

# 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

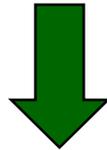
- Missouri S&T, Lead

# 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

<b>Month/Year</b>	<b>Milestone</b>
October 08	Distributed online survey: Early Market Development Strategies for Stationary and Portable Fuel Cells.
March 09	Complete data collection in order to proceed with lessons learned and best practices.
April 09	NHA Workshop: Stationary & Portable Fuel Cell Market Transformation and Applications.
September 09	Final Recommendations/Report
October 09	Follow-up Workshop (at Fuel Cell Seminar)?

# Approach – Milestones

Task	Description	% Complete
<b>1. Compilation and Classification of Programs</b>	<ul style="list-style-type: none"> <li>•listing of past and existing programs</li> <li>•classification by type, application, etc.</li> </ul>	<p>100%</p>
<b>2. Program Data Collection</b>	<ul style="list-style-type: none"> <li>•participants</li> <li>•technology status</li> <li>•consumer behavior and attitudes</li> <li>•impact of infrastructure availability, including environmental benefits/impacts</li> <li>•cost-effectiveness of the program (investment vs. market success/failure)</li> <li>•major achievements of the project/program or justification for lack of success</li> <li>•description of challenges/solutions</li> </ul>	<p>100%</p>
<b>3. Analysis of Lessons Learned and Best Practices</b>	<ul style="list-style-type: none"> <li>•What has worked well, what has not?</li> </ul>	<p>75%</p>

# Approach – Milestones

Task	Description	% Complete
<b>4. Pathways Analysis</b>	<p>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.</p>	<p>75%</p>
<b>5. Strategy Recommendation</b>	<p>What system combinations be approached related to implementation of fuel cell technologies? Specifically, the recommendations will address the:</p> <ul style="list-style-type: none"> <li>•most promising applications for early market introduction?</li> <li>•role of “niche” markets?</li> <li>•required technological (or policy) breakthroughs?</li> <li>•policy instruments to promote early market penetration?</li> <li>•technical and economic synergies (with, for example, transportation)?</li> <li>•impact of other developments, e.g., green technologies?</li> </ul>	<p>25%</p>

