More detailed studies on the linkage between the increased use of natural gas in vehicles and the reduction in air pollutants and greenhouse gases as well as oil imports will help to put the promotion of NGVs or alternative-fueled vehicles in the proper context of a broad range of policy options required in a comprehensive energy and environmental strategy.

APPENDIX A

A SYNOPSIS OF RECENT FEDERAL AND STATE INITIATIVES AFFECTING NATURAL GAS VEHICLES

This appendix summarizes recent federal and state initiatives affecting the development and use of alternative-fueled vehicles, in particular the natural gas vehicle. These initiatives include the Alternative Motor Fuels Act of 1988 (AMFA), the Clean Air Act Amendments of 1990 (CAAA), the 1991 National Energy Strategy (NES), and many other initiatives of federal, state, and local governments. Various policy options have been proposed in these initiatives. Many have been used in the past, but some innovative features are also introduced. The Clean Air Act Amendments of 1990, for example, initiated a new trend in emission control through regulating not only the motor vehicle, but also the composition of the fuel. The CAAA also introduced the option of emission credits trading among the operators of fleet to allow them flexibility in complying with the act's provisions. A progressive procurement mandate of alternative vehicles is another important policy option introduced in both the Alternative Motor Fuels Act, and the National Energy Strategy, as well as most of the reported state governments programs. The following sections present some of the traditional policy options that have been used in the past to promote cleaner fuels or restrict traditional fuels, followed by a discussion of the more recent policy initiatives.

Traditional Government Policies

Auto Emission Control

The California legislature in 1948 established air pollution control districts empowered to curb emission sources. Initial efforts addressed the reduction of industrial particulate emissions. Because it was thought that the automobile was a significant source of the pollution problems, the Automobile Manufacturers Association established a vehicle combustion products committee in 1953 to further define the problem and to search for solutions. The California legislature enacted air quality standards for oxidants and carbon monoxide (CO) in 1959, and the California Motor Vehicle Pollution Control Board was created in 1960 to implement these standards. Its function was to set

specifications on vehicle exhaust and evaporative emissions and to certify that future vehicles sold in California met the specifications.

In 1955, the federal government became involved.[1] It empower the Department of Health Education and Welfare to provide technical assistance for resolving problems related to air pollution. This activity was further enhanced by the Clean Air Act of 1963, which was structured to stimulate state and local air pollution control activity. A 1965 amendment specifically authorized writing national standards for emissions from all new motor vehicles sold in the U.S.

Through the years the control of motor vehicle emissions has involved both progressively reduced standards and improved test procedures. Emission standards are enforced by a program of preproduction design review, testing, and certification. Production prototypes are certified to emit at or below standard levels for 50,000 miles. The federal government also administers assembly line audits and surveillance-recall programs designed to ensure that production motor vehicles perform as well as certification prototypes.

Studies during the 1970s and since then have revealed that a large percentage of vehicles on the roadways exceed the emission limits for which they were designed. Inspection and maintenance and antitampering programs have been instituted to identify such vehicles and require their repair. The 1977 Amendments to the Clean Air Act required state or local governments to administer these programs in all cities exceeding CO or ozone quality standards.

Financial Incentives

This policy tool usually includes price supports or tax benefits. Until the recent increase in concern over the federal budget, this was one of the favorite tools of policy makers for a wide range of initiatives. Price subsidies for alternative fuels would control

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[1] Frank M. Black, "Control of Motor Vehicle Emissions--The U.S. Experience," *Critical Review in Environmental Control* 21 (1991): 373-410.

the price relative to conventional fuels. Subsidies could take the form of reduced fuel taxes, direct price subsidies to fuel suppliers, or a governmental role as a fuel wholesaler, as in the current California program. Such subsidies would mitigate high prices and future oil price volatility; in addition, they were perceived as certain and long term--they could be the key to an alternative fuels transition. Although the costs of subsidies could be very high, they incur no costs unless alternative fuels are used.

Also, a price subsidy in the form of a tax/rebate program, similar to the gas-guzzler tax as it was originally proposed in the 1970s, is used in several state initiatives (California and Oklahoma). Such a program can be effective if alternative fuel vehicles with high purchase costs, such as dual-fuel CNG vehicles, were introduced. The fuel tax revenue (conventional fuel tax) is proposed in two different utility programs in California (by PG&E and SDG&E) and approved by the California PUC, to be used to provide the funds for a rebate to alternative fuel vehicles.

Tax subsidies for the alternative fuels infrastructure are another possibility. Vehicle manufacturers, vehicle purchasers, fuel suppliers, and possibly fuel producers could be given one or more tax subsidies (credits, faster depreciation, and so on) to cover the cost of an alternative fuels infrastructure. While this would spread the costs to all taxpayers and be predictable in size, such benefits may not be large enough to overcome the market uncertainty of getting enough fuel used to give an adequate return on investment. These subsidies also would do little to directly encourage fuel use, although the selling price of the fuel could be lowered.

In general price and tax subsidies spread the costs and shift risk from market participants to the government and taxpayers. However, in the new initiatives that are discussed later, economic incentives are considered more aggressively at the state and local levels. At the federal level, unlike the Alternative Motor Fuels Act and the National Energy Strategy, the CAAA gives an incentive credits to the more cleaner covered fleets.

Direct Government Mandates

A regulatory approach to an alternative fuels transition has precedent in the energy and environmental areas. The Clean Air Act Amendments of 1977 was used to bring unleaded gasoline into the market. The Fuel Use Act of 1978 and other state and local regulations have controlled different fuels used in certain applications.

Regulatory mandates, for example, could require vehicle manufacturers to produce multifuel or dedicated alternative fuel vehicles and require fuel suppliers to have facilities capable of handling them. Such mandates could further require that alternative fuels be available at some or all fuel sales outlets. This approach has been considered in an environmental context in California and might work well from an energy policy perspective in conjunction with environmental strategies. At the national level, these mandates have been applied to all cars, but limited to fuel suppliers in major urban areas with air pollution problems.

Regulatory incentives are another possibility. The existing regulatory requirements would be relaxed or modified to encourage alternative fuels' infrastructure use. The corporate average fuel economy (CAFE) credits for alternative-fuel vehicles are an obvious example. As discussed later, the National Energy Strategy had proposed to eliminate the 1.2-mile-per-gallon cap on CAFE to manufacturers who produce alternative fueled vehicles. Others might include emission tradeoffs (that is, lower hydrocarbons for higher NO_x) or reduced annual vehicle emissions inspection requirements (an incentive to vehicle purchasers).

Research and Development

Government funded R&D remains one of the principal mechanisms to assist the private sector and serve the national interest. There are some clear R&D needs in the alternative fuels area. Some are longer term and would do little to affect a transition in the near future (that is, fuel cells and combustion research). Other research areas are short term, such as work on C1 chemistry, lower cost CNG storage, fuel-flexible vehicle

emissions performance, and engine durability using methanol. Most of these areas are being addressed in the private sector, but governmental efforts could be helpful, particularly if carried to the demonstration phase for more in-use experience. The Alternative Motor Fuels Act of 1988 focuses on carrying out demonstrations and tests of alternative fuels in a variety of vehicles, and on performing studies to increase understanding of these vehicles.

