2005 DOE Hydrogen Program Review

Advanced Manufacturing Technologies for Renewable Energy Applications

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This presentation does not contain any proprietary or confidential information

National Center for Manufacturing Sciences

Project ID # ST17

LEVERAGING EXCELLENCE

Overview

- **Timeline**
  - Project start date October 2004
  - Project end date March 2007
  - 23% Percent complete
- **Budget**
  - Total - $3,679,040
    - DOE - $2,943,232
    - In-Kind - $735,808
  - Funding received in FY04 - $2,943,232
- **Barriers**
  - Covered on next slide
- **Partners**
  - National Renewable Energy Laboratory
  - Various companies, universities, national laboratories based upon project approvals

Technical Barriers and Targets from the HFCIT Program Multi-year Program Plan

- Technical Barriers
  - Fuel Cell Components
    a) O. Stack Material and Manufacturing Cost
    b) P. Durability
  - Fuel-Flexible Fuel Processors
    a) N. Cost
  - Hydrogen Storage Systems
    a) A. Cost
    b) B. Weight and Volume
    c) D. Durability
  - Other barriers may be addressed by collaborative projects as a result of Task 1.

- Technical Targets
  - Costs: Range from $10/kWe for fuel-flexible systems to $45/kWe for integrated systems operating on direct hydrogen; Storage system costs of $2/kWh net.
  - Durability: Targets are all 5000 hours or greater. Portable storage systems equivalent to 300,000 miles.
  - Weight and Volume: Target is 3 kWh/Kg net useful energy/maximum system mass

Objectives

- Working with DOE and the private sector, identify and develop critical manufacturing technology assessments vital to the *affordable manufacturing* of hydrogen-powered systems.
- Leverage technologies from other industrial sectors and work with the extensive industrial membership base of NCMS to do feasibility projects on those manufacturing technologies identified as key to reducing the cost of the targeted hydrogen-powered systems.

Approach

- Identify Manufacturing Hurdles to Hydrogen-Powered and Storage Systems
- Rank as to impact for producing affordable structures
- Institute collaborative development projects that address the manufacturing technology issues deemed of highest impact.
- Provide a clearinghouse of information to promote technology utilization

(See Notes page for further information)

Progress/Results

Task 1: Developing the manufacturing technology roadmap for affordable hydrogen-powered systems

Subtask 1:Working with DOE, industry, federal laboratories, and universities, identify key manufacturing capabilities required to produce high volume, affordable hydrogen-powered systems, including storage.

Subtask 2: Rank and prioritize manufacturing areas as to impact on affordable systems. Focus on those manufacturing technology issues that reduce overall production and storage costs tenfold

Progress/Results

- Held two workshops with industry and hydrogen technology providers and successfully identified a list of targeted manufacturing needs relevant to hydrogen storage and fuel cell components.
  - Reviewed with NREL
  - Information gathered from a wide variety of sources (following slides)

Hydrogen Storage:

- Collected preliminary program inputs from:
  - Luxfer
  - Structural Composites Industries
  - Shell Hydrogen
  - Air Products & Chemicals
  - Lincoln Composites
  - Praxair
  - Texaco-Ovonic
  - UTC Fuel Cells
  - General Dynamics
  - ORNL
  - NREL

Fuel Cell Components:

- Collected preliminary program inputs from:
  - Freudenberg NOK
  - Cabot Superior Micropowders
  - General Motors Fuel Cell Group
  - Adaptive Materials Inc.
  - US Fuel Cell Council
  - UTC Fuel Cells
  - University of Michigan, SM Wu Manufacturing Research Center
  - NREL

Workshops

- Held in collaboration with the Society of Manufacturing Engineers
- March 9-10 2005 in Dearborn, MI
- Two workshops
  - Fuel Cell Components
  - Hydrogen Storage Systems
- Approximately 70 attendees representing over 40 organizations

