Hydrogen Men

The benefits of hydrogen and fuel cell technology, say University of Alabama scientists, will be cleaner air, economic growth and less dependence on foreign oil

By Elizabeth M. Smith

The recent record rise of gasoline prices underscored for consumers a need scientists have been interested in for some time — the search for alternative fuel sources. The University of Alabama is on the cutting edge of that search and is working toward innovative solutions to make hydrogen-powered cars and trucks more practical.

As part of President George W. Bush's Hydrogen Fuel Initiative, the University has been named a partner in the Department of Energy's Center of Excellence for Chemical Hydrogen Storage. The benefits of hydrogen and fuel cell technology, say UA scientists, will be cleaner air, economic growth and less dependence on foreign oil.

The Center, which includes multiple university and industry partners as well as Los Alamos National Laboratory and Pacific Northwest National Laboratory, plans approximately $5 million in funding annually for five to six years. It is part of the Secretary of Energy's $350 million in science and research projects, which represents nearly one-third of the president's $1.2 billion commitment in research funding to accelerate hydrogen and fuel cell research. UA's share, which is also subject to appropriations, is planned for at least $250,000 a year for five years.

UA researchers Dr. David Dixon (standing left), Dr. Joseph Thrasher (seated) and Dr. Anthony J. Arduengo

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Dr. Anthony J. Arduengo, Saxon professor of chemistry, and Dr. David A. Dixon, Ramsay professor of chemistry and formerly of the Pacific Northwest National Laboratory, are the principal investigators with Dr. Joseph Thrasher, professor and chemistry department chair, serving as the co-principal investigator on the project.

All three UA scientists are known internationally for their research.

Arduengo's focus will be on synthesizing new compounds capable of taking up and releasing hydrogen on demand, and Dixon will study the energetics of hydrogen storage systems and help design molecules that will provide maximum hydrogen storage capacity.

"We want to be able to develop a working prototype fairly early in the project," Arduengo says. "It may not be the optimal system, but it will allow us to address not only the fundamental problems of hydrogen storage, hydrogen transport and heat transport but also the questions of system integration.

Why hydrogen? Hydrogen burns with oxygen in the air to produce water, is not harmful to release into the environment, and there are no byproducts.

"In fact, the water that comes out of fuel cells is normally very pure," Arduengo says. "The Apollo space program used fuel cells for power, and the water produced from the fuel cells was used as drinking water by the astronauts."

Energy from hydrogen is produced in a simple chemical reaction. Chemically combined in a fuel cell with oxygen, electrical energy is produced, harnessed and can be used to power an electric motor or other electrical device.

The United States has natural resources that can be used to produce hydrogen, and the use of these resources will make the country less dependent on foreign oil. In that way, the use of hydrogen as a fuel has significant national security implications. It is also safer than gasoline.

"Hydrogen is a lighter-than-air gas," says Arduengo, who, like his project colleagues, is a researcher in UA's College of Arts and Sciences. "So, when it is released it tends to move up into the atmosphere and away from individuals on the ground. The chances of ignition are reduced, and, if it does ignite, hydrogen is lighter than air and is moving away from the accident or spill."

Two of the main components the

scientists will be studying are storage and transportation. Hydrogen storage that meets customers' driving range expectations, without compromising weight, passenger or cargo space, safety and cost is critical within the Department of Energy's Hydrogen Program.

"What we have to come up with are low-weight materials that release hydrogen safely and on demand without a lot of energy being required to release the hydrogen or to make the fuel, so we can keep it a cost-effective process," Dixon says.

In addition to acting as a fuel source for automobiles, other uses for hydrogen could be home heating or the local production of electricity.

"If hydrogen were to be used in the economy to replace natural gas or propane for the home, you can imagine either delivering that hydrogen

Hydrogen and fuel cell technology are either being tested or in use in numerous applications, including those pictured on these pages.

through a pipeline or through a tank," Arduengo says.

So, can today's natural gas pipelines be used to transport hydrogen? UA scientists say, "maybe."

Hydrogen is such a small molecule that it has a tendency to leak out of systems where nothing else will leak.

According to Arduengo, steel, which is perfectly good for containing methane, is not so good for containing hydrogen because eventually some steels will become fragile after prolonged exposure to hydrogen, as the hydrogen can creep into the microscopic cracks found in any material.

There is a lot of plastic in today's systems, as natural gas companies have been lining older steel and laying new pipe with polyethylene. Arduengo says permeability will again have to be studied for these plastics.

"There will be some small diffusion of hydrogen, but the question is how much, and is it enough to worry about, or is it just a small loss?" Arduengo says. "I think you can probably find people to support both sides of that question. It'll just mean looking at the system and seeing what sort of pressures can be used."

The research is conducted within UA's new interdisciplinary transportation and science complex, Shelby Hall.

All three researchers say this piece of science and technology will be a fantastic teaching tool for UA students.

"Our number one objective at the University is to produce and train nationally and internationally competitive students to enter the work force," Thrasher says.

"The problem of solving the hydrogen transport problem gives us a great opportunity to train students in a relevant area of technology," Arduengo says. "I think it's a tremendous opportunity to help us train these new generations of scientists while, in fact, being able to come up with a creative solution to an important real world problem."

Dixon agrees. "That's what I think is unique, our students will be getting a fundamental science understanding, and they'll also be able to apply it to a real problem and work in a team environment."

Thrasher adds that before the general public puts fuel cells in their cars and hydrogen in their tanks, the public is going to have to accept these changes. Students trained at UA will enter all facets of science: grade school and high school science teachers, professors, and research and development at companies around the state and the nation.

"We need people in all these areas talking to their neighbors and friends about this new science application to get the word out," he says. "We'll have to show that this is a safe and valuable technology, so they'll accept it when it comes along."■