

# Alternative **FUELS**

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## **NATURAL GAS AS A TRANSPORTATION FUEL**

by Boone Pickens, Chairman & Chief Executive Officer, MESA, Inc.

**T**he fact that foreign oil imports accounted for 58 percent of the nation's supply in July 1994 is anything but good news for America's trucking industry.

The seemingly non-stop increase in the United States' reliance on foreign oil brings back memories of the 1973 Arab oil embargo, when diesel prices increased by more than 140 percent — in about the time it took to drive from Denver to Phoenix.

That's a significant upswing in an industry where the difference between profit and loss is often controlled by fuel costs and measured in mere pennies per gallon.

Foreign oil imports accounted for only 35 percent of U.S. oil consumption in 1973. The 58 percent level reached in July means that, by the turn of the century, the country may have to rely on foreign producers to meet 70 percent of its energy needs — including gasoline and diesel fuels.

Over the past two decades the U.S. trucking industry has undergone marked change and become increasingly competitive with the help of concepts such as core carriers and deregulation that were largely unknown here in 1973.

But one thing hasn't changed: the trucking industry's partnership with diesel as a transportation fuel. To remain competitive in the decades ahead and avoid the devastating economic

consequences that would result from another Arab oil embargo, the U.S. trucking industry has to become as open to alternative transportation fuels as it has been to intermodalism and just-in-time inventories.

Despite the signs of peace in the Middle East, don't think the idea of another oil embargo is far-fetched. It could occur because of something as simple as a decision by OPEC to reduce U.S. exports to meet the demands of developing nations, or a policy change based on the complicated aftermath of the 1991 war in the Persian Gulf. As a result of that skirmish, the United States now has more enemies than friends in the Middle East. To a vast majority there, Iraq's Saddam Hussein is a hero.

Three years ago, who would have believed that:

1. Saddam Hussein could stay in power?
2. He could survive almost three years without selling oil?
3. President Bush would lose the election in 1992?

I would have lost on all three bets.

Now we've reached the point where the Middle East producers don't even have to stop selling us oil to bring our economy to its knees — all they have to do is ratchet their exports down by 10 to 15 percent. They might do it in the name of energy conservation, or they

might do it to protect their long-term financial interests. The point is, they can do it, and they can have a major impact on the U.S. economy, diesel prices, and the trucking industry.

Fortunately, there is a solution: Begin substituting clean-burning domestic fuels, particularly natural gas, for foreign oil. If we're going to make any headway in this area, the transportation industry has to play a lead role. In economic terms and from a competitive standpoint, the trucking industry has a lot at stake.

Natural gas is cleaner and more efficient than crude oil in virtually every application, from power generation to transportation. On a gallon-equivalent basis, this 130-octane fuel costs substantially less than gasoline or diesel.

Why hasn't natural gas cracked the transportation market before? For two reasons.

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# ALTERNATIVE FUELS ARE ESSENTIAL!

by Mary D. Nichols, Assistant Administrator, Office of Air and Radiation, U.S. Environmental Protection Agency

**F**irst the good news: The latest air quality data for the past 10 years show consistent reductions across the country in every air pollutant for which we have national ambient health standards: ozone, lead, nitrogen dioxide, carbon monoxide, particulates, and sulfur dioxide.

Air quality monitoring also indicates that almost half the nation's ozone nonattainment areas have met health standards for the past three years. In fact, 26 of these areas have already applied to be redesignated as attainment areas.

As 10 years of data show, this cleaner air is not just a fluke. Rather, it is the result of significant emission reduction efforts across the board: chemical plants, cars, trucks, buses, refineries, manufacturing facilities, incinerators, lawn mowers, leaf blowers, chain saws, and outboard motors, just to name a

few. In short, almost everyone is contributing to the national effort to clean the air, and those contributions are showing up in real, verifiable reductions in pollution.

Now, unfortunately, comes the bad news: Despite this progress at the national level, more than 50 million Americans still live in areas that don't meet air-quality-related health standards. Asthma is on the rise across the country and far too many people are still exposed to toxic air pollution from both industry and motor vehicles. In other words, we still have much to do if we are to keep the promise of the Clean Air Act.

Simply put, cleaner transportation fuels are a significant and essential part of the ongoing national effort to keep that promise. The challenge for all of us concerned with air quality and trucking is to develop policies and technologies that can provide for cleaner fuels, more efficient vehicles, and the related infrastructure requirements. Those of us with responsibility for these efforts, in both the public and the private sectors, must continue to develop the options that can give the general public the benefits of alternative fuels that the trucking industry uses.

In particular, we are glad to see clean fuel efforts like those being developed by the ATA Foundation's Trucking Research Institute; such efforts begin with a solution-oriented commitment to work cooperatively toward real progress. In my judgment, these kinds of efforts are absolutely essential if we

are to meet the challenge of providing air quality to all Americans.