# 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.

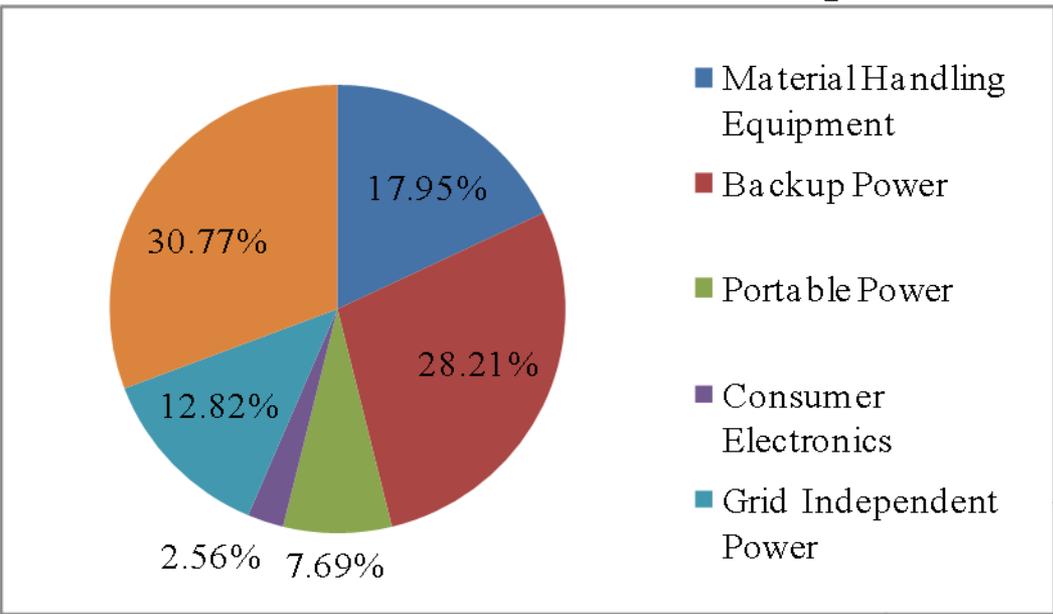
Yes

No

<http://web.mst.edu/~grasmans/Survey.htm>

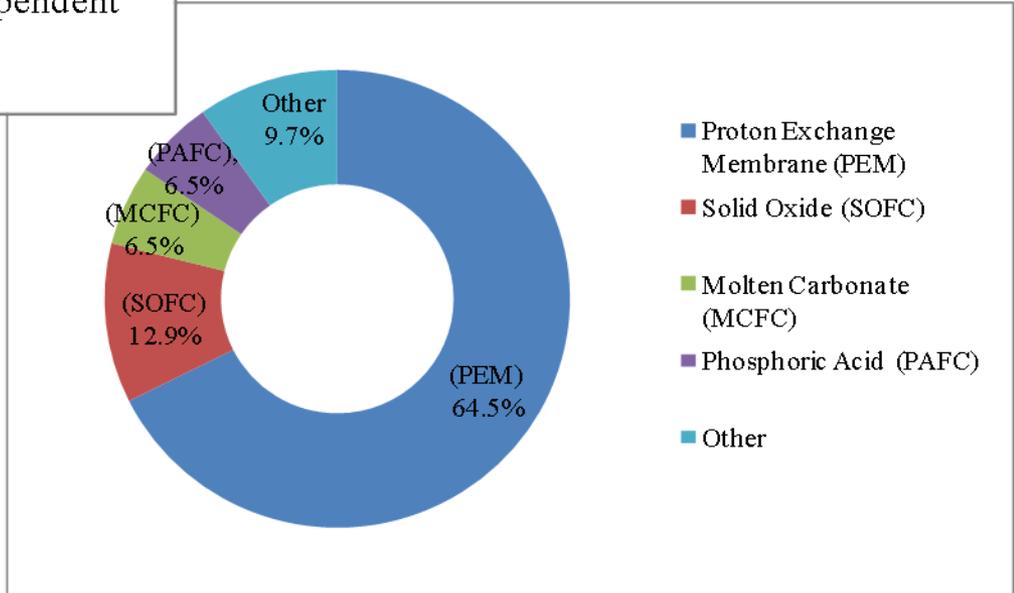
> 100 respondents

# Technical Accomplishments & Progress



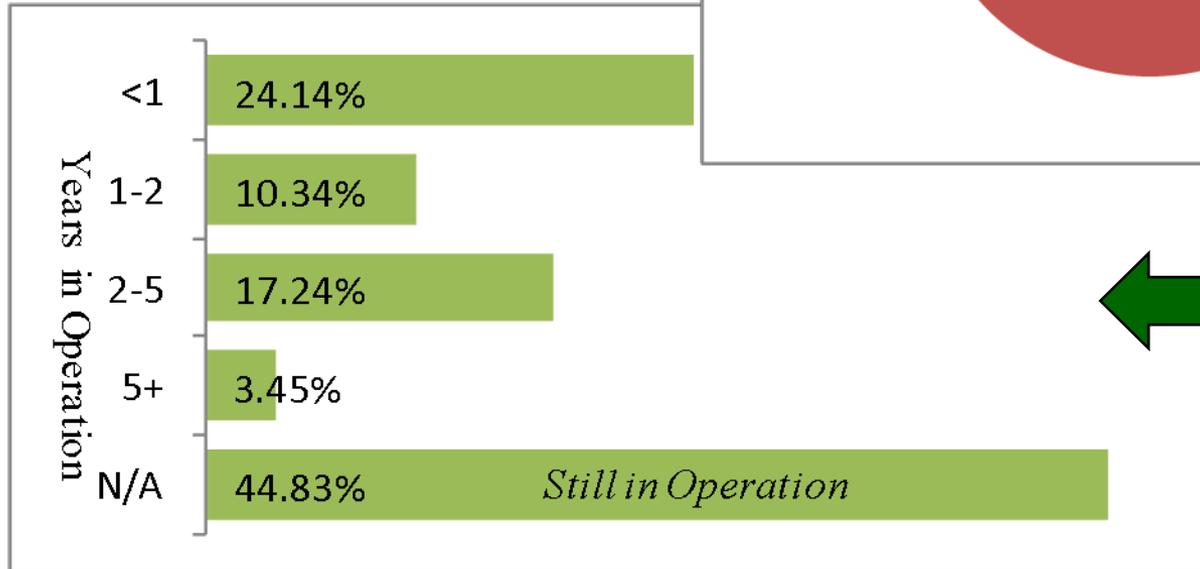
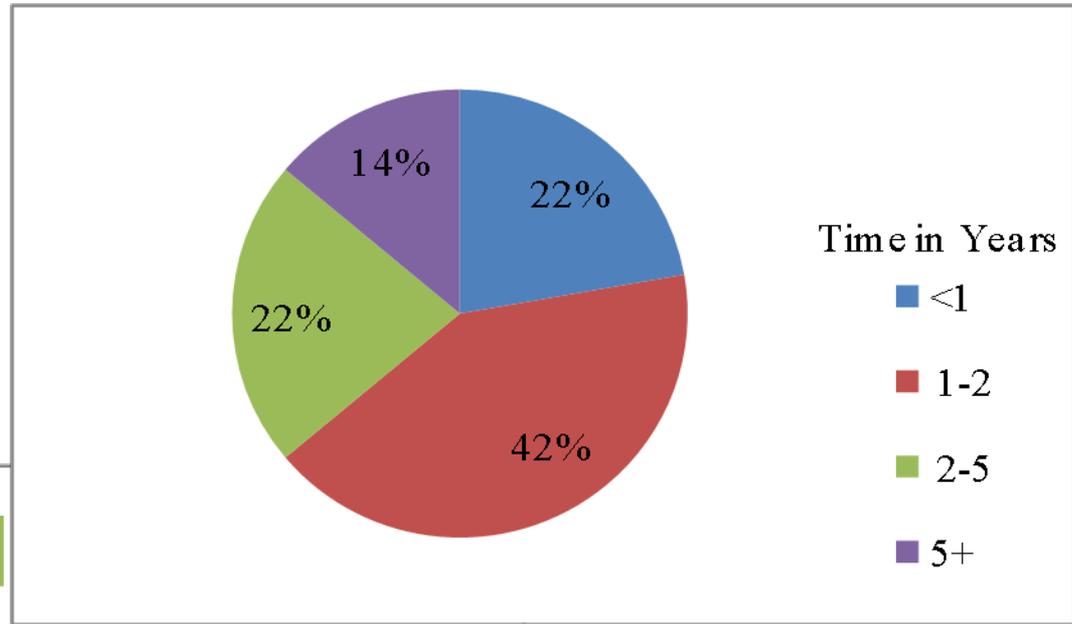
← Application Type?

