

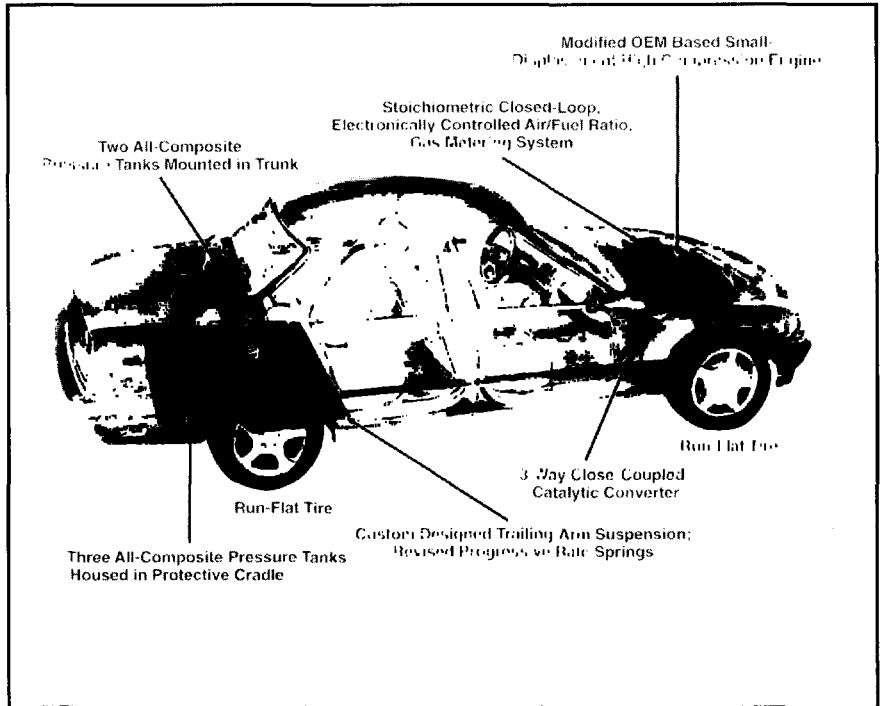
# AEDC UPDATE

News of the Alternative Fuels Data Center

## DOE Unveils Advanced Natural Gas Vehicle

An advanced natural gas vehicle (ANGV), which features performance, fuel economy, and range equivalent to that of a gasoline vehicle, was unveiled at a November press conference held at the U.S. Department of Energy (DOE). The dedicated compressed natural gas (CNG) vehicle, in the form of a compact-sized four-door sedan, was developed by an industry consortium headed by the Johns Hopkins University Applied Physics Laboratory (APL).

The prototype will undergo testing and evaluation for a year by APL staff and others. Initial road tests have demonstrated a 315-mile driving range between refuelings—about twice the range of CNG vehicles on the road today—and a fuel economy of 32 miles per gallon. APL also said that 75% of the vehicle's original trunk space will be retained by re-engineering the rear underbody for fuel storage and by compensating for the absence of a spare tire/jack by using "run-flat" tires.



These tires are capable of being driven up to 250 miles—with no air in them—without incurring damage.

"We recognized a good idea when we saw it," said DOE's Office of Alternative Fuels Acting Director John Russell, explaining why DOE decided to co-sponsor ANGV research and development.

In the past, DOE had attempted to convince major automobile manufacturers that such a concept was feasible. With technological advancements like the ANGV, DOE believes that as early as 1997, it can present manufacturers with a natural gas vehicle that is virtually identical to

contemporary gasoline automobiles while surpassing California Air Resources Board Ultra-Low Emission Vehicle (ULEV) standards. DOE hopes other advanced, clean-burning vehicles, such as those that run on ethanol and propane, will be available in the next 2 years.

A second generation ANGV is expected to be available by late 1996. Research and development of the second generation vehicle will be aimed at lowering manufacturing costs and enhancing driving range to at least 350 miles. The vehicle will also be tested to verify its crash-worthiness in a 30 mile-per-hour rear-end collision. □

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## First Report on Fuel Replacement Goals Completed

The U.S. Department of Energy (DOE) will soon release a draft report indicating that alternative fuel use could be sustained at a level of the fuel replacement goals of the Energy Policy Act of 1992 (EPACT).