The Environmental Protection Agency (EPA) takes this challenge very seriously, and believes it can help meet it. Certainly, the Clean Air Act Amendments of 1990 provided a strong regulatory basis for moving forward in these efforts with, among other things, the Clean Fuel Fleet and Reformulated Gasoline Programs. And, although heavy-duty trucks above 26,000 lbs/gvwr are not subject to the Clean Fuel Fleet Program, it is likely that tightened standards will eventually result in additional use of cleaner fuels for them as well.

However, as EPA looks to the trucking industry for significant progress toward clean air, it also knows that the engineering and cost challenges are real, and it will continue to assess the economic viability of alternative fuel options. In fact, that's part of why focusing on alternative fuels makes sense.

In our judgment, the primary advantage of clean fuels is their effect on emissions. Supporting the domestic fuels industry and lowering our dependence on foreign oil supplies are important policy advantages, but lower emissions are the key benefit. Clean fuels tend to reduce emissions of many pollutants simultaneously, which adds significantly to their cost-effectiveness as a pollution reduction tool.

EPA's goal is to encourage approaches that capitalize on this effectiveness while minimizing any

## Alternative FUELS

IN TRUCKING

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Timothy R. McGrath, Editor

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The aim of **Alternative Fuels in Trucking** is to inform fleet owners and operators, equipment suppliers, government officials, and other interested parties about important developments in the use of alternative fuels in heavy-duty trucks. Suggestions and comments are welcome. Views expressed by guest authors are their own, and not necessarily those of ATAF, DOE, or NREL.

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# DOE'S CLEAN CITIES PROGRAM

by Tom Foltz, Director, Clean Cities Program, U.S. Department of Energy

It is ironic that one of the 20th century's greatest inventions, one that has improved the quality of life for millions, also threatens to deprive us of other comforts. The automobile — and more importantly, the fuel it uses for operation and all its other contributions to society — has led to increasing problems in our environment, economic outlook, and national security.

The U.S. transportation sector accounts for 62 percent of the nation's oil consumption and is 97 percent dependent on petroleum. This dependence, which is still growing, places a greater demand on production than U.S. industry can support.

America's growing dependence on foreign oil poses a serious threat to our domestic energy industries, and could mean the loss of jobs and paychecks, decreased revenues for governments at all levels, and serious threats to our national security.

In response to these concerns, Congress passed the Clean Air Act Amendments of 1990, the Intermodal Surface Transportation Efficiency Act of 1991, and most recently, the Energy Policy Act of 1992.

The U.S. Department of Energy's (DOE) Office of Transportation Technologies, responsible for carrying out the alternative fuels section of the Energy Policy Act, has developed a program called Clean Cities. This program seeks to accelerate and expand the use of alternative fuel vehicles in communities throughout the country and simultaneously provide refueling and main-

tenance facilities for their operation. The Clean Cities Program focuses on the importance of forming public/private partnerships, and represents an innovative approach to coalition building.

The response to Clean Cities has been phenomenal. So far, 14 cities have joined: Atlanta; Austin; Albuquerque; Boston; Chicago; Denver; Colorado Springs; Las Vegas; Long Beach; Miami; Milwaukee; Philadelphia; Washington, D.C.; and Wilmington.

Clean Cities has generated strong interest and enthusiasm. This fall, we expect to designate 10 to 15 additional areas, for a minimum of 25 participants by the end of the year. New participants will probably include Salt Lake City; Buffalo, New York City, and White Plains; Baltimore; Louisville; the State of West Virginia; Portland and Medford, Oregon; Sacramento, Oakland, San Francisco, San Bernardino, Lancaster, and Los Angeles; St. Louis; and Dallas and Houston.

Although Clean Cities is based primarily in metropolitan areas, we have ambitious goals. To gain widespread public acceptance and encourage individuals to use alternative fuels, we must promote the ability to travel longer distances using alternative fuels rather than confining our driving to urban areas where alternative refueling stops are plentiful.

The trucking industry can help us extend the refueling infrastructure beyond the core cities, along the American highway system and into

rural areas. The industry's commitment can coincide with a pledge from fuel suppliers to ensure the growth of the appropriate infrastructure. Light-duty fleet operators have made this promise in our Clean Cities.

One can easily identify potential alternative fuel transportation corridors already developing. As Clean Cities develop their refueling and maintenance infrastructures, that infrastructure will eventually spread beyond the core metropolitan areas originally designated and overlap with other cities in their region.

In fact, the groundwork is already being laid for a corridor that will run from Washington, D.C., through Baltimore, Philadelphia, Wilmington, and New York City to Boston. Similar efforts are under way in the South, in Colorado, and on the West Coast.