Federal Initiatives

This section outlines the efforts to create a market for alternative transportation fuels and alternative-fueled vehicles at the federal level. It elaborates in some detail the provisions in each major recent act and initiative.

The Alternative Motor Fuels Act (AMFA)

The Alternative Motor Fuels Act of 1988 was signed into law on October 14, 1988.[2] The AMFA legislation calls for several actions to propel methanol, ethanol, propane, and natural gas-fueled vehicles onto the nation's highways. AMFA doesn't mandate a program for the public by specifying that a certain number of alternative-fueled vehicles must be on the road by a given time. Instead, it gives the government responsibility foe leading the nation in boosting the adoption of alternative-fueled vehicles. The Department of Energy (DOE) is in charge of the bulk of the actions and is assisted by the General Services Administration (GSA), the Department of Transportation (DOT), and the Environmental Protection Agency (EPA). AMFA focuses on carrying out demonstrations and tests of alternative fuels in a variety of vehicles, and on performing studies to increase the understanding of these vehicles. As AMFA directs the DOE and other federal agencies to implement its provisions, it also

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[2] U.S. Congress, Alternative Motor Fuels Act of 1988, Public Law 100-494 100th Congress, 102 Stat. 2441, October 14, 1988.

provides for an active role for industry, as well as for state and local governments. Congress authorized $18.5 million to fund this act over four years, from fiscal year 1990 through fiscal year 1993.

The demonstrations and tests stipulated by AMFA fall into three areas: federal light-duty vehicles (cars and vans), heavy-duty trucks, and buses. The following briefly describes these provisions in some detail.

Federal Light-Duty Vehicle Program

The objective of the light-duty project is to encourage federal agencies to purchase dual-fuel passenger automobiles and light-duty trucks. Under the act, DOE must work with other federal agencies to ensure that the maximum practical number of passenger automobiles and light-duty trucks acquired annually for the federal fleet be alternative-fueled vehicles. These vehicles are to include alcohol-powered, dual-fueled alcohol, natural gas-powered, and dual-fueled natural gas vehicles. The act requires that the vehicles be supplied by original equipment manufacturers and authorizes $12 million to implement this provision. Data collection is also an important part of this program. DOE must (1) assess how these vehicles perform in cold weather and at high altitude; (2) determine their fuel economy, safety, and emissions; and (3) compare their operation and maintenance costs with conventional gasoline and diesel passenger automobiles and light-duty trucks.

GSA and DOE procured sixty-five methanol dual-fueled vehicles in 1990. Since the vehicles were delivered in early 1991, test data are just starting to be collected. As of March 1991, Chrysler Corporation has reached agreement with GSA to produce fifty natural gas-powered vans to be delivered in early 1992.

Commercial Truck Alternative Fuel Program

The heavy-duty truck project involves jointly funded demonstration projects with state governments and the private sector. Rather than launching a totally independent

effort, DOE plans to augment existing state and private heavy-duty fleet tests already in place throughout the nation. DOE is required, in cooperation with heavy-duty engine manufacturers and other federal agencies, to study the use of alcohol-powered, duel-fueled alcohol, compressed natural gas-powered, and duel-fueled natural gas in heavy-duty trucks. To date, the DOE has not been able to establish truck fleets or collect data to study the use of alternative fuels in heavy-duty trucks.

Bus Alternative Fuel Program

The act requires DOE, in cooperation with other federal agencies, to assist state and local government agencies in testing alcohol and natural gas buses in urban settings. This project is closely linked with the clean air program run by DOT's Urban Mass Transportation Administration (UMTA). AMFA funds are earmarked for testing buses in the UMTA program and collecting the resulting data. This demonstration project ultimately may involve more than fifty state and local transit agencies throughout the United States. DOE will also fund UMTA to supplement the purchase of additional alternative-fueled buses for urban mass transit authorities. Performance data have been collected on fifty-nine methanol buses while emissions data have been collected on six of the fifty-nine buses.

AMFA has also provide incentives to encourage change. The act includes provisions that encourage automobile manufacturers to produce alternative-fueled vehicles. All automobile manufacturers are required to meet corporate average fuel economy standards. AMFA gives bonus CAFE credits for producing alternative fueled vehicles. AMFA also spells out incentives that encouraged federal agencies to buy alternative-fueled vehicles. One such incentive permits agencies to count only half the number of alternative fuel vehicles against their total vehicle allocation, thus enabling them to add more vehicles to their fleets.

Another stipulation of AMFA was the establishment of an Interagency Commission of Alternative Motor Fuels, composed of heads of several federal agencies. The Commission's functions include the following:

- coordinate federal agencies efforts to develop a national alternative fuels policy;
- develop a long-term plan for commercialization of alternative fuels;
- ensure communication among federal agencies and others involved with alternative fuels;
- establish a U.S. Alternative Fuels Council; and
- submit two interim reports (September 1990 and 1991) and a final report by September 1992 to the Congress.

In 1989, the Commission was established and held its first meeting. Its first interim report was submitted to the Congress in January 1991 and was the first of its three measured steps to develop a national alternative fuels policy. Specifically, the report provides the status on the act's requirements and a comprehensive discussion of alternative fuels--natural gas, methanol, ethanol, liquefied petroleum gas, and electricity. The Commission's second interim report (released September 1991) assesses energy security and environmental implications of increased use of alternative fuels and the implications of the 1990 Clean Air Act Amendments. The Commission's third and final report will provide a long-term plan to implement a national alternative motor fuels policy.

Clean Air Act Amendments (CAAA)

The Clean Air Act Amendments of 1990, will require many fleet vehicles in some of the nation's most polluted cities to begin operating on clean alternative fuels, including natural gas.[3] Urban transit buses will also be required to reduce certain emissions significantly or the Environmental Protection Agency (EPA) will be empowered to require them to begin operating on low-polluting fuels, rather than diesel fuel. Automakers must reduce the permissible exhaust emissions from conventional

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[3] 101st Congress, *Clean Air Act Amendments of 1990*, Report 101-952, (Washington, D.C., U.S. Government Printing Office, October 26, 1990).

vehicles, and equipment that captures evaporative emissions will also be added to cars and trucks. Nine of the smog-plagued urban areas in the country will require a reformulated gasoline to replace conventional gasoline. Leaded gasoline will be banned from use by highway vehicles. Under the act's overall framework, clean alternative fuels will become more accessible to motorists.

In the act, California must initiate a pilot program that will place over one million clean-fuel vehicles on the road before 2000. Some other stipulations that California must initiate are also included in the act. The California pilot program also will require clean alternative fuel fleet programs be started in several California cities. Moreover, California has already begun and will continue to influence vehicles emissions nationwide. The California Air Resources Board recently adopted a low-emissions-vehicle program that served as a model for the nationwide clean-fuel fleet vehicle program and the conventional vehicle emission standards contained in the act. States other than California may also adopt the California pilot program by opting into a nearly identical program. States may choose to require conventionally fueled vehicles to achieve higher emission standards than those adopted in California.