The DOE Office of Energy Efficiency and Alternative Fuels Policy has been working on the fuel replacement study for the past 2 years. "This study is not about our ability to make the transition to a high level of alternative fuel use, but rather the ability to sustain that level of fuel use," said DOE's Barry McNutt, who worked on the study. A second study on how the United States might make the transition to increased alternative fuel use began in January and will take about 2 years to complete.

EPACT was designed to increase U.S. energy security by reducing energy imports. Section 502(b) of EPACT requires DOE to determine the economic and technical feasibility of producing enough fuel to replace, on an energy equivalent basis, at least 10% of fuel used in light-duty

vehicle operations by 2000 and at least 30% by 2010.

The study, which is one part of that assessment, looks at a number of scenarios, including a "constrained" case that assumes there will be little alternative fuel vehicle use beyond the requirements of EPACT, the Clean Air Act Amendments, and various existing state mandates; one in which alternative fuels and alternative fuel vehicles are widely available, and fuels are taxed the same as gasoline; and one in which the fuels and vehicles are widely available, but the current tax situation is followed, which favors certain alternative fuels.

"In the two very different tax worlds, about the same amount of alternative fuel, about 30%, is used," McNutt said. However, the proportion of the various alternative fuels used makes logical shifts, depending on each tax situation, he added. Under the current tax situation, ethanol use would dominate over propane and methanol use; if all taxes were

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### INTERNET & PHONE INFORMATION

- For more information on any of the articles in the newsletter or to obtain a user ID and password for the AFDC, call the National Alternative Fuels Hotline at 800-423-1363.
- For Worldwide Web Internet access, our Uniform Resource Locator (URL) is <http://www.afdc.nrel.gov>
- E-mail messages should be sent to [hotline@nrel.gov](mailto:hotline@nrel.gov)
- To access the AFDC over the Internet through anonymous FTP, the address is [afdc.nrel.gov](http://afdc.nrel.gov)
- To access the AFDC via modem, use our new number: 800-588-2336.

## Peoria Transit District Pleased with Ethanol Bus Experience

The Greater Peoria Mass Transit District, through the U.S. Department of Energy's (DOE) Urban Transit Bus Program, has completed 2 years of submitting alternative fuel bus data to the AFDC. Peoria contributed information about the reliability, operating costs, facility and capital costs, and efficiency of five of its ethanol (E95/E93') buses and three of its diesel buses, which have been fitted with particulate

traps.<sup>2</sup> Emissions data on Peoria's buses were collected and submitted by West Virginia University's (WVU) Transportable Vehicle Emissions Testing Laboratory.

Data that were collected from the ethanol buses represent 389,000 miles traveled over 23 months. In the same period, the diesel buses traveled 225,000 miles.

An element of measuring bus reliability is the number of road

calls per 1,000 miles traveled; this refers to calls made by drivers who cannot complete their routes because of problems that require replacement buses. Peoria's buses had few calls, averaging 0.13 per 1,000 miles for the ethanol buses and 0.12 per 1,000 miles for the diesel buses.

"We've been pleasantly surprised about the reliability of

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## Peoria Pleased with Ethanol Bus Experience

(continued from page 2)

the [Detroit Diesel Corporation 6V92TA] ethanol engines," said Greater Peoria Mass Transit District Director of Maintenance George Stout. "The only problems we had were that fuel filters, glow plugs, or injectors in the buses had to be replaced. The power of the ethanol buses is acceptable. There is a slight lag in acceleration compared to diesel, but otherwise, the buses are equivalent."

Stout said that Peoria's ethanol bus drivers commented about the possible health effects of ethanol, but these concerns subsided after the first week of operation. "Drivers wondered about the odor of ethanol," he said. "But we told them that ethanol is a lot cleaner and has fewer pollutants than diesel. Once we showed them how much cleaner the ethanol buses were, they adjusted."

Peoria's E95 buses had about the same fuel economy<sup>3</sup> as their diesel counterparts, compared on a diesel-equivalent gallon basis. But preliminary fuel economy data for its E93 buses show that these vehicles are less fuel efficient than the diesel controls. Nonetheless, Stout considers the decrease in fuel economy a minor limitation.

