Hydrogen and Fuel Cell Analysis: Lessons Learned from Stationary Power Generation

Award Number: DE-FG36-07GO17107
October 1, 2007 to September 30, 2009.

2009 Hydrogen Program Annual Merit Review and Peer Evaluation Meeting
May 19, 2009

Project ID# an_10_grasman
Overview

Timeline
• Start: October 1, 2007
• End: September 20, 2009
• Percent Complete: 35%

Budget
• Total DOE Share: $387,038
• FY08: $199,948
• FY09: $187,090
• FY10: $0

Barriers
• 3.6.4 Technology Validation (H) Hydrogen from Renewable Resources
• 3.6.4 Technology Validation (I) Hydrogen and Electricity Co-Production
• 4.5 System Analysis (A) Future Market Behavior

Partners
• Missouri S&T, Lead
Relevance – Project Objectives

- to consider opportunities for hydrogen in **stationary & portable applications** in order to make recommendations related to research, development and demonstration (RD&D) strategies.

- to analyze the different **national and international** strategies utilized in existing systems and identify the different **challenges** and **opportunities** for producing and using hydrogen as an energy carrier.
Relevance – Impact

- Lessons Learned and Best Practices
- Early Market Applications/Market Transformation
  - most promising applications for early market introduction?
  - role of “niche” markets?
  - required technological (or policy) breakthroughs?
  - policy instruments to promote early market penetration?
  - technical and economic synergies (e.g., with transportation)?
  - impact of other developments (e.g., green technologies)?
## Approach - Milestones

<table>
<thead>
<tr>
<th>Month/Year</th>
<th>Milestone</th>
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</thead>
<tbody>
<tr>
<td>October 08</td>
<td>Distributed online survey: Early Market Development Strategies for Stationary and Portable Fuel Cells.</td>
</tr>
<tr>
<td>March 09</td>
<td>Complete data collection in order to proceed with lessons learned and best practices.</td>
</tr>
<tr>
<td>September 09</td>
<td>Final Recommendations/Report</td>
</tr>
<tr>
<td>October 09</td>
<td>Follow-up Workshop (at Fuel Cell Seminar)?</td>
</tr>
</tbody>
</table>
## Approach – Milestones

<table>
<thead>
<tr>
<th>Task</th>
<th>Description</th>
<th>% Complete</th>
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</thead>
</table>
| 1. Compilation and Classification of Programs  | • listing of past and existing programs  
• classification by type, application, etc. | 100%       |
| 2. Program Data Collection                     | • participants  
• technology status  
• consumer behavior and attitudes  
• impact of infrastructure availability, including environmental benefits/impacts  
• cost-effectiveness of the program (investment vs. market success/failure)  
• major achievements of the project/program or justification for lack of success  
• description of challenges/solutions | 100%       |
| 3. Analysis of Lessons Learned and Best Practices | • What has worked well, what has not? | 75%        |
## Approach – Milestones

<table>
<thead>
<tr>
<th>Task</th>
<th>Description</th>
<th>% Complete</th>
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<tbody>
<tr>
<td>4. Pathways Analysis</td>
<td>In order to recommend a strategy, the study will model and analyze the hydrogen supply network, hydrogen demand growth, and perform scenario analysis on different strategies in order to identify strengths and weaknesses of various approaches. Models will address both cost and environmental factors related to potential opportunities.</td>
<td>75%</td>
</tr>
</tbody>
</table>
| 5. Strategy Recommendation          | What system combinations be approached related to implementation of fuel cell technologies? Specifically, the recommendations will address the:  
  • most promising applications for early market introduction?  
  • role of “niche” markets?  
  • required technological (or policy) breakthroughs?  
  • policy instruments to promote early market penetration?  
  • technical and economic synergies (with, for example, transportation)?  
  • impact of other developments, e.g., green technologies? | 25%        |
Technical Accomplishments & Progress

**Early Market Development Strategies for Stationary and Portable Fuel Cells**

### 1. Survey Description

1. The purpose of this survey is to provide critical information in support of a U.S. Department of Energy study that will consider opportunities for stationary and portable applications in order to make recommendations related to research, development and demonstration (RD&D) strategies that incorporate lessons learned and best practices from relevant national and international efforts, as well as cost and environmental modeling of pathways. The study will analyze the different strategies utilized in and will identify the different challenges and opportunities for fuel cell applications.

We are requesting that you provide information for fuel cell operation and demonstration programs with which you have participated. All information provided will be kept confidential and you are free to skip any question. We expect the survey to take 15 minutes to complete. Thank you for your time in completing this survey.

If you wish to receive the results of this study, please check the appropriate box below. Contact information will be requested at the end of the survey.

- [ ] Yes
- [ ] No

- [http://web.mst.edu/~grasmans/Survey.htm](http://web.mst.edu/~grasmans/Survey.htm)

- **> 100 respondents**
Technical Accomplishments & Progress

Application Type?

Material Handling Equipment
Backup Power
Portable Power
Consumer Electronics
Grid Independent Power

Fuel Cell Type?

Proton Exchange Membrane (PEM)
Solid Oxide (SOFC)
Molten Carbonate (MCFC)
Phosphoric Acid (PAFC)
Other

(PEM) 64.5%
(SOFC) 12.9%
(MCFC) 6.5%
(PEM) 6.5%
Other 9.7%
Technical Accomplishments & Progress

Planning?

Duration?

<table>
<thead>
<tr>
<th>Years in Operation</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;1</td>
<td>24.14%</td>
</tr>
<tr>
<td>1-2</td>
<td>10.34%</td>
</tr>
<tr>
<td>2-5</td>
<td>17.24%</td>
</tr>
<tr>
<td>5+</td>
<td>3.45%</td>
</tr>
<tr>
<td>N/A</td>
<td>44.83%</td>
</tr>
</tbody>
</table>

Still in Operation

Time in Years
- <1
- 1-2
- 2-5
- 5+

14% 22% 42%
Technical Accomplishments & Progress

Cost Effective (Investment vs. Market Success Failure)?

- Extremely Successful: 36%
- Moderately Successful: 21%
- Neutral: 25%
- Moderately Unsuccessful: 18%
- Extremely Unsuccessful: 0%
Technical Accomplishments & Progress

Lessons Learned
• Technical Considerations
• Cost Competitiveness
• Fuel Flexibility
• Performance and Reliability
• Public Acceptance
• Niche Markets

Best Practices
• Market Penetration
• Balancing Objectives
• Cost, Durability, and Reliability.
• Trade-offs
• Systems Perspective
Collaborations
/site visits and meetings/

- Over 2500 State, National, International and Multinational Programs
- Over 1000 Fuel Cell Developers
Future Work FY09/10

- Final Recommendations/Report
- Follow-up Workshop

- Early Market Applications
- CHP and CHHP Systems
- Renewable-Hydrogen Systems
  (integrated with vehicle systems)
Summary

Relevance:
The role and use of hydrogen fuel cells in stationary and portable applications can be significant!

Approach:
Compilation and Classification of Programs
Program Data Collection
Analysis of Lessons Learned and Best Practices
Pathways Analysis
Strategy Recommendation

Technical Accomplishments and Progress:
Survey and Site Visits
Lessons Learned and Best Practice Recommendations

Technology Transfer/Collaboration: Numerous site visits, publications and presentations.

Proposed Future Work: Continue beyond FY09/10?
Thank you!

Questions?

Scott E. Grasman, Principal Investigator
Engineering Management & Systems Engineering
grasmans@mst.edu; 573-341-7011