The Act requires vehicles' emission reduction through a long list of measures:

- A program that requires centrally refueled fleets of ten or more vehicles to run on clean alternative fuels will be required in twenty-two urban areas. (Table A-1 lists these classified areas.)
- Vehicles in the fleet program (clean-fuel vehicles) include passenger cars, light-duty trucks, and heavy-duty trucks up to 26,000 pounds gross vehicle weight rating (that is, furniture delivery trucks and school buses).
- Covered fleet operators must begin to purchase clean-fuel vehicles in model year 1998 when they replace existing fleet vehicles with new ones. Clean-fuel vehicles must be purchased in at least the following percentages: passenger cars and light-duty trucks up to 6,000 pounds gross vehicles weight rating--30 percent in model year 1998, 50 percent in 1999, and 70 percent in 2000 and thereafter; heavy-duty trucks--50 percent in 1998 and

TABLE A-1

URBAN AREAS COVERED BY VEHICLE FLEET PROVISIONS OF THE CLEAN AIR ACT AMENDMENTS OF 1990*

Ozone Nonattainment Areas
(EPA data 1987 through 1989)

Area	Design Value
Extreme (1 area):	
Los Angeles, CA	330
Severe (7 areas):	
Baltimore, MD	194
Chicago, IL	190
Houston, TX	220
Milwaukee, WI	183
New York, NY	201
Philadelphia, PA	187
San Diego, CA	190
Serious (13 areas):	
Atlanta, GA	162
Bakersfield, CA	170
Baton Rouge, LA	164
Beaumont, TX	160
Boston, MA	165
El Paso, TX	170
Fresno, CA	170
Hartford, CT	172
Huntington, WV	164
Providence, RI	162
Sacramento, CA	160
Springfield, MA	167
Washington, DC	165

Carbon Monoxide Area
(EPA data 1988-1989)

(1 area)	
Denver, CO	16.2

Source: Dennis Eshmann, *AGA Gas Energy Review* (April 1991), 2-8.

*The Act covers serious, severe, and extreme ozone nonattainment areas and carbon monoxide areas with a design value of at least 16.0 ppm; to be covered an area must have had a population of at least 250,000 in 1980.

thereafter; light-duty trucks over 6,000 pounds gross vehicle weight rating but less than 8,500 pounds gross vehicle weight rating--the percentage will be determined under each affected state's implementation plan.

- Fuel providers, including natural gas companies, must provide fuel at locations where covered fleets are refueled.
- Credits for fleet operators will be permitted for purchasing more vehicles than required, or for purchasing vehicles that are cleaner than required, or for purchasing vehicles that are not otherwise covered by the program (for example, heavy-duty trucks over 26,000 pounds). Credits will also be available for purchasing clean-fuel vehicles before 1998.
- The act will require a pilot program under which 150,000 clean-fuel vehicles will be sold annually in California starting in model year 1996 with 300,000 such vehicles sold in the state starting in 1999.
- Other states may adopt the California pilot program for serious, severe, or extreme ozone nonattainment areas. They also may adopt California vehicle emission standards for all vehicles.
- A clean-fuel urban bus program will be required in forty-eight urban areas if particulate standards for diesel buses fail to meet a prescribed particulate matter standard.
- Tailpipe standards for vehicles sold nationwide will be lower than current applicable standards.

Clean-Fuel Vehicles

The Act will require covered fleet operators in the most polluted urban areas to begin purchasing clean-fuel vehicles during the ordinary course of replacing old vehicles. Clean-fuel vehicles must meet certain emission standards that are significantly below those of vehicles that run on conventional fuels (for example, gasoline and diesel), presumably by using a clean alternative fuels. A system of earning, trading, and selling emission credits for vehicles will allow fleet managers some flexibility in complying with

the program. California will implement a special pilot program that may be adopted by other states. The entire fleet program will be conducted through revisions to state implementation plans, which are programs devised by states and approved by the U.S. EPA to attain compliance with air quality standards in a specified period of time.

Urban Buses

EPA will be required by January 1, 1992 to issue standards requiring emissions of particulate matter (PM) from urban buses to be reduced by 50 percent.

Reformulated Gasoline and Oxygenated Gasoline

Starting January 1, 1995, reformulated gasoline must be sold in the nine worst ozone nonattainment areas with a 1980 population of at least 250,000; the sale of conventional gasoline in those areas will be illegal. Also, by November 1, 1992, all CO nonattainment areas with a design value of 9.5 ppm or more must require that gasoline contain an oxygen content of at least 2.7 percent by weight during the portion of each year in which ambient concentration of CO are highest.

Emission Standards for Conventional Motor Vehicles

All conventional fueled passenger cars and light-duty trucks (LDTs) will have to meet new exhaust emission standards.

Control of Vehicle Refueling Emissions

All new passenger cars must carry an on-board canister for capturing refueling emissions. This requirement will begin a phase enduring the fourth model year after the standard is promulgated by the U.S. EPA and will be completely phased in by the sixth

subsequent model year. The standard will require a minimum emission-capture efficiency of 95 percent.

Adoption by Other States of California Standards

This section provides assurance that other states may adopt California's vehicles emission standards, but may not adopt standards of their own that differ either from the California or the federal standards.

The CAAA contains some other related sections such as: section 211 which mandates information collection by manufacturer; section 226 which prohibits production of engines requiring leaded gasoline; section 217 which prohibits manufacturing, selling, transporting, or introducing into commerce any motor vehicle diesel fuel with a sulfur content in excess of 0.05 percent; section 231 which mandates the ethanol substitute for diesel; and section 228 which deals with enforcement.

The Clean Air Act Amendments provide significant opportunities for increased natural gas sales and use of NGVs. The high estimate of annual increased natural gas sales of 1.0 Tcf by 2005 represents an opportunity to increase gas demand by over 5 percent compared to gas demand in 1990. Increased use of NGVs attributable to the act is also very dramatic. The 30,000 NGVs currently estimated to be in use in this country could increase to perhaps as many as 6.7 million NGVs by 2005.[4]

National Energy Strategy (NES)

The National Energy Strategy (NES), which addresses the production and use of all forms of energy, includes five initiatives intended to bring alternative motor fuels into the marketplace.[5] These initiatives are briefly stated as follows:

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[4] Eshman, "Clean Air Act Amendments Affecting Mobile Source Emissions."

[5] *National Energy Strategy, First Edition 1991/1992* (Washington, D.C.: U.S. Government Printing Office, 1991).