"When we switched to E93, the fuel economy drop was slight, amounting to two-tenths of a mile per gallon," Stout said. Future data collection will determine whether the drop in fuel economy might have been an anomaly or if it was related to fuel use.

In 1994, WVU performed chassis dynamometer tests on five E95 and five diesel buses in Peoria. Test results showed that emissions of oxides of nitrogen

(NO<sub>x</sub>) were lower in the E95 buses, and the particulate matter (PM) levels were comparable to those of the diesel buses.<sup>4</sup> Nonetheless, organic material hydrocarbon equivalent (OMHCE)<sup>5</sup> and carbon monoxide (CO) emissions were much higher in the E95 buses than in the diesel buses.

Results from these tests have been quite variable and have not always agreed with engine certification data. Potential causes of the increased emissions levels—including catalytic converter malfunction, improper tuning for emissions, and fuel injector problems—are being investigated.

The approximate increase in capital costs to purchase an E95 bus is \$36,000 (in 1992 dollars). This cost is less expensive than each of the other alternative fuel buses in the program except St. Louis' biodiesel buses, which use conventional diesel engines. Each ethanol bus cost \$247,000; each diesel bus was \$211,000 (costs in 1992 dollars).

No incremental facility cost changes were necessary because the site had already been gasoline-certified.

Total operating costs for the buses are \$525 per 1,000 miles for the E93 buses<sup>6</sup> and \$289 for their diesel counterparts. Peoria switched from E95 to E93 to take advantage of a 43 cents per gallon (¢/gal) "blenders credit" tax break for E93. Peoria had been paying \$1.10/gal for E95; the E93 credit lowered the cost to 71¢/gal. But even with the blenders credit, E93 still costs nearly twice as much as diesel per 1,000 miles, on a diesel #2 equivalent basis.

Fuel expense is the only drawback of the E93 buses,

according to Stout. "The cost is a little more than we would like to see it," he said. "Diesel is low in cost right now. If time goes on and we're in a situation like in Europe where [diesel] fuel is \$3 a gallon, then ethanol could be viable [economically]."

Despite the fuel cost, Stout said he has enjoyed taking part in the program. "This has been a fun project for us," he said. "And we feel honored that the Department of Energy has included us in the program. Our community has been really interested in the project. People call us up and ask how the buses are doing. They hope the project is trouble-free."

*Bus data on Peoria and other fleets can be accessed through the AFDC. For more information, contact the National Alternative Fuels Hotline at 800-423-1363.* □

Notes:

<sup>1</sup> Approximately 70% of Peoria's bus data represents information collected from its E95 buses. The remaining 30% was compiled from E93 buses.

<sup>2</sup> The particulate trap causes a slight decrease in fuel economy.

<sup>3</sup> For more Bus Program fuel economy information, see February *AFDC Update*, page 1.

<sup>4</sup> Tests run at other sites show that PM emissions from diesel buses with particulate traps are significantly lower than those without traps.

<sup>5</sup> For diesel vehicles, unburned hydrocarbon is expressed as HC. For ethanol vehicles, measurement is expressed as OMHCE.

<sup>6</sup> Total costs include the blenders credit tax break for E93. Fuel costs for the E95 buses are not included because the fuel is no longer in use.

## NREL Reports Examine New AFV Technologies

The assessment and improvement of alternative fuel engine and vehicle technology have been explored in six recent technical reports published by the U.S. Department of Energy's National Renewable Energy Laboratory (NREL). Consultants, equipment manufacturers, and research organizations tested vehicles and engines to determine the future viability of a CNG (compressed natural gas) and LPG (liquefied petroleum gas, or propane) vehicle, which may be bi-, dual-, or flex-fuel, and hydrogen as a fuel in internal combustion (IC) engines.

The goal of a May 1994 report, *Technical Evaluation and Assessment of CNG/LPG Bi-Fuel and Flex-Fuel Vehicle Viability*, based on a study conducted by J.E. Sinor Consultants, Inc., was to determine the pros and cons of a bi-, flex-, or dual-fuel vehicle that runs on both CNG and LPG. LPG would act as a "range extender," compensating for the comparatively short range of CNG; CNG would accommodate possible supply limitations of LPG.

