

Center for Electric & Hydrogen Technologies & Systems

Hydrogen Technologies & Systems Group

Facilitating the Transition to a Hydrogen Economy

Dependence on imported oil, climate change, air emissions, national energy security, decreasing energy supplies, and increasing efficiency demands — hydrogen could be the solution to all of these problems.

All energy resources, from fossil fuels to renewables, can be used to produce hydrogen. Hydrogen can be used in fuel cells, engines, and turbines to produce fuel for our vehicles and power and heat for our homes and offices. This flexibility, combined with our nation's ever-increasing demand for energy, opens the door for hydrogen power systems and the associated societal benefits. But there are several key barriers to hydrogen becoming America's clean and secure energy option. Hydrogen technology must be flexible, affordable, safe, and available to all sectors of the economy and all regions of the country. And to truly be sustainable it must be produced from domestic renewable resources.

The Hydrogen Technologies and Systems Group is working to meet these challenges to facilitate the transition to a hydrogen economy.

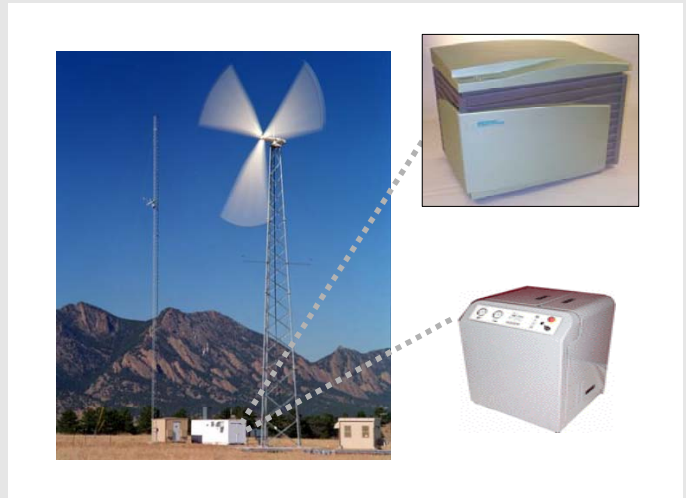
Group Mission

The Hydrogen Technologies and Systems Group works toward the integration of hydrogen systems to ensure successful deployment of technologies and to deliver multiple products and services from renewable resources by developing advanced technologies and systems. The group partners with other programs at NREL, DOE and other government agencies, industry, communities, universities, and other national labs to implement the National Hydrogen Energy Vision for America's clean and secure energy future.

Systems Integration

The group takes a systems engineering and integration approach to match hydrogen research and development (R&D) needs and opportunities with NREL's expertise in renewable hydrogen. The group provides strategic support to DOE's Hydrogen, Fuel Cells & Infrastructure Technologies Program to coordinate research priorities across multiple NREL research centers, and advise DOE on innovation pathways.

Process and Systems Analysis — The group uses process analysis to provide direction, focus, and support to the development and commercialization of hydrogen



Hybrid power plants can use renewable energy to produce and store hydrogen on site. The hydrogen can then be used for transport or by fuel cells to generate electricity when the wind isn't blowing. Such systems overcome the intermittency of solar and wind resources.

technologies. Technoeconomic analyses (TEA) are performed to determine the potential economic viability of a research process and to direct research toward areas in which improvements will result in the largest cost reductions. TEA is also used to design and optimize integrated systems. To identify and evaluate the environmental impacts associated with a specific process, life cycle assessments are performed to quantify the emissions, resource depletion, and energy consumption of all steps in the process, from the initial extraction of raw materials, through transportation and production, to the final disposal of products and by-products.

Infrastructure Development — Major infrastructure development efforts will be required to transition from the current fossil fuel supply infrastructure to a hydrogen-based production, storage, and delivery system. The Hydrogen Technologies and Systems Group is working to integrate innovative R&D programs with creative deployment projects. Analytical models have been developed to determine the most economical hydrogen delivery option for a given scenario, and geographical information systems mapping of energy resources is used to identify opportunities for hydrogen

production throughout the United States. In addition, technology validation efforts led by the group can help remove barriers to commercialization by testing R&D advances in real-world operating conditions.

Safety, Codes, and Standards

The development and acceptance of codes and standards are essential if hydrogen is to become a significant energy carrier and fuel. This step is critical to establishing a market-receptive environment for commercializing hydrogen-based products and systems. The group coordinates standards development organizations, code developers, and regulatory agencies under a national program sponsored by DOE.

Partnerships and Collaborations

Education — Understanding the long-term benefits and near-term realities of hydrogen, fuel cell systems, and related infrastructure are essential to transition to a hydrogen economy. The group draws on NREL capabilities to provide information to target audiences about fuel cell and hydrogen systems in order to facilitate commercialization and market acceptance.

International Collaboration — Because all countries possess some form of sustainable primary energy sources, hydrogen energy technologies offer an important potential alternative to fossil-fuel energy supplies — in many instances, to imported fuels. The Hydrogen Technologies and Systems Group works with experts from around the world to address many of the technical challenges and long-term research needs that face the hydrogen community under the auspices of the International Energy Agency, International Gas Union, and related forums. The group is also working with DOE's Office of Energy Efficiency and Renewable Energy to explore the potential for hydrogen demonstration projects at the 2008 Summer Olympic Games in Beijing, China.

Hydrogen Analysis Working Group (H2A) — Coordination of analysis work being conducted on hydrogen and fuel cell systems is essential to ensure consistent analysis methodologies and a stronger understanding of the pathways to the hydrogen future. The Hydrogen Technologies and Systems Group is working with DOE to enable this collaboration between analysis experts through the H2A.

Research in Hydrogen Production and Utilization

Hydrogen from Renewable Resources — Currently, grid stability and intermittency issues are major limitations to significant penetration of renewables like wind and solar into the electricity market. By combining these generation technologies with hydrogen production

and storage, intermittent renewables could potentially capture a larger share of the power-production market without major upgrades to the existing grid. The hydrogen produced using renewables can also help to develop the market for hydrogen as a transportation fuel.

Photoelectrochemical Water Splitting — This is a one-step process for producing hydrogen using solar irradiation of semiconductor devices. Group researchers test new materials and structures that have the proper characteristics to collect the required energy and are stable in the reaction environment. The Hydrogen Technologies and Systems Group holds the world record for efficiency in direct water splitting.

Advanced Fuel Cell R&D — Manufacturing challenges are one of the major obstacles to the implementation of fuel cell technology. Component material properties, manufacturability, and overall fuel cell operation are thus key research areas. Currently, research is conducted to understand and control the corrosion mechanisms in bipolar plates and to evaluate new materials for use in a solid electrolyte system that can operate in an intermediate temperature range. The group is also working with other technology centers at NREL to integrate fuel cell systems with renewable energy conversion technologies and advanced thermally activated building technologies.



Photoelectrochemical water splitting: Using a photovoltaic cell/electrolyzer submerged in an alkaline aqueous solution to produce hydrogen.
(Photographer: Richard Peterson)

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