The trucking industry has a unique opportunity to advance this process and help make alternative fuel transportation corridors a necessary and practical reality. We invite you to help us make the move to cleaner air, greater economic prosperity, and enhanced energy and national security. We look forward to your participation in Clean Cities. Together we can achieve a strong national alternative fuels market.

*Tom Foltz is Director of the DOE's Clean Cities Program. Before that appointment, Mr. Foltz served as Deputy Staff Director for the Federal Fleet Conversion Task Force. For more information on the Clean Cities Program, contact Mr. Foltz at (202) 586-4264.*

# THE ALTERNATIVE FUELS TASK FORCE

by William H. Peerenboom, Vice President, ATA Foundation

**W**hen the ATA Foundation began investigating the use of alternative fuels in heavy- and medium-duty trucks in 1989, it formed a task force composed of interested motor carriers, original equipment manufacturers (OEM's), engine and component manufacturers, fuel suppliers, consultants, and government officials. The Alternative Fuels Task Force serves many purposes; principally it is an information conduit that brings together many diverse interest groups to share technical, policy, and operational information about the operation of heavy-duty trucks using any of the alternative fuels. The task force has more than 100 members, and the list is growing as interest in alternative fuels increases.

Because so few heavy-duty trucks actually use these fuels, the group's early meetings were purely informational. They mainly covered reports on projects being undertaken by the ATA Foundation's Trucking Research Institute (TRI) in conjunction with the National Renewable Energy Laboratory (NREL); the United States Department of Energy (DOE); engine manufacturers' plans to introduce alternative fuel engines; and technical presentations on the unique factors involved in using the several kinds of fuels, including the alcohols (methanol and ethanol), liquefied petroleum gas [LPG], and the natural gas fuels (liquefied natural gas [LNG] and compressed natural gas [CNG]). The task force has also addressed the continuing changes in regulations resulting from the Clean Air Act Amendments of 1990, the Energy Policy Act of 1992, and,

most recently, the potential effects of the rules in the Federal Implementation Plan issued by the U.S. Environmental Protection Agency in May 1994, for three areas of California.

It is becoming apparent that liquefied natural gas enjoys some unique advantages for commercial trucking. LNG promises to deliver better range, and its combustion characteristics offer significant emissions benefits. The major engine manufacturers have begun producing and certifying heavy-duty engines for truck use with natural gas, and OEMs have begun engineering these engines and their attendant fuel systems into production chassis. A group of task force members have formed a Manufacturers' LNG technical subcommittee this year to address the many issues that will arise in bringing these vehicles into use.

Although cryogenic technology is not new — trucks have been transporting cryogenics for many decades — the use of cryogenic liquids as fuel in heavy-duty trucks presents new technical challenges for both the trucking and the cryogenic industries. It is one thing to move a cryogenic liquid as cargo, loading and unloading it in bulk; it is quite another to use it as a fuel — making a vehicle's safe and reliable operation dependent on cryogenic LNG. The Manufacturers' LNG technical subcommittee is responding to the many challenges posed by the technical issues involved in powering heavy-duty trucks, in a variety of duty cycles, with LNG. The subcommittee's members have recommended a series of technical specifications for on-board

cryogenic fuel systems and the fuel they use.

General recommendations are:

- Cryogenic fuel tanks and associated plumbing/fittings, etc. should be designed for the least amount of heat leak and the fewest number of connections.
- Refueling stations, cryogenic on-board tanks, and fuel system must ensure integrated, inter-related design/performance functions. All items should comply with appropriate standards; e.g., NFPA-57 (Draft), ASME, DOT, and local codes applicable to the automotive application.
- Refueling stations should provide a minimum fuel-delivery rate range of 30-40 gallons per minute.
- On-board fueling systems must be capable to continuously deliver the engine's rated fuel pressure and flow immediately after refueling and starting the engine. System components should comply with California Air Resources Board's warranties and recommendations where appropriate.
- Suppliers of vehicle fuel-system components, cryogenic tanks, and refueling station components should provide the following information with products or bids: (1) written confirmation of testing and performance criteria; (2) type, materials, cryogenic rating for fittings; (3) service policy; (4) manuals for installation, service, maintenance, repair, and safety; and (5) written warranty policy.