Eliminating the gasoline component in the multi-fuel system would prevent drivers from running the vehicles on gasoline, allow for a raised compression ratio that would take advantage of CNG's high octane, and eliminate evaporative emissions associated with gasoline. Using CNG/LPG vehicles could help to achieve clean air and domestic energy production goals.

The report finds "no technical problem with two-fuel CNG/LPG vehicles that would be particularly worse than with current two-fuel CNG/gasoline and

LPG/gasoline systems." Necessary system adjustments are "believed to be technically feasible without great expense or technical risk."

Another report, *Advanced Hydrogen Utilization Technology Demonstration*, described a test conducted by Detroit Diesel Corporation (DDC). Results showed that a DDC methanol engine could be converted to run on hydrogen with few modifications. When running on hydrogen, the engine's performance was comparable with that of a methanol engine, producing relatively low emissions.

As with the CNG/LPG system, a hydrogen engine would offer environmental advantages. Hydrogen is abundant and does not produce carbon-based emissions. The fuel can also be produced from sustainable resources, such as solar energy and biomass.

One of the report's goals was to try to assess whether hydrogen

IC engines can act as an intermediate technology between hydrocarbon-fueled engines and hydrogen fuel cells. DDC and NREL concluded that auto-ignition of hydrogen in a modified diesel engine can be achieved. But the hydrogen injector must undergo further development to enhance performance and durability. Also, the combustion system must be adjusted to improve the mixing of hydrogen and air for improved fuel efficiency.

Other reports issued during the past few months by NREL include:

- *Combustion Characterization of Methylal in Reciprocating Engines*
- *Injector Spray Characterization of Methanol in Reciprocating Engines*
- *Advanced Hydrogen/Methane Utilization Technology Demonstration: Final Report*
- *Hydrogen-Air Mixing Evaluation in Reciprocating Engines.* □

## DOE Issues Updated Alternative Fuel Documents

During the past several months, the U.S. Department of Energy (DOE) has issued many booklets that represent updated versions of those published in 1994. Some of these documents are listed below.

### *Alternative Fuel Information brochures*

DOE has published six Alternative Fuel Information brochures that update those that were initially issued in spring 1994. The documents are entitled:

- *Comparative Alternative/Clean Fuels Provisions of the Clean Air Act Amendments of 1990 and the Energy Policy Act of 1992*
- *Domestic Alternative Fuel Vehicle Outlook*
- *Facts About CNG and Propane Conversions*
- *State Alternative Fuel Laws and Incentives*
- *Alternative Fuel Vehicle Glossary of Terms*
- *Alternative Fuel Information Sources.*

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## AGA Furnishes AFDC with New CNG Site Information

The American Gas Association (AGA) has reported that the number of open natural gas refueling sites will increase to more than 1,000 nationwide in the near future. More than 900 sites are operational, and 100 more will open shortly. AGA has provided the AFDC with information for each site, including name, address, phone number, public/private access, and hours of operation.

