U.S. DEPARTMENT OF ENERGY
OFFICE OF ENERGY EFFICIENCY
AND RENEWABLE ENERGY

Clean and Efficient Transportation FOR THE 21ST CENTURY

Take a ride in a taxicab or bus fueled by natural gas or slide behind the wheel of a new hybrid automobile which is powered by an electric battery and a gasoline engine, and you'll be using technology developed with support from the U.S. Department of Energy's (DOE) Office of Transportation Technologies (OTT). By using new fuel blends, lightweight materials, and innovative engine designs developed through research and development programs supported by OTT, technology being used in your neighborhood today is changing the character of American transportation.

Transportation accounts for more than 65% of the oil consumed in this country, and more than half of that oil is imported. To reverse this trend, OTT supports research in new engine technologies and designs, new lightweight materials for vehicles, and new cleaner burning fuels and fuel distribution systems. Because they will enable our 21st century vehicles to run cleaner and go farther on a gallon of fuel, these technologies will help reduce our nation's dependence on foreign oil imports and reduce the air-polluting emissions caused by the combustion of fossil fuels.

Research Paves the Way

OTT has many noteworthy research, development, and deployment objectives for the next century in areas such as fuel cell systems; diesel engines; electric batteries; hybrid systems; lightweight materials for vehicle parts and long-lasting lubricants; alternative fuels such as ethanol, methanol, biodiesel, natural gas, and hydrogen; fleet evaluation and testing; and information outreach and technology transfer.

For example, OTT-funded research in fuel-cell technology has sprinted forward with the development of an ultra-compact fuel reformer that converts any fuel into hydrogen to power a vehicle fuel cell. The compact reformer, a *Discover Magazine* award winner for technological innovation, is the size of a soup can and reduces smog-causing emissions by 90%. This work, done at the Massachusetts Institute of Technology, is a big step toward the DOE goal of validating vehicle fuel-cell systems that will meet customer cost and performance expectations by 2004.

Fuel cells are but one option in OTT's integrated systems approach to improving U.S. transportation in the 21st century. OTT is also developing fundamental technologies for non-petroleum, alternative fuel engines powered by natural gas, biodiesel, methanol, ethanol, E-85 (ethanol/gasoline mixture), and M-85 (methanol/gasoline mixture). Evidence that this research is paying off for U.S. industry and consumers can be found in the announcement by the United States Postal Service (USPS) to augment its 1998 purchase of 10,000 ethanol flexible-fuel vehicles by adding 11,275 more by the end of 1999. In addition, recent progress in the development and introduction of hybrid vehicles is a result of OTT's successful partnership with industry.

These and many other advances are being implemented through efforts such as the Clean Cities Program, a voluntary, locally based government and industry partnership coordinated by DOE. Clean Cities is designed to promote the use

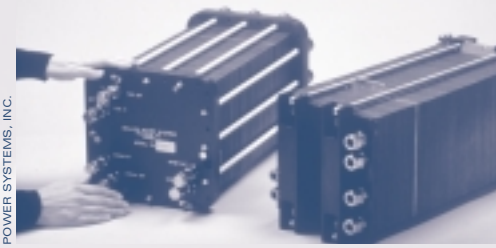
NREL/PIX 06254, ATLANTA GAS LIGHT

This fleet of natural gas taxis in Atlanta, Georgia, exemplifies the successful Clean Cities Program, which encourages the voluntary use of alternative fuel vehicles and the development of a supporting infrastructure throughout the nation.

Benefits Driving Us into the 21st Century

Technologies developed with the assistance of OTT research will significantly benefit the American auto industry, the American economy, and the environment.

