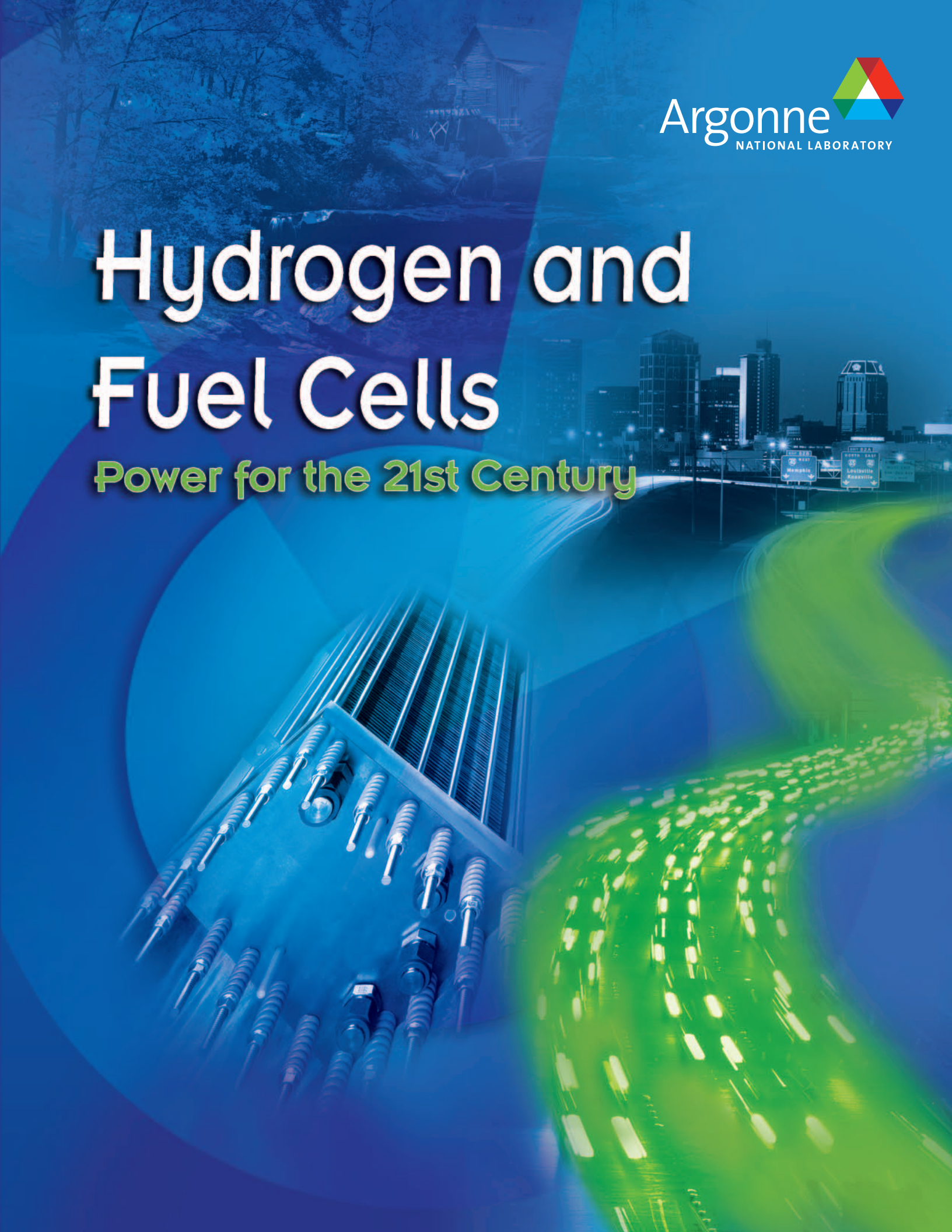
Argonne NATIONAL LABORATORY

Hydrogen and Fuel Cells

Power for the 21st Century



Introduction

Scarcely a day goes by that we don't hear some mention of fuel cells or the new "hydrogen economy." The environmental advantages of a hydrogen economy are so promising that the push toward hydrogen is strong. In the coming decades, the United States will need new energy supplies and a better energy infrastructure to meet growing demands for electric power and transportation fuel. Hydrogen and fuel cells offer one of the most promising paths toward meeting those goals. Here's why:

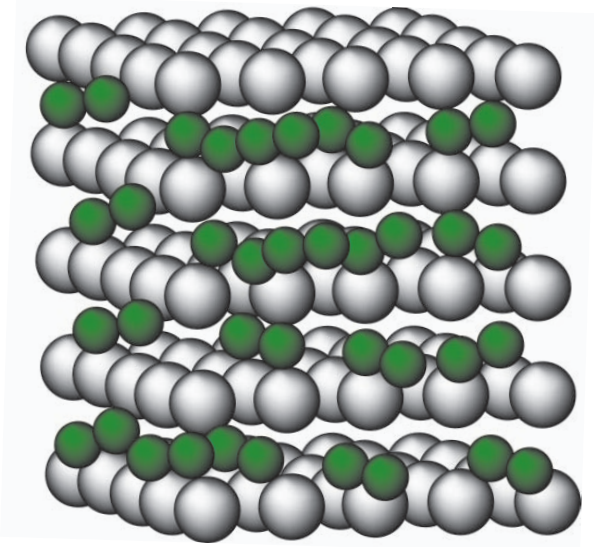
- Hydrogen is a versatile energy carrier that can be used to power nearly every end-use's energy need. The fuel cell – an energy conversion device that can efficiently capture and use the power of hydrogen – is key to making it happen.
- Use of fuel cells could reduce U.S. dependence on foreign oil.
- Fuel cells, when fueled by pure hydrogen, can provide pollution-free energy for both transportation and electric utilities.
- Fuel cells operate quietly, and are reliable, easy to maintain, and safe.
- Hydrogen poses fewer environmental dangers, such as oil spills, than those associated with petroleum.
- Fuel cells are modular; they can be installed on sites as energy demand warrants without investing in large, centralized power plants and new high-voltage lines.

ARGONNE NATIONAL LABORATORY'S RESEARCH

With breakthroughs in fuel cell and hydrogen technology developments, such as those being worked on by the U.S. Department of Energy's Argonne National Laboratory, we are already heading toward a hydrogen economy. This includes research to develop materials, processes, and systems for fuel cell systems, as well as hydrogen production, delivery, storage options. Specifically, Argonne researchers are focusing on:

- Hydrogen production pathways and delivery system alternatives:
- Low-cost, high-capacity carbon-based hydrogen storage materials;
- Advanced fuel processing in integrated fuel cell power systems;
- Enhanced fuel cell designs; and
- More durable, lower-cost materials for fuel cells.

Where and How Will Hydrogen be Stored?

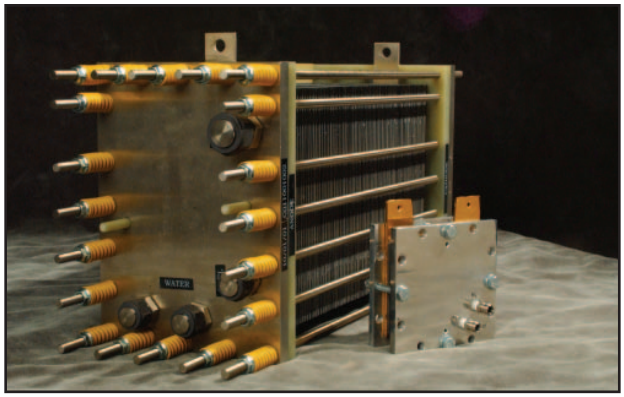


One of the biggest challenges in making the transition to fuel cell power involves getting the hydrogen we need to where we need it. The United States lacks adequate infrastructure for transporting, storing, and dispensing hydrogen in sufficient quantities. Hydrogen can be stored as compressed gas, a liquid, or in a solid, but it is difficult to store in quantities large enough to generate the same amount of power as gasoline. The issue is significant for fuel cell vehicles, which must have a driving range of 300-400 miles between refueling stops to compete with today's gasoline vehicles.