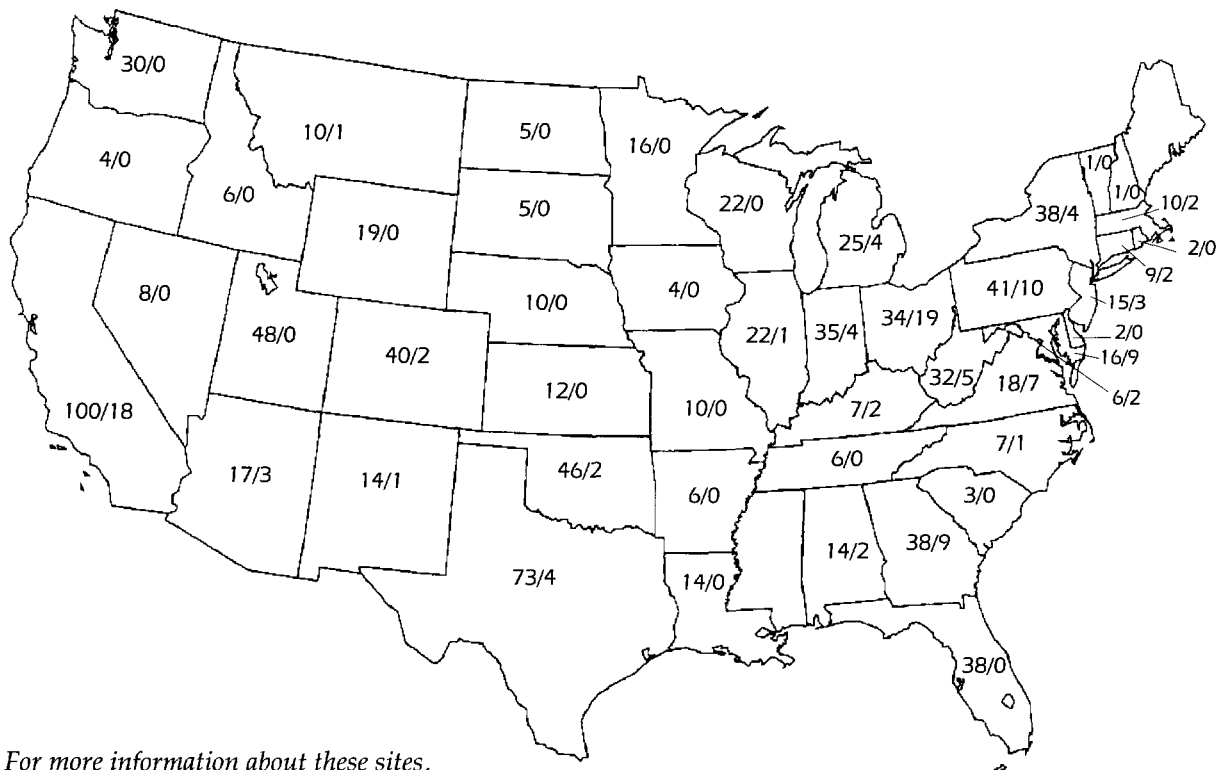
The number of natural gas sites reported by AGA has increased by almost one-third since April 1993. Sites are added at a rate of three to four per week, according to the association, and nearly every state has at least one facility in operation.

The states with the most sites include: California, 118; Texas, 77; Pennsylvania, 51; Oklahoma, 48; Utah, 48; and Colorado, 42. (These

numbers include existing and planned sites.)

According to AGA, 550 of the sites (almost 60%) are open to the public or can be made accessible by appointment. Utilities own 579 of the sites, private organizations own 179, and governments own 100. □

**Figure 2**  
**U.S. CNG Refueling Sites**  
(Existing Sites/Planned Sites)



For more information about these sites, call the AGA at 703-841-8559. To access data through the AFDC, contact the National Alternative Fuels Hotline at 800-423-1363. For Mosaic access, see **Internet & Phone Information** box, page 2.

## Updated Alternative Fuels Documents

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The *Clean Air Act/Energy Policy Act* brochure offers a side-by-side chart that describes the similarities and differences between the two laws. It specifies who must comply with each law, which areas are affected, and other provisions. It also provides definitions of alternative and clean fuels.

The *Domestic Alternative Fuel Vehicle Outlook* lists alternative fuel vehicles (AFVs) offered during the current model year by major U.S. automobile manufacturers. It outlines the specifications of each AFV, including emissions standards and vehicle costs.

*Facts About CNG and Propane Conversions* discusses converting vehicles that were initially de-

signed to run on conventional gasoline or diesel, to run on CNG (compressed natural gas) or propane. The document includes information on emissions and tampering regulations, safety standards, and general facts about CNG and propane.

*State Alternative Fuel Laws and Incentives* contains provisions of state legislation that apply to alternative fuels and AFVs, such as California's Low Emission Vehicle Standards and Illinois' Ethanol Blenders' Credit.

The *Glossary and Information Sources* documents feature definitions of pertinent alternative fuel terms and helpful contacts in the alternative fuels industry, respectively.

### *Federal Alternative Motor Fuels Program—Light Duty Federal Vehicles, Trucks, and Buses: Third Annual Report to Congress for Fiscal Year 1993*

DOE also recently released the above document. The report includes information on fuel economy, emissions, performance, operating costs, and safety.