- Eliminate the 1.2-mile-per-gallon cap on corporate average fuel economy credits to manufacturers who produce flexible-fuel alcohol vehicles or dual-fuel natural gas vehicles. With the cap, there is an incentive to produce only a few hundred thousand alternative-fueled vehicles (AFVs) per year. Lifting the cap encourages manufacturers to produce as many AFVs as they can sell, paving the way for a large market for future U.S. alternative fuel production and distribution.
- Increase the size of the Federal alternative-fuel fleet. To stimulate the early production of AFVs, the Federal Government will purchase as many AFVs as possible. The extent, timing, and quantity will depend on negotiations currently underway with automobile manufacturers.
- Ensure the use of AFVs in clean-fuel fleets. The Clean Air Act Amendments of 1990 contain significant new requirements for the use of clean-fuel vehicles in fleets of ten or more vehicles. These requirements, however, do not mandate the use of alternative fuels. The NES proposes modifying the clean-fuel-fleet concept to ensure use of alternative transportation fuels (which are not required by CAAA's clean-fuel-fleet program) and to expand the program nationwide.
- Increase research and development (R&D) on AFVs. The Federal Government is taking several steps to accelerate R&D on AFVs. A consortium of vehicle manufacturers, battery developers, and utilities, along with DOE, is being formed to carry out an aggressive R&D program to make major advances in battery technology, the major hurdle to market acceptance of electric vehicles. The Government is continuing R&D on gas turbine engines, which can be 30 to 40 percent more efficient than conventional gasoline engines and can operate well on a variety of alternative fuels.
- Accelerate development of advanced biofuels technology. The Federal Government will accelerate R&D in the areas of new feedstocks and

conversion technologies to achieve commercial readiness of cost-competitive alcohol fuels from biomass by the year 2000.

These five measures, if enacted, are supposed to make a significant contribution to reducing petroleum use in the transportation sector, by substituting alternative motor fuels for gasoline and diesel fuels. The NES projections indicate a potential to replace 2.2 million barrels a day of gasoline and diesel by 2010. Thus, the NES meets the requirements of the AMFA for the development of a long-term plan to encourage the widespread use of alternative transportation plan.

At the present time, the U.S. Senate has passed a bill, the National Energy Security Act of 1992, that has provisions similar to the policies advocate in the NES. A similar legislation is pending before the U.S. House of Representatives. It is expected the Congress will enact the legislation later this year. The Senate version (National Energy Security Act of 1992) is intended to "reduce the Nation's dependence on imported oil, to provide for the energy security of the Nation."[6] The objectives of the legislation are similar to those of the AMFA and NES. Subtitle "C" states the objectives of the proposed initiatives on alternative fuels as:

- enhance energy security;
- reduce air pollution;
- improve the balance of trade;
- reduce the budget deficit;
- improve the marketability of alternative and flexible fuel vehicles; and
- improve the condition of the national economy through the enhancement of the replacement fuel industry and the creation of an alternative fuel industry.

The legislation mandates that the federal,state, and private and municipal fleets shall contain at least the following number (or percentage) of vehicles as alternative fuel vehicles:

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[6] 102D Congress, 2D Session S.2166, "National Energy Security Act of 1992."

Federal	State	Private and Municipal
-in 1993, 5,000 vehicles	--	--
-in 1994, 7,500 vehicles	--	--
-in 1995, 10,000 vehicles	10%	--
-in 1996, 25%	15%	--
-in 1997, 33%	25%	--
-in 1998, 50%	50%	30%
-in 1999, 75%	75%	50%
-in 2000 and each year thereafter, 90%	90%	70%

The legislation gives any state or other qualified person that purchases an alternative fuel vehicle exceeding the above limits one credit per vehicle. It also authorizes $20 millions for purposes of providing financial assistance to the states. Each state must submit a report to the Secretary of Energy on the incentives for alternative fuel vehicles being considered or approved by the state. Each state must also consider:

- allowing public utilities to include the rates costs associated with the development and installation of alternative fuel facilities;
- exempting alternatives fuel vehicles from high occupancy vehicle and other highway vehicle restrictions;
- exempting alternative fuel vehicles from state highway taxes, road tolls, vehicle and fuel taxes, and other state taxes or charges otherwise applicable to motor vehicles; and
- providing alternative fuel vehicles special parking places at public buildings, airport, and transportation facilities.

FERC Vehicular Natural Gas Initiatives

On March 19, 1992, the Federal Energy Regulatory Commission (FERC) issued a Notice of Proposed Rulemaking (NOPR) on the sales for resales of natural gas used as a fuel for vehicles.[7] This NOPR would simplify the sale of vehicular natural gas (VNG) and reduce the regulatory burden on local distribution companies selling VNG by codifying the FERC's earlier determination that VNG is ultimately consumed in the state where it is pumped regardless of whether the vehicle later crosses a state line or not. The proposed regulation would also provide for the generic issuance of a blanket certificate of public convenience and necessity authorizing sales of VNG for resale by (1) any local distribution company that does not qualify for the exemption under Section 1(c) of the Natural Gas Act (NGA), (2) any holder of a service area determination under Section 7(f)(1) of the NGA, and (3) any other person, including all interstate pipelines, all natural gas marketers, as well as persons not otherwise natural gas companies for purpose of the NGA.

The proposed regulations are intended to promote the availability of VNG to endusers. The proposed rule's generic blanket certificates would be limited-jurisdiction certificates, which would not subject the holders to any other regulation under the NGA jurisdiction of the FERC.

State Initiatives

Since 1987, states have been devising ways to advocate and promote natural gas vehicles. The passage of the Clean Air Act Amendments of 1990 provides additional incentives for state and local governments to consider the benefits of an aggressive NGV program. A wide variety of policy options has been proposed and undertaken by state

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[7] Federal Energy Regulatory Commission, *Vehicular Natural Gas*, Docket RM92-2-000, 57FR 9515, March 19, 1992.

governments and commissions.[8] These options ranged from restricting the use of conventional fuel vehicles in certain urban areas to giving economic incentives for encouraging the use of alternative fuel vehicles. There are nineteen states reported in the following paragraphs, which have initiated some formal policies and programs to develop a market for NGVs. It is likely that other states have organized task forces and started some informal discussions and investigations on the development of natural gas vehicles. Also, several states have worked jointly in developing NGV initiatives. For example, The Northeast States for Coordinated Air Use Management has drafted a plan that, in principle, adopts a more stringent automobile emission standard equivalent to that in California. The new standard would apply to model year 1993 vehicles that enter commerce in Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, Rhode Island and Vermont. Consequently, this appendix should not be viewed as a complete description of recent state initiatives on NGVs.

Arizona

The Arizona legislature enacted a law in 1987 to comply with the Environmental Protection Agency order to cut carbon monoxide emissions.[9] Under the law Phoenix and Tucson must offer oxygenated fuels during winter months. The oxygenated fuel law required buses purchased by a city or county in nonattainment areas to use clean-burning fuel beginning January 1990. In 1988, the mandate was extended to buses, and natural gas was given a partial and temporary exemption from the state's fuel tax. Under a law

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[8] The information presented here is based on on-line computer searches conducted on March 1992 regarding state legislative and administrative activities. For an earlier discussion on state NGVs initiatives see Andy McGin and Wendy James, "State Government Initiatives to Promote Clean Transportation Fuels," *AGA Gas Energy Review* (May 1991): 22-25. Some of the material presented in this section is adapted from this article.

[9] Senate Bill No. 1360, "Arizona Clean Air Act." Also Known as the "Oxygenated Fuel Law."

signed by the governor in April 1990, cities and towns in nonattainment areas must purchase buses that operate on clean-burning fuels in quantities sufficient to meet the standards.[10] The law mandates that the percentage of clean-burning buses out of the total number of buses purchased must be 10 percent in 1990, 20 percent in 1991, 35 percent in 1992, 75 percent in 1993, and 100 percent after December 31, 1993.

