

Partnering to Develop Tomorrow's Transportation Technologies



Challenge

America's dependence on petroleum and the energy and environmental consequences resulting from that dependence have been discussed for a generation. FreedomCAR, a new government-industry research program announced by U.S. Department of Energy (DOE) Secretary Spencer Abraham early this year, gives hydrogen-powered fuel cell cars the nod as the country's target alternative to the internal combustion engine. Because hydrogen can be made from water or renewable sources and produces only water when used to generate power, its potential in transportation applications is enormous.

Along with U.S. manufacturers, government agencies, and other DOE laboratories, Argonne plays a prominent role in the R&D efforts for FreedomCar and The 21st Century Truck Partnership (see sidebar).

Argonne's Role

FreedomCAR: Because it will take a decade or more before a hydrogen production, storage, and delivery infrastructure is in place, carmakers are expected to adopt transitional technologies, such as onboard fuel reformers. Fuel cells are like batteries with fuel tanks; they combine hydrogen fuel with oxygen from the air to generate electricity, which then powers vehicles with electric motors. As long as the hydrogen keeps coming, they never run down. Argonne has been a leader in fuel cell research for more than 20 years. During that time, the Laboratory has fostered a long line of innovations in new materials, analytical methods, and design concepts for advanced fuel cell systems.

The 21st Century Truck Partnership: The success of the nation's trucking industry is essential: revenues for the motor carrier industry — some \$300 billion annually — represent approximately five percent of this nation's gross domestic product. At the same time, members of the commercial motor vehicle industry face increasing pressure to ensure that they remain

FreedomCAR — a government-industry research partnership to develop hydrogen-powered fuel cell vehicles that use no petroleum and produce no harmful emissions. FreedomCAR also supports advanced technologies that can dramatically reduce oil consumption and environmental impacts of conventional petroleum-dependent vehicles.

The 21st Century Truck Partnership — a partnership that combines the resources and capabilities of DOE, the U.S. Department of Transportation, the U.S. Department of Defense, the U.S. Environmental Protection Agency, and 16 industrial partners to increase the safety, fuel economy, and environmental performance of trucks.

competitive and technologically efficient. Argonne is working with DOE and its industrial partners to develop commercially viable technologies for heavy-duty trucks and buses that improve fuel efficiency, reduce emissions, enhance safety and performance, and lower operating costs.

Approach

Hydrogen Production: Current hydrogen production technologies generate and release significant amounts of polluting gases because hydrogen production consumes a lot of energy, typically from burning fossil fuels. A primary goal of the FreedomCAR program, therefore, is to devise methods of obtaining vast quantities of hydrogen in sustainable and environmentally responsible ways.

Argonne researchers are working to develop an economical thermochemical process that uses the next generation of nuclear reactors to provide a pollution-free heat source for hydrogen manufacture. The system employs a modular fast-neutron reactor that can exploit the full energy content of uranium, thereby reducing concerns about nuclear proliferation.

Fuel Reformer Catalyst: Transitional technologies will be based on gasoline, natural gas, or some other readily available fuel. These vehicles will have an onboard fuel processor (fuel reformer) to strip hydrogen from the fuel, allowing vehicles to make their own hydrogen as needed.

Argonne has developed a reforming catalyst (a key component of a fuel reformer) that can efficiently convert gasoline, diesel fuel, natural gas, methanol, or ethanol into a hydrogen-rich fuel (Figure 1). The technology won a coveted R&D 100 Award in 2001 and has recently been licensed by a catalyst supplier for fuel cell processors.

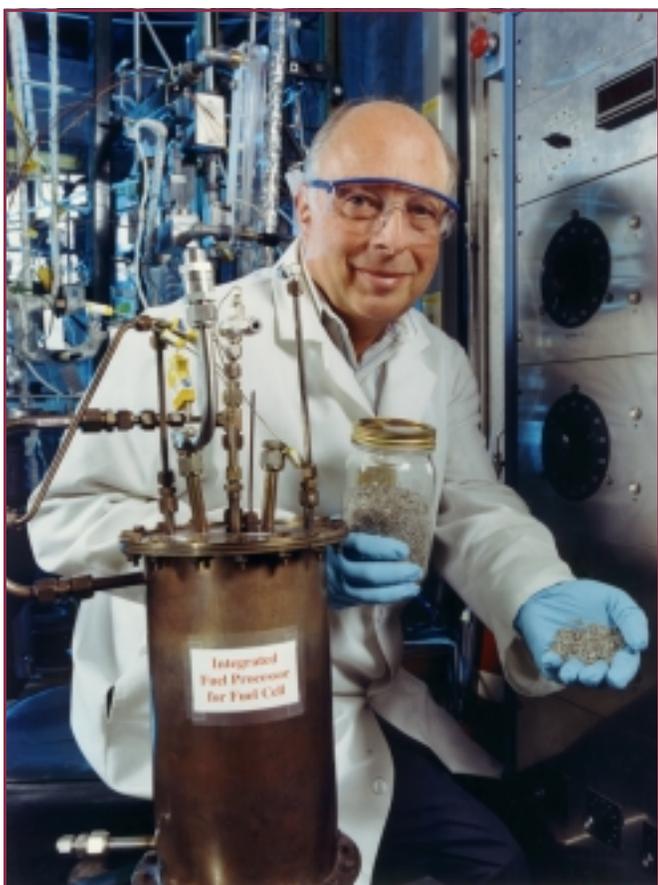


Figure 1. Michael Krumpelt, of Argonne's Chemical Technology Division, displays the new catalyst he and his colleagues developed to help bring fuel cell vehicles to the marketplace. The catalyst was named one of the top 100 technological innovations by R&D Magazine in 2001.

Modeling: Argonne's Greenhouse gases, Regulated Emissions, and Energy use in Transportation (GREET) model helps decision makers to select the fuel that delivers the greatest overall benefits in advanced vehicles, including fuel cell systems. The software model provides complete well-to-wheel evaluations of how energy and emissions considerations change with use of different fuels.

Emissions Reduction:

- Researchers used x-rays at Argonne's Advanced Photon Source to penetrate gasoline and diesel sprays to reveal how to improve combustion in engines that use fuel-injector systems. Argonne designed and constructed a pressurized spray chamber that allows scanning of the spray plume through the small x-ray-transparent windows. The data collected will eventually help manufacturers build cleaner, more efficient fuel injection systems.
- Argonne is developing new bifunctional catalytic systems that reduce nitrogen oxides to environmentally friendly products (primarily carbon dioxide and nitrogen) under lean-burn conditions and enhance diesel engine performance.

Collaborators

DaimlerChrysler
Ford
General Motors
Texas A&M University
General Electric
Japan Atomic Energy Research Institute
Italian National Agency for New Technology,
Energy and Environment

Sponsor

U.S. Department of Energy, Office of Energy
Efficiency and Renewable Energy

Contact

Larry Johnson, Director
Transportation Technologies
Research and Development Center
Phone: 630/252-5631
Fax: 630/252-4211
johnson@anl.gov



ARGONNE NATIONAL LABORATORY
IS OPERATED BY THE UNIVERSITY OF CHICAGO FOR THE U.S. DEPARTMENT OF ENERGY