National Renewable Energy Laboratory (NREL) Hydrogen and Fuel Cell Capabilities Overview

2014 Fuel Cell Seminar and Energy Exposition

National Lab Showcase

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NREL Overview

The National Renewable Energy Laboratory (NREL) is the only national lab dedicated solely to advancing energy efficiency and renewable energy technologies

- Founded in 1977
- Location: Golden, Colorado
- ~1,750 full-time staff
- Full spectrum of RD&D, from basic science to deployment
- Unique research and testing capabilities across multiple scales
- Systems approach
- Strong history of partnering with industry to bring technologies to market
NREL Hydrogen and Fuel Cell Core Capabilities

~35 employees in hydrogen and fuel cell R&D

Core capabilities:
- Hydrogen storage sorbent material characterization
- National Fuel Cell Technology Evaluation Center
- Hydrogen production via fermentation
- Photobiological hydrogen production
- Photoelectrochemical hydrogen production

Enabling capabilities:
- **Fuel cells**: MEA and electrode development; alkaline exchange membranes/electrolytes; hydrogen PEM MEA testing and evaluation
- **Storage**: Solid state storage and regeneration; Engineering Center of Excellence
- **Analysis**: Total cost of fuel cell ownership energy analysis; hydrogen infrastructure scenario and techno-economic analysis; economic impact (jobs/competitiveness) and manufacturing/supply-chain analysis
- **Manufacturing**: Manufacturing quality control and metrology
- **Codes and standards**: Safety, codes and standards; hydrogen safety/detection sensors
- **Other**: Hydrogen Fueling Infrastructure Research and Station Technology (H2FIRST); renewable electrolysis and grid integration; objective (outside of R&D) systems integration of Fuel Cell Technologies Office analysis and activities
NREL Technology Transfer Activities

NREL is best in class:

- More than **165** active CRADAs, the most in the DOE laboratory system
- More than **400** active industry partners
- Able to work with a variety of partners from small and large businesses to non-profits
Energy Systems Integration

NREL evaluates and optimizes the use of hydrogen and fuel cells in integrated energy systems

- Ability to test system performance in MW-scale testing and simulations
  - Unique megawatt research power bus
- Real-world integration of hydrogen production and high-pressure vehicle fueling infrastructure
  - Hydrogen made on site and dispensed through state-of-the-art 700-bar hydrogen research station (Fall ‘14)
- Opportunities to leverage other grid integration and transportation work at the lab
  - Energy storage, power to gas, vehicle to building, vehicle to grid

http://www.nrel.gov/esif/
Advancing technology development through component design, testing, and validation

- Fuel cells
- System contaminants
- Hydrogen sensors
- Manufacturing quality control
- Accelerated component reliability
- High-pressure testing: hydrogen dispenser hose reliability and pressure relief devices
- Numerous models and tools
Specific Example: Fuel Cell Manufacturing R&D

Development of real-time quality control to support scale-up of fuel cell materials

- Development of in-line quality control techniques
- Validation of techniques on NREL’s web-line
- Study of performance and durability effects of defects
- Transfer of techniques to industry
Research to Overcome Technical Barriers

Advancing hydrogen production and delivery, hydrogen storage, and fuel cell technologies

• Renewable hydrogen production:
  o World record PEC solar-to-hydrogen efficiency >16% using state-of-the-art III-IV semiconductor materials
  o O₂-tolerant strains for improved photobiological H₂ production

• Storage materials validation and testing
  • Measuring external samples to characterize and validate sorption capacities
  • Developing hydrogen adsorption standards

Validating new technologies and systems in real-world operation

• National Fuel Cell Technology Evaluation Center (NFCTEC)
  o Secure processing and analysis of hydrogen and fuel cell related field data, publication of aggregate results
  o Helping industry evaluate progress toward technology readiness
“Proton has built a strong relationship with NREL on topics ranging from fundamental study to technology demonstration...data from the simulated energy storage profiles being tested with our electrolyzers and stacks is invaluable in establishing Proton’s credibility and robustness of the cell stack under varying operating profiles.” – Dr. Katherine Ayers, Director of Research, Proton OnSite

“Ion Power has engaged in a partnership with NREL over the past two years, focusing on development and validation of in-line quality inspection techniques directly on Ion Power’s electrode manufacturing line...this partnership has positively impacted Ion Power...The results demonstrated that this new material selection provided for a more uniform and higher quality coating.” – Dr. Stephen Grot, President, Ion Power

“The Department of Energy has developed significant capability in fuel cell R&D, both in people and equipment, within the national lab system. [The GM/NREL CRADA] provides the framework to efficiently apply the fundamental perspective and tools at NREL to address the real-world development challenges we are currently working to resolve.” – Charles Freese, Executive Director, General Motors Fuel Cell Activities

“Toyota greatly benefits from NREL’s unique expertise in vehicle and energy systems development and integration. This past year we leveraged their new state-of-the-art ESIF to evaluate plug-in vehicle and grid interactions, and sought their expertise in renewable hydrogen production.” – Nihar Patel, VP North American Business Strategy, Toyota Motor Sales, U.S.A., Inc.
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www.nrel.gov/hydrogen/