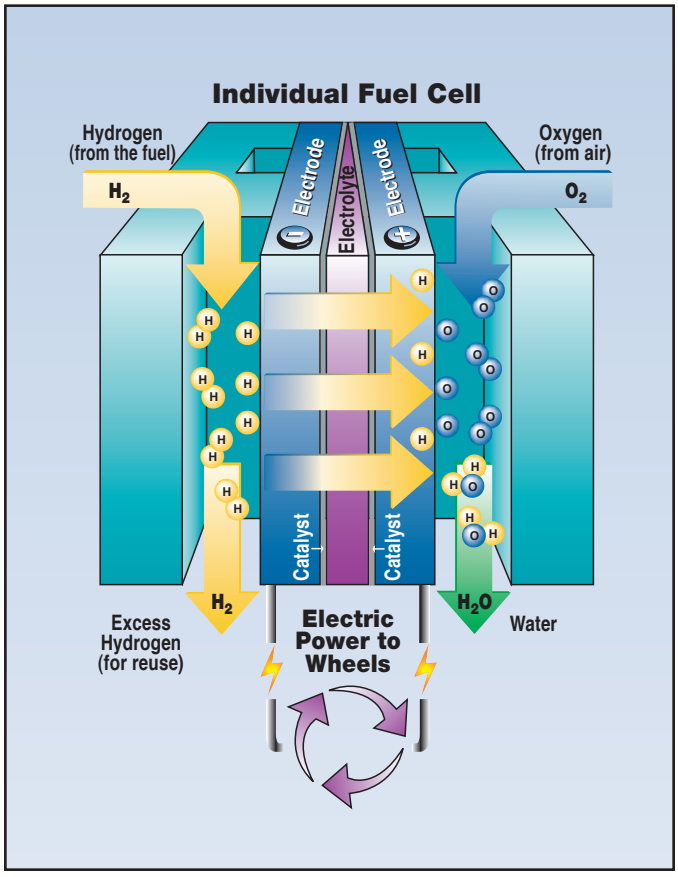
Argonne researchers have received $1.88 million from the U.S. Department of Energy to study the use of nanostructured polymeric materials as hydrogen adsorbents for storage. Here, the hydrogen molecules (green spheres) are adsorbed inside of layered polymeric storage material. Preliminary tests of the material have demonstrated encouraging hydrogen storage capacity, reversibility, and stability.

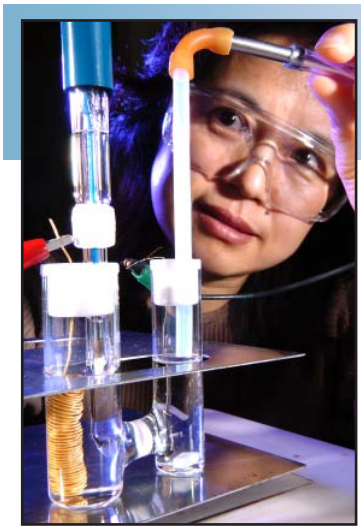
What are Hydrogen Fuel Cells?

Unlike an internal combustion engine, fuel cells rely on electrochemical reactions rather than combustion of fuel to generate power. And, unlike a battery, a fuel cell does not run down or require recharging: it operates as long as fuel is supplied. Because a fuel cell converts the chemical energy of the fuel directly into electricity, it's cleaner and more efficient than any carbon-fueled engine. When fueled by pure hydrogen, a fuel cell's only by-products are water and heat. Fuel cells have a variety of potential applications; they can provide energy for systems as large as a utility power station and as small as a laptop computer.



The chemical reaction in a single fuel cell produces less than 1.16 volts of electricity, so many separate fuel cells must be combined into fuel cell "stacks." The potential power generated by a fuel cell stack depends on the number and size of the individual fuel cells that comprise the stack.





More Durable Materials for Fuel Cell Systems

A major hurdle to commercializing polymer electrolyte fuel cell systems, especially for automotive use, is the high cost of the cell's platinum electrocatalysts. Argonne chemists are working on low-cost, non-platinum electrocatalysts (employing bi-metallic base metal/noble metal systems) for the oxygen-reduction reaction. These durable materials would be stable in the fuel cell's operating environment and retain high electrochemical activity over the fuel cell's design lifetime.

Argonne Fuel Cell Test Facility

Argonne's Fuel Cell Test Facility, operational since 1998, has capabilities for evaluating full-size automotive fuel cell stacks with power ratings of up to 80kW. The facility provides fuel cell developers, government agencies, and U.S. automakers with an independent testing source for evaluating and validating fuel cell technologies. Through standardized tests and test conditions, Argonne provides its sponsors with comparative data on the performance, operational characteristics, and durability of fuel cells. The test results also help developers and sponsors evaluate technical progress. Here, engineers check a fuel cell stack before starting a test.

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