Fuel Cell Type? →



# Technical Accomplishments & Progress

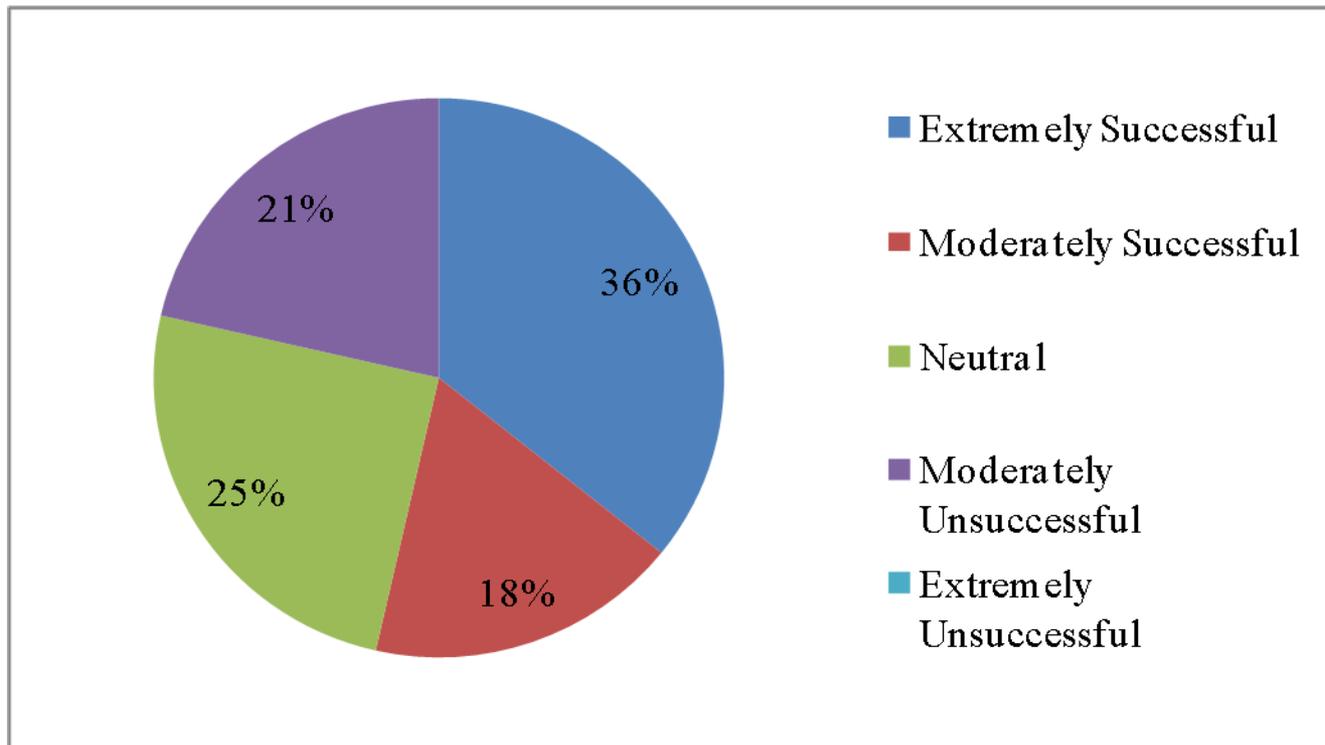
Planning? →



← Duration?

# Technical Accomplishments & Progress

Cost Effective (Investment vs. Market Success Failure)?



# 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](mailto:grasmans@mst.edu); 573-341-7011