For copies of these brochures, contact the National Alternative Fuels Hotline at 800-423-1363. The *Alternative Fuel Information documents* and some data from the *Report to Congress* can also be accessed over the Internet using Mosaic. For assistance in accessing the information, see page 1, *Internet & Phone Information* box, or call the Hotline. □

***If you are interested in becoming an Alternative Fuels Data Center user, please detach, fill out this form, and return to:***

AFDC, P.O. Box 12316, Arlington, VA 22209  
Phone: 800-423-1DOE Fax: 703-528-1953

Date \_\_\_\_\_

Name \_\_\_\_\_ Company \_\_\_\_\_

Address \_\_\_\_\_ City \_\_\_\_\_

State \_\_\_\_\_ Zip \_\_\_\_\_ Phone \_\_\_\_\_ Fax \_\_\_\_\_

In order to use AFDC/View for Windows, your PC must meet the following minimum specs: 80386 Processor, DOS 3.3, Windows 3.1, 2 MB RAM (4 recommended), Mouse, 1200 baud modem (minimum).

## First Report on Fuel Replacement Goals

(continued from page 1)

equal, ethanol would represent a very small portion of the market.

Either way, he pointed out, it is an important conclusion of the report that by 2010 the market could support the widespread use of alternative fuels without additional subsidies.

Once reaching the 30% goal in 2010, the displacement would not necessarily be reflected in a reduction of petroleum imports, partly because domestic oil would be included in what was displaced, according to the report. Instead, the report shows there would be about a 10% reduction in oil imports. Methanol and propane would remain a small portion of U.S. energy imports but would increase under each scenario of the study (see Figure 4).

The analysis also points out that non-transportation markets could increase their oil use. The reduced oil use caused by reaching transportation displacement goals could cause oil prices to drop and make petroleum products more attractive in secondary fuel markets, such as the industrial and power sectors. The growth in demand for natural gas or propane, from their increased use in vehicles, would also make the fuels less attractive in the same markets.

Reaching the fuel displacement goals could depend largely on how fleet requirements in EPACT are implemented. Federal fleets were mandated to acquire alternative fuel vehicles with the act's passage, and fuel provider fleets will be covered by a rulemaking now in progress.

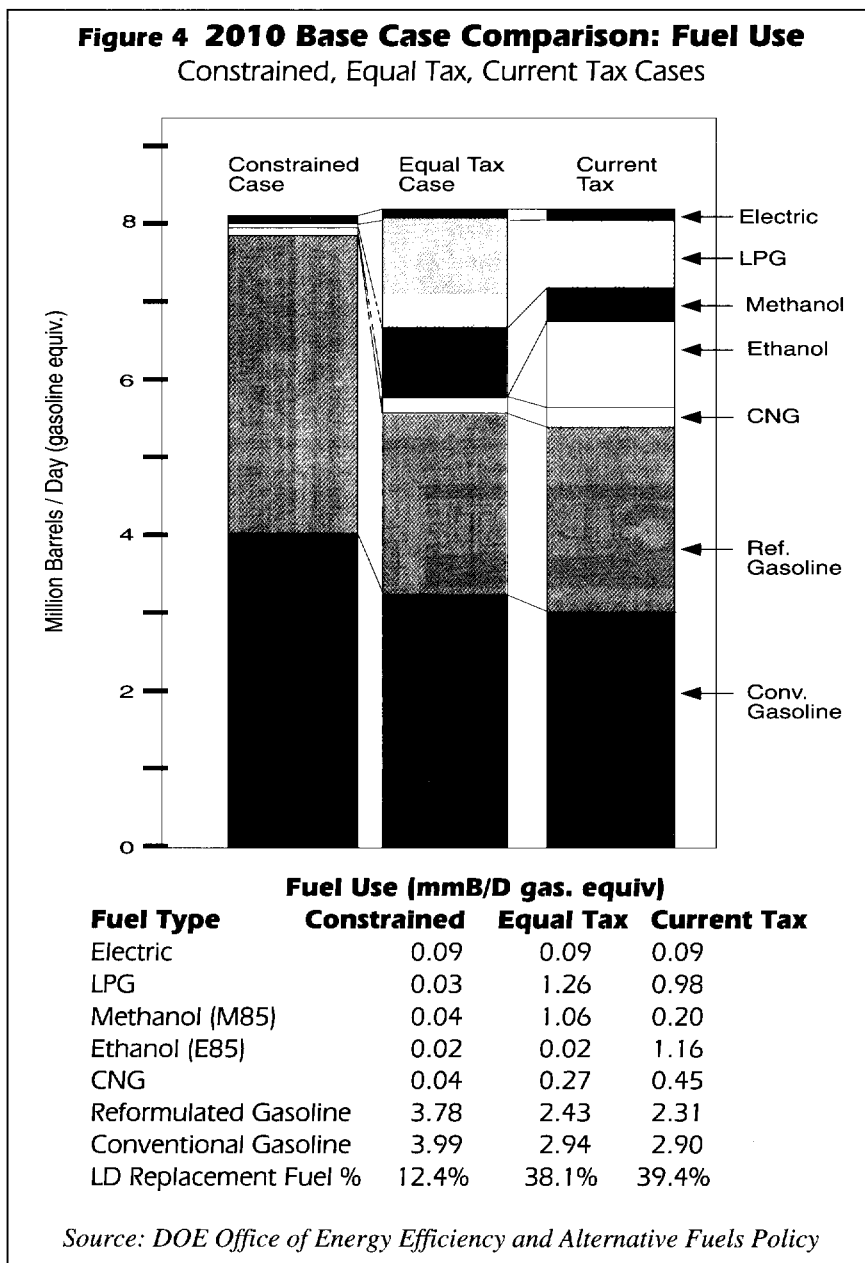
Municipal and private fleets will not be required to purchase

