

## Hydrogen Energy Science and Technology: Critical Ingredients in DOE's Hydrogen Programs

Hydrogen is an energy carrier that can be used to power advanced technologies like fuel cells and conventional technologies, reciprocating and turbine internal combustion engines (ICEs). Its end use in these devices produces no greenhouse gases and can offer “zero criterion” gas emissions. It is considered the ultimate clean fuel.

Sandia is broadly engaged in this field with the Department of Energy and industry, from hydrogen production to its use in transportation systems. Responding to President George W. Bush's statements in his 2003 State of the Union message and subsequently, Sandia supports the FreedomCAR & Fuels Partnership and the Hydrogen Fuel Initiative, a pathway to the hydrogen economy across a broad front of scientific research and technology development. In support of the DOE hydrogen programs Sandia has activities in hydrogen production by nuclear, solar, biomass, and fossil sources to utilization in advanced vehicle power supplies, including fuel cells and hydrogen-combustion reciprocating and turbine internal combustion engines.

Sandia has been active in hydrogen science and technology for 45 years through its primary mission in the nation's nuclear weapons program.

The laboratories:

- play a leading role in the international partnership that supports DOE's Nuclear Hydrogen Initiative. The aim is to develop advanced high-temperature thermochemical processes for the next generation of nuclear plants that can co-produce hydrogen and electricity. This activity is leveraged by efforts in the solar production of hydrogen using similar thermochemical processes as those pursued in the nuclear hydrogen initiative.
- lead DOE's Metal Hydride Center of Excellence (MHCoE) for metal-hydride-based hydrogen storage, managing approximately \$30M of work over five years and partnering with 19 partners consisting of universities, other national laboratories and industrial companies. Sandia's objective is to develop new materials that meet DOE's 2015 systems goal for on-board storage.
- are partnering with General Motors to engineer state-of-the-art, integrated, metal-hydride storage systems that permit advanced prototyping for vehicle designs.
- lead the DOE's research and risk analysis effort to provide the technical foundation to develop building codes and standards for commercialization of the hydrogen economy.
- play a leading technical and programmatic role in the DOE's effort in solar thermochemical production of hydrogen.
- are undertaking a growing effort in the systems modeling of an emerging energy infrastructure in a carbon constrained environment.

- through its Laboratory-Directed Research and Development (LDRD) program, continues to invest in advanced materials for hydrogen separation, new high-temperature materials for fuel-cells and electrolysis membranes and electrodes, new methods for thermochemical water splitting using clean nuclear and solar energy, and new computational tools for dynamic modeling of novel fuel-cell systems, systems for co-production of hydrogen and electricity, and systems for CO<sub>2</sub> sequestration.

Transportation is largely dependent on petroleum (almost 100%) and hence is critically dependent on the supply of this single commodity. The challenge of developing a hydrogen economy, with hydrogen-fueled engines (fuel cells or reciprocating ICEs) replacing gasoline- and diesel-powered autos and trucks, is significant, but the potential value to society — diversifying the energy feed stock for transportation and taking the personal vehicle out of the environmental equation — is enormous.

“Transition to a hydrogen economy for transportation requires a national commitment,” says Don Hardesty, Sandia’s senior manager for Combustion and Industrial Technology. “To accomplish this vision requires the concerted effort of industry, government, national laboratories, and universities worldwide to do the advanced R&D”. These include:

- economic and efficient, new technologies for hydrogen production, with minimum CO<sub>2</sub> release
- R&D to permit technically based, building codes and industrial standards that facilitate development of the infrastructure for commercial hydrogen technologies
- new technologies for on-board storage of hydrogen in vehicles
- reliable, robust, efficient, economically competitive hydrogen end-use technologies

“While there is much work to do, the development of a hydrogen infrastructure has begun. There are over 100 hydrogen refueling stations operational or planned as of 6/26/2008 and there are more than 100 hydrogen fueled vehicles on the road in various demonstration projects in North America,” says Jay Keller, Sandia’s hydrogen program manager.

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