Workshop Agenda – Hydrogen Storage Systems

9:00	Overview of the NCMS–DoE Hydrogen Program, *Richard Pearson and Chuck Ryan, NCMS*
9:30	Hydrogen Fuel Cartridges for Portable Applications, *Shailesh Shah, Millennium Cell Inc.*
9:50	Metal Hydride Storage Systems (Solid Hydrogen Storage) Vessel Construction/Assembly, *Richard Geiss, Ovonic Hydrogen Systems LLC*
10:30	Large Steel Seamless Pressure Vessels, *Kevin Collins, CP Industries*
10:50	ASME Hydrogen Codes and Standards, *John Koehr, ASME*
11:20	Panel Discussion for Q&A, F*acilitated by Steve Hale, NCMS*
12:00 noon	NETWORKING LUNCH
1:00 p.m.	Break-Out Sessions
2:00	Report-Out from Sessions
3:00	Identify and Prioritize Manufacturing R&D Areas - Group Comment and Consensus
4:00	Next Steps and Adjourn

Workshop Agenda – Fuel Cell Components

8:30 a.m.	Overview of the NCMS-DoE Hydrogen Program, *C. Ryan and M. Mehta, NCMS*
9:00	Challenges Facing High-Volume Fuel Cell Manufacturing, *William Schank, Ford Motor Company*
9:20	PEM Fuel Cell Stack Sealing, St*eve Koch, Freudenberg-NOK General Partnership*
9:40	High Volume Manufacturing of Fuel Cell CCM/MEA, *Hanwei Lei, Cabot Corporation*
10:20	SOFC Component Manufacturing and Assembly, *Aaron Crumm, Adaptive Materials Inc.*
10:40	Proton Exchange Membrane Fuel Cell Power Plants, *Henry Johnson, UTC Fuel Cells*
11:00	Rapid Manufacturing for Production Ramp-up, *Denny Reiland, General Pattern*
11:20	Panel Discussion for Q&A, F*acilitated by Steve Hale, NCMS*
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Progress/Results – Call for Project Ideas

Based upon workshop results and other information to date, NCMS put out a call for submission of collaborative project ideas in the following areas:

- Hydrogen storage structures
  - Manufacturing processes
  - Assembly processes
  - Joining technologies
  - Manufacturing of fittings, valves, tubing, … (plumbing)
  - Parts reduction/simplification
- Efficient/lean manufacturing of Fuel Cells
  - Coating processes
  - Automated manufacturing
  - Assembly technologies

Call For Project Ideas Cont.

- Sealing Technologies
  - Fuel cell stacks
  - Components
- Balance of Plant
  - Discrete parts manufacturing and assembly
  - Parts reduction/simplification
  - Water/heat management
- Inspection and Safety
  - Non-destructive testing and evaluation methods
  - Leak-testing
  - Sensor technologies

Other Progress/Results

- Designed and Implemented NCMS-DOE Program Website and Collaboration Materials, Forms, etc. (visit http://hydrogen.ncms.org)

Future Work

Task 2: Manufacturing Technology Development and Implementation

Subtask 1: Develop and implement collaborative development projects amongst technology providers, commercializing companies, and end-users that address the manufacturing technology issues deemed of highest impact to meeting targets.

Future Work - Project Development and Implementation

- Project ideas due April 22, 2005
  - One-page description of a collaborative project for consideration in the program.
- Successful project teams will be notified by May 9 to submit a 5-7 page proposal for evaluation. All projects **must be collaborations** with others in industry, academia, and/or federal laboratories.
- Expect to develop 4-6 projects, 12-18 month duration, approx. $500,000 in value each

Future Work

- Select Project Ideas and Evaluate 5-7 pagers Using Project Criteria
  - Topics must apply to manufacturing issues (as opposed to material science or design/product specific topics)
  - Emphasis on cost reductions and the production of affordable systems
  - Looking for near-term impact (2-5 years)
  - Must entail cross-industry collaboration and demonstrate impact on US industry

Supplemental Slides

The following three slides are for the purposes of the reviewers only – they are not to be presented as part of your oral or poster presentation. They will be included in the hardcopies of your presentation that might be made for review purposes.

Publications and Presentations

- None

Hydrogen Safety

The most significant hydrogen hazard associated with this project is:

Will be dependent upon the specific manufacturing projects this program supports. Manufacturing projects will be identified in the next phase of the program.

Hydrogen Safety

Our approach to deal with this hazard is:

To be addressed by individual manufacturing projects.