alternative fuel vehicles unless DOE determines it is necessary and issues a rule. However, Ervin stated to Congress last year that DOE does not foresee meeting EPACT's fuel replacement goals without municipal and private fleet requirements.

A final rule on private and municipal requirements may be

issued by December 15, 1996, and, if issued, would become effective beginning with the 1999 model year.

The final report is expected this spring. For more information or to obtain a copy, call the National Alternative Fuels Hotline at 1-800-423-1363. □



## Recent and Upcoming Meetings and Conferences

**April 18-20:** Instructor's Course In Alternative Fuels Safety (CNG), Oxnard, CA. For information, call Cindy Daniel at 405-954-3682, or write to Transportation Safety Institute, P.O. Box 25082, DTI-80, Oklahoma City, OK 73125-5050.

**April 18-19:** AD HOC EV Battery, Stouffer Mayflower Hotel, Washington, DC. For information, call Jeri Wagner at 303-275-4317, or write to National Renewable Energy Laboratory, Conferences Group, 1617 Cole Boulevard, Golden, CO 80401-3393.

**April 30-May 2:** Sixth Annual Alternative Vehicle Fuels Market Fair & Symposium, Austin Convention Center, Austin, TX. For information, call Debbie Avila or Deeann Denton at 800-6-FUEL-99, or write to Texas General Land Office, Office of Alternative Fuels, 1700 N. Congress, Austin, TX 78701-1495.

**May 7-11:** 17<sup>th</sup> Symposium on Biotechnology for Fuels & Chemicals, The Westin Hotel, Vail, CO. For information, call Steve Rubin at 303-275-4065, or write to National Renewable Energy Laboratory, 1617 Cole Boulevard, Golden, CO 80401-3393.

**May 16-18:** Instructor's Course In Alternative Fuels Safety (CNG/LNG), Hayward, CA. For information, call Cindy Daniel at 405-954-3682, or write to Transportation Safety Institute, P.O. Box 25082, DTI-80, Oklahoma City, OK 73125-5050.

**May 16-19:** 13<sup>th</sup> Annual Photovoltaics Program Review Meeting, Lakewood, CA. For information, call Dr. Harin S. Ullal at 303-384-6486, or write to National Renewable Energy Laboratory, Conferences Group, 1617 Cole Boulevard, Golden, CO 80401-3393.

**May 20-27:** 1995 American Tour de Sol, starts in Waterbury, CT, and ends in Portland, ME. For information, call Nancy Hazard at 413-774-6051, or write to Northeast Sustainable Energy Association, 23 Ames Street, Greenfield, MA 01301.

*Published by the Alternative Fuels Division of the National Renewable Energy Laboratory: 1617 Cole Boulevard, Golden, CO 80401-3393. NREL is a national laboratory of the U.S. Department of Energy. The National Alternative Fuels Hotline number is 800-423-1DOE. NREL/SP-425-7610*

# AFDC UPDATE

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