California

In September 1990, California enacted a number of laws to help promote the use of NGVs.[11] One law provides for tax credits for the cost of devices installed on new or used vehicles to convert them to low-emission vehicles.[12] Another law allows for ratebased utility expenditures on the development of equipment and infrastructure for low-emission vehicles.[13] The PUC will review utility expenditures to determine if the utility investments are in the interest of ratepayers. The third one makes the following appropriations in support of low-emission vehicles: $ 1-million to support fueling infrastructure for CNG, methanol and electric vehicles; $ 1-million for technology advancement of electric and compressed natural gas vehicles; $ 1-million earmarked for CEC's ongoing methanol-fueled vehicle program, which is to be co-funded by Chrysler Corp.; $ 250,000 for ongoing assistance to the CEC for testing the health, safety and environmental impacts of alternative fuel vehicles; and $ 150,000 to the state Air Resources Board to study the impacts clean fuels will have on California's energy independence.[14]

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[10] House Bill No 2126.

[11] "Courts and Commissions," *Public Utilities Fortnightly* (November 19, 1990), 32.

[12] Senate Bill 2600, (1990).

[13] Senate Bill 2103, (1990).

[14] Senate Bill 2211, (1990).

A 1991 law requires the Public Utilities Commission to evaluate and implement policies to promote the development of equipment and infrastructure required for the extensive use of NGVs and electric vehicles.[15] The Commission must hold hearings, consider specific policies, and provide the legislature with a program report. It also must sponsor workshops addressing issues related to the regulation of the sale of natural gas in vehicles.

In March 1989, the California Air Resources Board adopted rules establishing exhaust emissions standards and test procedures for light- and medium-duty vehicles, and the distribution and availability of clean fuels. The proposal was designed to achieve the greatest possible emission reductions in the most efficient manner by spurring development of advanced vehicle technology and allowing the use of cleaner-burning fuels. The rules establish emission standards in four progressively more stringent categories: transitional low-emission vehicles, low-emission vehicles, ultralow emission vehicles, and zero-emission vehicles. The phased-in production mandate for clean-fuel vehicles applies to vehicles produced for sale and use in the state of California. The hydrocarbon emission standards, expressed as nonmethane organic gases (NMOG), include measurements of nonmethane hydrocarbons, aldehydes, ketones, and alcohols. The NMOG will be adjusted for reactivity and, starting with the 1994 model, the light-duty vehicles (including passenger cars) category will have to meet a fleet average NMOG standard. A system for earning marketable credits for use in complying with fleet average standards will be established.

In response to encouragement by the California PUC and the state legislature to research, develop, and use clean-fuel vehicles, San Diego Gas & Electric proposed a $6.8 million plan to switch its fleet to natural gas. The pilot program was approved by the California Public Utilities Commission.[16] The program as subtitled to the PUC intended to:

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[15] Public Utility Code 740.3.

[16] California Public Utility Commission, Decision A90-06-028 (June 1990).

- install twelve compressed natural gas refueling stations to serve its and its customers' vehicles as well as enter into agreement with oil companies to install CNG compressors at six gasoline service stations;
- offer incentives to fleet vehicle owners of up to 50 percent of the cost (estimated at $3,000 each) to convert them to CNG;
- reduce emission from SDG&E's own fleet by converting many of its vehicles to CNG and purchasing new CNG vehicles;
- provide emission and technical information to air quality regulators for use in developing regulations and policies pertaining to the use of low-emission fuels; and
- furnish data and assistance to state and federal agencies, the California NGV coalition, and businesses to promote the development and to explore ways to expand the use of CNG vehicles.

The costs for the program will be funded on an equal-cents-per-therm basis of natural gas sold to all of the utility's customer classes. Similarly, the California PUC has approved a plan by Pacific Gas & Electric (PG&E) to expand its natural gas vehicle program.[17] Under the program, PG&E will augment its fleet of vehicles with NGV vehicles and facilitate conversion by other fleet operators of their gasoline-fueled vehicles to compressed natural gas fuel.

Colorado

A 1989 Colorado law provides a $200 rebate for any person who acquires a clean-fuel vehicle or retrofits an existing vehicle. State and municipal agencies are also eligible to receive the rebates, which are capped at five vehicles per person.

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[17] California Public Utilities Commission, Decision 91-07-018, "Application of PG&E for Authority to Increase Gas Rates and Recover Costs for Implementation of an NGV Program" (July 2, 1991).

In 1990, the Colorado legislature enacted a law requiring that 10 percent of the new motor vehicles purchased or leased by state agencies during fiscal year 1991-92 operate on clean fuels.[18] Each year thereafter, through fiscal year 1994-1995, an additional 10 percent must use alternative fuels. New vehicles may be bifuel, and existing vehicles may be converted to reach the percentage requirements. Emergency vehicles and heavy-duty vehicles are exempt. The law also removes the sale of natural gas as a vehicle fuel from the jurisdiction of the public utilities commission.

Connecticut

In 1989, the General Assembly required the Commissioner of Environmental Protection to conduct a feasibility study on adopting the California vehicle exhaust emissions program. A more stringent emissions standard was mandated in another bill in 1991.[19]

A bill proposing a 10 percent tax credit on investment made in clean alternative fuels including compressor stations, conversion equipment and dedicated vehicles was to be introduced to the Connecticut General Assembly for consideration in 1991.[20] The bill would allow a credit for taxpayers in an amount equal to 10 percent of the amount of expenditures paid or incurred for purchasing vehicles, installing fueling stations, or converting equipments to use CNG. Other favorable tax treatment was proposed to establish compressed natural gas as a vehicle fuel. Also being considered is a bill to encourage the use of natural gas powered vehicles by requiring the Department of Public Utility Control to approve a special discount rate for natural gas sold as a motor vehicle fuel.

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[18] House Bill No.1257, "An Act Concerning Motor Vehicles Operated by Governmental Entities."

[19] Public Act No. 91-142, House Bill 5847.

[20] Public Utility Act No.91-179 (substitute House Bill No. 6740).

District of Columbia

Alternative fuels legislation was enacted in late December 1990 requiring government and private owners and operators of fleets of ten or more to convert 5 percent of their vehicles to operate on clean alternative fuels each year beginning in 1993 through 2000.[21] Reformulated gasoline was excluded from the clean alternative fuels definition.

Effective 1998, the law bans commercial vehicles not powered by an alternative fuel from operating in the central employment area of the District from sunrise to sunset between May 1 and September 15, the period when smog is particularly bad.

By February 15, 1992, and on October 1 of the subsequent year, each owner and operator of a commercial fleet is required to submit plans to the Mayor that contain specific short- and long-range goals and timetables for the implementation of a clean alternative fuels program. Those who fail to comply may be fined up to $5,000 a day.

Iowa

The Department of Agriculture & Land Stewardship has proposed a bill to create an office of alternative fuels coordinator. The purpose of the office is to facilitate and coordinate alternative fuel concerns, monitor programs and regulations, serve as a clearinghouse and referral service for alternative fuel resources, and assist in public research.

A senate bill in 1990 authorized the Department of Natural Resources to award demonstration grants to persons who purchase vehicles which operate on alternative fuels.[22] It also asked the governor to seek cooperation with the governors of other

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[21] D.C. Code @ 48-2001 (1991), "Alternative Fuels Technology Act of 1990."