## Specific LNG On-board Fuel System and Fuel Composition Recommendations

Engine application pressure range	05-135 PSIG
LNG fuel composition quality	99.5% - 100% methane
Tank construction material	304 stainless steel (inner & outer)
Insulation material	Vacuum-insulated with Non-flammable superinsulation — oxygen-rated service
Tank design life	15-year vacuum
Design criteria/codes	DOT-4L in accordance with NFPA-57(draft)
Contents indicator	In-dash fuel display accurate to plus or minus 1/8 tank
Evaporation rate	1% per day of volume @ static pressure
Relief criterion	Dual: primary @ 230 PSIG secondary @ 350 PSIG
Filling mode	Top fill with vapor ullage collapse
Overfill protection and tank design	Not dependent on fueling inner station functions Provides vapor ullage space protection
Tank hold time criterion:	5-day minimum 75% full @ 135 PSIG

These initial technical recommendations will provide clear guidance to suppliers and manufacturers. If you have questions or comments on any of them, call Bill Peerenboom at (703) 838-1863.

The subcommittee is developing a detailed analysis of potential "failure modes" of the on-board fuel system components to help provide a framework for developing a sensible testing program that will ensure safe and efficient operation of LNG on-board fueling systems on heavy-duty trucks. Look for progress reports in future editions of *Alternative Fuels in Trucking*.

**William H. Peerenboom** is Vice President of the ATA Foundation

and its subsidiary, the *Trucking Research Institute*. In this capacity he is the principal investigator in the *Trucking Research Institute's* ongoing research into the effects of alternative fuel use in heavy- and medium-duty operations. This research is under contract with the U.S. Department of Energy through NREL. In an earlier career, Mr. Peerenboom served in the U.S. Navy, where he began as a ship-board engineer and later became captain of several ships.

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initial cost disadvantages. For example, focusing on alternative fuel usage for trucks in urban areas where infrastructure can, in effect, be shared with passenger vehicles can increase those fuels' economic viability relative to traditional fuels. And under this scenario, the pollution benefits would occur exactly where we need them — in urban areas where particulate and ozone problems are most severe.

As we pursue these and other options in the years ahead, it is EPA's hope that everyone interested in these issues can continue to develop their efforts from discussion to action, and continue to move ideas and plans from the demonstration-project stage to commercial viability. We look forward to meeting the technological and cost challenges so that one day, not too long from now, we, together, will have kept the promise of clean air for all Americans.

*Mary Nichols is the EPA's Assistant Administrator for Air and Radiation. Before her appointment at the EPA, Ms. Nichols served as a senior staff attorney and director of the Los Angeles office of the Natural Resources Defense Council. She has extensive experience in environmental law and administering public-sector agencies responsible for civil litigation and environmental policy. She has written and taught widely on environmental and legal issues. She is a founding trustee of the California Environmental Trust and a board member of the Los Angeles 2000 Partnership.*

# NATURAL GAS

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First, there has never been any sponsorship for natural gas.

Crude oil, gasoline, and diesel have had their sponsors for decades: the major oil companies, Detroit's Big Three automakers, and government. But with the passage of the Clean Air Act Amendments of 1990 (CAAA) and the Energy Policy Act of 1992 (EPACT) mandating fleet use of cleaner domestic fuels, natural gas now has the sponsors it has needed.

If you haven't read the CAAA you should get acquainted with it. Billions of dollars are going to be spent because of that legislation, and much of that money will be spent by the U.S. trucking industry.

California has adopted tough anti-pollution measures — even tougher than the federal government's. The District of Columbia and 12 states in the Northeast, including New York, are moving to adopt the California standards. Half the U.S. population could be subject to the California standards before the end of the decade.

Second, without sponsors for natural gas, the private sector has been slow to develop the fueling infrastructure or advance the engine technology necessary to help the transportation sector — and the trucking industry — move from diesel to natural gas.

The incentives and mandates incorporated in the CAAA and the EPACT have changed all that.

Today companies across the country are involved in the research, development, production, and marketing of a wide range of transportation oriented natural gas services and products, from compressed and liquefied natural gas fueling facilities to advanced-technology diesel-engine conversion equipment.

America's railroad sector — the trucking industry's chief competition — is advancing the use of cost-effective and clean-burning liquefied natural gas as a transportation fuel. By using liquefied natural gas instead of compressed natural gas, Burlington Northern Railways has overcome many of the range and storage concerns once associated with natural gas. Railway involvement with liquefied natural gas, coupled with expanded use of the fuel among mass-transit bus operators, is helping develop a national fueling infrastructure that the trucking industry will ultimately rely on to meet its needs.

On the engine front, technology is improving rapidly as well. Detroit Diesel has produced and is now testing a prototype natural-gas-fueled version of its Series 60 engine. This lean-burn, spark-ignited, wastegate turbocharged engine is designed to use air-to-air charge cooling and is rated 370 horsepower at 1,800 rpm.

Does anyone expect the trucking industry to make the switch to natural gas this year or next? No. But if the industry confronts the economic threat posed by the United States' escalating dependence on foreign oil, it will inevitably turn to natural gas and to the private sector to meet its fueling and engine needs.

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