- **A more competitive auto industry will improve the balance of trade.**
- **Domestically produced fuels will expand agricultural markets.**
- **More jobs will be created in the automotive and agricultural sectors.**
- **Increased vehicle fuel efficiency will lower vehicle emissions.**



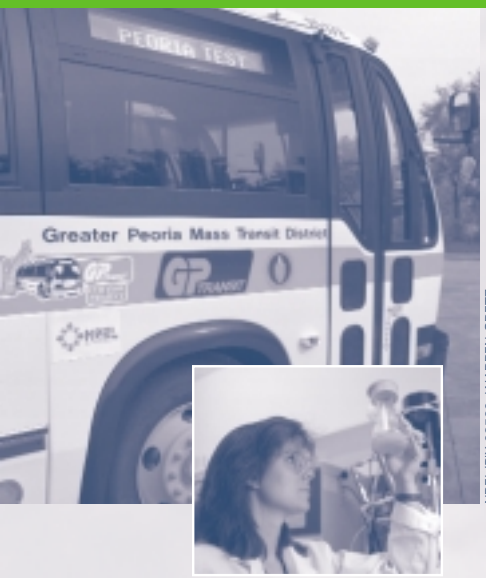
NREL/PIX 01440, BALLARD POWER SYSTEMS, INC.

The fuel cell on the left is a previous generation of proton-exchange membrane technology and can generate 5 kW of power; the fuel cell on the right is about the same size, but can generate 13 kW of electricity, demonstrating the rapid advancement in fuel-cell technology. Each fuel cell can fit within the engine compartment of a diesel bus.

NREL/PIX 02472, ACUREX ENVIRONMENTAL

This alternative fuel heavy-duty truck runs on liquefied natural gas.

THE OFFICE OF TRANSPORTATION TECHNOLOGIES



NREL/PIX 03560, WARREN GRETZ. INSET: NREL/PIX 04979, DAVID PARSONS

Alternative fuel vehicles such as this ethanol-powered bus will help reduce our nation's dependence on foreign oil imports, and reduce emissions caused by the combustion of fossil fuels. Inset: A DOE researcher examines cellulase enzymes used to produce ethanol through a fermentation process.

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of alternative fuels and alternative fuel vehicles, achieve cleaner air in major U.S. cities, reduce dependence on imported oil, and stimulate local economic activity. Clean Cities creates an effective plan, carried out at the local level, for development of a sustainable, nationwide alternative fuels market. Information on Clean Cities fleets and other alternative fuel fleets is available through OTT's Alternative Fuels Data Center (see contacts).

Partnerships For a Cleaner, Competitive Future

The challenges of the future cannot be met with government funding and research alone. OTT advances must be transferred to U.S. industry and consumers if the nation is to achieve their ultimate benefits. To perform R&D, technology transfer, and information outreach, OTT has partnered with the private sector using several forums, including the Partnership for a New Generation of Vehicles (PNGV), the U.S. Advanced Battery Consortium, the Graduate Automotive Technology Education Program, and others.

The PNGV is a result of a vision shared by the federal government and the CEOs of Ford, General Motors, and DaimlerChrysler. They joined together in September 1993 to:

- Develop manufacturing techniques to reduce the time and cost of automotive development
- Improve fuel efficiency and emissions performance
- Develop a vehicle with up to triple the fuel economy of today's mid-size cars while maintaining or improving safety, performance, comfort, emissions, and price.

Under an aggressive PNGV timetable, production prototypes capable of providing up to 80 mpg will be unveiled by 2004.

At the same time OTT is working toward cleaner running, more energy efficient vehicles, it is also supporting research in cleaner burning, more energy efficient fuels. OTT, along with several DOE offices and other government agencies, is participating in the new bioenergy initiative announced by President Bill Clinton in August 1999. OTT's participation in the initiative will help expand the U.S. biofuels industry and improve the nation's economy, especially in the agricultural sector. Biofuels are derived from biomass materials, which include crops, agricultural residues, forest residues, and municipal solid waste. Agricultural residues, such as sugar cane bagasse and rice straw, along with municipal solid wastes, offer near term opportunities to demonstrate the technologies under development by OTT and its partners (which include Masada Resources Group, Arkenol, Inc., and BC International Corporation). These potential waste disposal problems become a source of low- or no-cost feedstocks for conversion facilities. For example, corn stover—a generic term for leaves, stalks, and sometimes cobs—represents the largest available farm-produced feedstock in the United States. OTT is working with existing corn ethanol producers and farmers to explore the potential of expanding the existing ethanol industry by using this resource. The Presidential initiative will help reduce the cost of biofuels through development of lower cost, faster acting biomass conversion processes.