[22] Senate File 2403.

states to establish an alternative fuels consortium to coordinate research, production, and marketing of alternative fuels.

Louisiana

Legislation has enacted legislation requiring 30 percent of new state agency fleet vehicles to have clean-fuel capability by September 1, 1994.[23] The percentage of clean-fueled vehicles increases to 50 percent in 1996, and could increase to 80 percent in 1998, pending a review of the program by the Louisiana Department of Environmental Quality.

Additional pro alternative fuels legislation has been introduced in 1991.[24] A senate bill was enacted providing an income tax credit for conversion of vehicles to alternative fuel usage.[25] An alternative fuel revolving fund modeled after Oklahoma's will be examined as will a package of tax incentives for conversion equipment.

Massachusetts

In 1990, the Massachusetts legislature enacted a law that will allow the Commonwealth to adopt the nonmethane hydrocarbon emissions standards based on California's 1994 low emission vehicle standards. The Massachusetts standards are to be phased in beginning with model year 1993 vehicles; they will prohibit any corporation or person from selling vehicles in the state unless they comply with the standard that can be met by completely phasing out gasoline-powered vehicles. The law would allow a delay of implementing these standards by up to two years if the state determines that other New England states or New Jersey are unlikely to adopt the California standards.

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[23] Louisiana R.S. 33:1418.

[24] Proposed by the Department of Natural Resources/Office of Conservation on September 20, 1991 (not codified).

[25] Act 1060, Senate Bill No.537 (1991).

Another law was enacted in 1991 that encourage the implementation of an alternative fuel pilot program by providing funds for purchase or conversion of vehicles.[26]

Maryland

Two pieces of legislation were enacted in 1991 related to alternative transportation fuels. The first asked the state to develop strategic plans and implement policies relating to energy supply management, including promoting and supervising research on alternative fuels.[27] The second legislation authorized the secretary of agriculture to study the effectiveness of an alternative fuel (ethanol) for motor vehicles.[28]

Minnesota

In 1984, Minnesota deregulated the sale of natural gas for resale to end users for vehicle fuel purposes, making such sales a nonutility function. In 1991, two pieces of legislation were enacted. One piece of legislation promotes (among other things) research and potential use for alternative fuels.[29] The other states that the tax imposed for motor vehicle use does not apply to sales of compressed natural gas or propane for use in vehicles.[30]

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[26] House Bill No. S506, ALS 33 (1991).

[27] MD. Ann. Code art.41, @10-702 (1991).

[28] Md. Ann. Code Art.41, @ 18-202(1991).

[29] Minn. Stat. @ 1160.1 (1991).

[30] Minn. Stat. @ 296.01 (1991).

New Jersey

The Coalition of Northeastern Governors, chaired by New Jersey's governor, established a regional alternative fuel program to encourage greater use of alternative fuel vehicles in public and private sector fleets in the Northeastern United States. The Coalition of the nine state decided in November 1991 to adopt California's rules on auto pollution. Participating states are New York, New Jersey, New Hampshire, Maine, Pennsylvania, Delaware, Maryland, Virginia, and the District of Columbia. These are the first states to choose California's standards over less stringent U.S. EPA rules.

Furthermore, a $2 million demonstration project funded in part by Public Service Electric & Gas Company (PSE&G), will allow more than 200 alternative-fueled vehicles in the state-owned fleet. Legislation in 1991 reduced the tax on compressed natural gas used to propel motor vehicles upon the public highways to one half the rate applicable and paid on the sale or use of other fuels.[31]

New York

In 1989, three state agencies issued a jointly developed New York State Energy Plan that calls for a 50 percent increase in natural gas use by 2008. This plan called for accelerating state government demonstration programs and asserted that New York State "should encourage the use of compressed natural gas as a transportation fuel."

In fall 1990, the New York Department of Environmental Conservation adopted California's 1993 motor vehicle emission standards and durability requirements. Beginning in 1993, 40 percent of passenger cars and light-duty trucks and certain medium-duty vehicles manufactured for sale in New York must meet exhaust standards of 0.25 gm/mi for hydrocarbons, 0.4 gm/mi for nitrogen oxides and 3.4 gm/mi for carbon monoxide. The percentage rises to 80 percent in 1994 and 100 percent in 1995. All emission control equipment must be certified to last 100,000 miles.

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[31] NJ. Stat. @ 54:39-27.1 (1991).

In August 1990, the state started a six-year, $40-million demonstration program to operate 268 cars, buses, and trucks on alternative fuels. The vehicles will be purchased or retrofitted, operated throughout the state, and tested extensively for performance, durability, and emissions. In addition, several refueling stations will be built, and funding will be provided for driver and mechanic training and an information network.

In 1990 the Port Authority and the Triborough Bridge and Tunnel Authority have lifted their ban on natural gas and certain other alternative-fueled motor vehicles that could operate on their tunnels and bridges.

Oklahoma

A 1990 law establishes a program for promoting the use of clean-fuel vehicles in both the public and private sectors.[32] This program relies mostly on incentives and is not limited to fleet and/or state-owned vehicles. Under the law, a newly created Oklahoma alternative fuel revolving fund administrated by the Oklahoma Corporation Commission will reimburse costs to any state, county, municipal, or school district that voluntarily converts a vehicle to compressed natural gas, LNG, propane, ethanol, or electricity. In return, the agencies will repay the fund from the fuel savings they achieve until the fund is repaid. Repayment will be suspended if the clean fuel prices are not below the price of gasoline. School districts and government entities that convert fleet vehicles from gasoline to an alternative fuel can obtain reimbursement loans for the cost of the conversion up to $3,000 a vehicle. In the first phase of expenditures, $300,000 will be allocated to convert 155 vehicles. The payback period to the fund will be seven years or less. The Oklahoma Governor's office has approved another $500,000 for the fund, bringing the total to be allocated after the first phase of conversions to $1.45 million.[33]

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[32] Okl. Stat. 17 @681 (1991), "Oklahoma Alternative Fuels Conversion Act."

[33] "Courts and Commission."

The private sector incentive program is built around a series of tax credits under the Oklahoma income tax. Three different tax credits limited to natural gas are available: (1) a 20 percent tax credit for conversion equipment, (2) a 20 percent tax credit for refueling equipment, and (3) a 10 percent tax credit up to $1,500 for the total cost of any clean-fuel vehicle that features clean-fuel equipment installed by a manufacturer.

Oregon

Since 1989, several pieces of legislation have been enacted or proposed to encourage the use of alternative fuels in transportation. Two statutes were enacted in 1989 that required the Department of Energy to provide a comprehensive energy plan that would give priority to the use of alternative fuels and state agencies were encouraged to purchase alternative fuel vehicles.[34] In 1991, two senate bills were introduced. The first mandates that state-owned passenger motor vehicles must use alternative fuel for operation to the maximum extent possible.[35] Also, state agencies after July 1, 1991 must acquire only motor vehicles capable of using an alternative fuel. A second bill offers cash payment to assist the utility's commercial and industrial customers in purchasing cost-effective conservation measures or alternative fuel fleet vehicles or facilities necessary to operate alternative fuel fleet vehicles.[36]

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[34] ORS. @ 469.060 and @ 469.750 (1989).

[35] Senate Bill No.765, ORE. Laws 399, (1991).

[36] House Bill No. 2130, ORE. Laws 711, (1991).

Texas

In May 1989, the Texas Legislature enacted a law that mandates a phased shift to clean transportation fuels by certain vehicles in nonattainment areas.[37] The mandate covers all metropolitan buses, state agencies with fleets of over fifteen vehicles, and school districts with fleets of over fifty school buses. The law directs affected fleet operators to attain clean fuel capability for all vehicles acquired after September 1, 1991.

The following targets for compliance must be met:

- 30 percent of each affected fleet by September 1, 1994,
- 50 percent of each affected fleet by September 1, 1996, and
- If certain findings are made by the Texas Air Control Board, 90 percent of each affected fleet by September 1, 1998.

The Texas Air Control Board is also empowered to set mandates for most local government fleets of over fifteen vehicles and for private fleets of over twenty-five vehicles. For compliance, vehicles must have the capability to use compressed natural gas or other alternative fuels that result in comparably lower emissions. Exemption can be obtained if refueling facilities are unavailable and/or if clean-fuel suppliers do not offer adequate financing.

Texas also passed a bill which deregulates the sale of natural gas for resale to end users for vehicle purposes and makes such sales a nonutility function, effective September 1989.[38] Several other laws enacted in 1991 which contain a tougher mandates for the use of alternative fuels.[39]

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[37] House Bill 1403, (1989).

[38] House Bill 1878, (1989).

[39] Senate Bill No.404,(1991); Tex. Rev. Civ. Stat. Art. 601b (1991); and Tex. Rev. Civ. Stat. art. 1118x (1991).

Utah

In the 1991 legislative session, several pro-alternative fuels bills were examined by the Utah legislature. A 20 percent tax exemption with a cap of $500 for the purchase of new alternative fuel vehicles and a 20 percent ($400 cap) exemption for conversion equipment were proposed.[40] One bill would deregulate the sale of natural gas as a vehicle fuel.[41] Another would set up a revolving fund similar to the one operating in Oklahoma to convert certain fleets of vehicles to alternative fuels.[42]

Virginia

In 1991, two pieces of legislation were enacted. One law empowers the Board of Education to make loans from a literary fund for equipping school buses for alternative fuel conversions and for construction of school bus fueling facilities for supplying compressed natural gas or other alternative fuels.[43] The other law prohibited the Commission from regulating, prescribing the rate charges, and charging fees for the provision of retail CNG service provided by corporations other than public service corporations.[44] Wholesale CNG sales provided by public service corporations shall continue, according to the law, to be regulated by the Commission as a public utility service.

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[40] House Bill No. 122 (1991), became Utah Code Ann. at 63-53-9 (1992).

[41] House Joint Resolution No.35 (1991).

[42] House Bill No. 142 (1991).

[43] Va. Code Ann. @ 22.1-146 (1991).

[44] Va. Code Ann. at 56-232.2 (1991), "Regulation of Compressed Natural Gas."

Washington

In 1991, the Washington legislature enacted a law requiring the state's Department of Transportation and the state energy office to cooperate in developing aggressive clean fuel performance, emission specifications, and conversion programs.[45] At least 30 percent of all new vehicles purchased through state contract must be clean-fuel vehicles. The percentage shall increase 5 percent more each year.

West Virginia

In January 1991, an executive order by the governor of West Virginia initiated a test group of state vehicles to be converted to use compressed natural gas. The executive order seeks to establish a series of natural gas refueling stations starting operation by September 30, 1991. Legislation enacted in 1991 directs the public service commission (PSC) to:[46]

- develop and implement programs designed to encourage the use of West Virginia alternative fuels as vehicles fuels;
- authorize ratemaking allowances for public utilities to encourage the use of alternative fuels in new demonstration technologies, including alternative fuel vehicles; and
- relinquish jurisdiction over the ultimate sale by nonutilities of alternative fuel to be utilized solely as fuel for motor vehicles.

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[45] House Bill No. 1028, (1991).

[46] W.Va. Code at 24-2D-1 (1991), "Alternative Fuel Initiatives."

Intergovernmental Groups

Several organizations representing local and state governments or agencies have adopted policy statements supporting the increased use of natural gas, especially in vehicles. Such organizations include: the National Association of State Energy Officials, the National Governors Association, the National League of Cities, South/West Energy Council, and the National Conference of State Legislatures. The National Association of Regulatory Utility Commissioners (NARUC) has adopted a resolution to further encourage the development and widespread use of natural gas vehicles.

APPENDIX B

INTERNATIONAL EXPERIENCE IN PROMOTING ALTERNATIVE-FUELED VEHICLES

The development and use of alternative fuels for vehicles have started receiving serious consideration in some countries over the last two decades. Several countries with abundant natural gas or biomass resources chose to use these in order to increase energy self-sufficiency and reduce their oil dependency.[1] There are quite a few research and testing programs of alternative transportation fuels. But, the large-scale programs that are supported and implemented by the national government existed mainly in New Zealand, Brazil, and to a lesser extent, Canada. This section describes the experience and the results of the programs implemented in Brazil, Canada, and New Zealand.

Brazil

Brazil's alternative transportation fuels are considered the most ambitious in the world. Brazil produced ethanol that supplied 22 percent of the automotive transport demand in 1985. By 1986, 90 percent of new car sales were dedicated ethanol vehicles. Also, the country had a goal of converting one-third of its truck and bus fleet to CNG.

The uncertainty of oil prices in the mid-1970s and the shortage of domestic oil supply were the major reasons that led Brazil to adopt the "Proalcool" program. Also, the country's overwhelming reliance on hydroresources for electric power generation has confined the uncertainties about hydrocarbon supply and costs to transportation and industry. At the same time, the large sugar industry, which had modernized and increased its output by the 1970s suffered from a sharp drop in world sugar prices in 1975. Against this backdrop, Proalcool, the National Alcohol Program, was born and implemented in two phases. The first phase (1975-1979) focused on increasing the ethanol percentage in gasohol to 20 percent nationwide. A second phase (1979-1985) was a major push to produce and supply dedicated ethanol vehicles. A third phase, proposed in 1985 to expand the use of dedicated ethanol vehicles and increase ethanol

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[1] This appendix is a summary of Chapters 9, 10, and 11 of Daniel Sperling, ed., *Alternative Transportation Fuels: An Environmental and Energy Solution*, (New York: Quorum Books, 1989).

production, was put on hold due to the world oil price drop, and the increase in oil domestic production and verified reserves.

Proalcool program tasks were carried on by various agencies which managed distillery construction, ethanol production and prices, gasoline blending, and credit. As a producer incentive, ethanol was purchased (originally by the National Petroleum Council and then by Petrobrás, the National Petroleum Company) on a sugar-equivalent basis: prices and quotas were fixed by the National Institute for Sugar and Alcohol on a cost basis. Additional incentives included producer credit subsidies, which paid for up to 75 percent of investment. The government assured that sugar mill/distilleries received a 6 percent return on their investment as long as they promised to produce ethanol and not export the sugar instead.

By 1979 alcohol fuel use in transport reached its goal: 33,000 barrel per day oil equivalent (BDOE). The first phase was successful mainly because it required little technological or institutional change. In the second phase the goal was to switch 50 percent of vehicle sales to dedicated ethanol vehicles, and produce 2.5 billion gallons of ethanol by 1985. The investment needed for the fuel production and distribution targets was $5 billion. This money was raised from an Energy Mobilization Fund (fuel taxes, vehicle licensing fees, loans, and other sources). Consumer incentives to buy the new vehicles included lower purchase taxes, lower registration fees, smaller down payments, greatly extended repayment periods, and lower fuel costs. Automobile manufacturers were encouraged by the strong government commitment, consumer incentives, and assurance of sufficient fuel supplies.

The success of the second phase was not as great as in the first phase. World sugar and oil prices, efficiency of vehicle conversions, sufficiency of ethanol supplies to meet the demand, and several other factors have caused ups and downs to the progress of achieving targets. However, the government continued to bolster the ethanol program when it was needed. It was revealed during that phase that the success of the program depended heavily on strong government support as well as the speed of consumer response to a change in the commitment.

The program overall is considered a success from the standpoint of implementation. Two main reasons were cited for that success. First, the ceiling on ethanol prices, imposed by the government, circumvented market signals that would otherwise have delayed transition. Second, the strategy of concentration in one region (São Paulo) also benefitted the program; that is, it allowed economies of scale in production and distribution, and increased the density of fuel outlets and support services.

Canada

The use of alternative fuels in transportation was part of a national strategy in 1980 that called for oil self-sufficiency, conservation, and oil substitution. The supply surplus of liquified petroleum gas (LPG) made it the focus of the first government efforts. The efforts later extended to CNG, and, to a much lesser extent, to alcohol fuels.

The objective of the LPG program was to create an LPG market of 1 to 2 percent of road gasoline demand, eventually to reach a level of 5 percent, or about 400,000 vehicles. The federal and provincial government coordinated to remove regulatory, supply, capital, and information barriers to expand use of LPG. The primary federal program was the Propane Vehicle Grant Program, which gave a taxable grant for converting a commercial vehicle to LPG or for purchasing a new LPG vehicle. In 1984, this program was extended to cover private vehicles as well. The federal government also reduced the tax on LPG.

The main incentive provided by the provincial government to promote the use of LPG was the removal of taxes on LPG. In British Columbia and Ontario, the sales tax was removed for dedicated LPG vehicles and conversion kits.

At the end of 1984, LPG vehicles had captured 3.3 percent of the commercial market. The government discontinued the LPG grant programs because the vehicle conversion target was successfully met. It continues research and development support to improve LPG conversion technology to keep pace with engine development.

The interest in CNG as an alternative transportation fuel did not start until the early 1980s. The Natural Gas Vehicle Research and Development Program was initiated by the British Columbia government in 1980 and supported by the federal government in 1981. The purpose was to evaluate and improve existing CNG technology. This led to the establishment of safety regulations, design of carburetion equipment suited to the Canadian environment, and a knowledge base concerning natural gas vehicle combustion and performance.

In July 1983, the federal government began two grant programs to overcome these obstacles: the Natural Gas Vehicle Program (NGVP) and the refueling station program. The station goal was set at 125 by 1986. The target for converted vehicles was 35,000. Natural gas utilities were expected to supplement government incentives. The NGVP gave grants to vehicle owners converting to CNG. It was complemented by removal of the provincial sales tax on conversion kits and/or vehicles in some provinces. A grant of Can. $50,000 was available for establishment of CNG refueling stations. While the program's fuel station goal was met and exceeded, the number of vehicles converted was less than planned.

Several policy options were used by gas utilities. Many gas companies offered grants and financial packages to encourage vehicle conversions and fuel station construction. Some gas utilities have adopted low profit margins for natural gas destined for CNG use. Other utilities have adopted the strategy of taking a somewhat higher margin on gas and giving a substantial rebate on conversion costs. Several companies were also developing CNG cylinder leasing programs. A second approach was to offer easy financing for conversion. Some utilities in Ontario and British Columbia have been able to negotiate rate basing of new refueling stations with the natural gas regulatory boards.

An agreement between the federal and provincial governments controlled the price of natural gas at 85 percent of that of crude oil from 1975 to 1981 and at 65 percent from 1981 to 1985 and since then the price has been decontrolled.

Despite all the incentives, the conversion rate has been low. The major barriers to public willingness to use CNG were cited as: cost of conversion, fuel availability, and driving range limitations.

New Zealand

Since New Zealand is largely dependent on imports for its oil supply, the government made a strong commitment to increase energy self-sufficiency and substitute petroleum used in transportation. By 1986, government efforts resulted in a displacement of gasoline demand by 35 percent by synthetic gasoline (produced from natural gas), 10 percent by compressed natural gas (CNG), and 3 percent by liquified petroleum gas (LPG). Synthetic gasoline was emphasized because its use required little infrastructure change and no adjustment of consumer behavior.

Also, the substitution of methanol produced from natural gas was rejected mainly because the country did not have its own integrated auto industry or extensive expertise in automotive engineering. Its domestic automotive market was small (about 90,000 new cars each year), and thus it had limited leverage in convincing overseas automobile manufacturing companies to produce dedicated methanol cars.

In a joint effort by the government and the private sector, the CNG program started in July 1979. The target started as the conversion of 150,000 vehicles to CNG by the end of 1985, and later changed to 200,000 vehicles by the end of 1990. By 1986, 110,000 vehicles, or 11 percent of all cars and light trucks, had been converted, and 400 fueling stations were in operation.

The government established a series of standards covering both vehicle conversion and refueling stations, and set up a CNG Coordinating Committee to address technical and regulatory issues confronting the industry. The government actively promoted the program with information and publicity campaigns. It encouraged dealers to maintain the price of CNG at half that of gasoline and publicly stated that any fuel tax charges would not disadvantage CNG. An incentive governmental grant for vehicle conversion and fueling stations was introduced. The grant offset the import tax levied on imported

CNG cylinders and conversion components as well as sales tax. The 25 percent grant for fueling stations included related expenditures as well as equipment. Tax write-offs were extended to new vehicles converted in the factory. The road-user tax for CNG vehicles was replaced by a lower fuel tax.

The program moved more slowly than expected despite the incentive. Motorists were reluctant to convert to a new technology and had concerns about fuel availability. Fuel cylinder approvals were delayed, causing the most popular model to be withdrawn from the market. The quality of conversions performed by some installers was poor. Because of the slow rate of conversions, no large company moved into the refueling business. The private sector saw promotion as the responsibility of the government.

A low-interest program was introduced in 1983 to overcome motorists' reluctance to incur a high first cost for conversion kits. The load program was run by the Ministry of Energy through trading banks. Market research indicated that the availability of the loan was a deciding factor for over 60 percent of those converting their vehicles.

Between 1980 and 1987 government support proved to be crucial. When a newly elected administration limited the number of CNG conversion loans and increased interest rates, conversions fell dramatically. Later the government attempted to revive the program by enlisting private industry to take over the leadership.

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