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

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October 1, 2007 to September 30, 2009.

2008 Hydrogen Program Annual Merit Review and Peer Evaluation Meeting

June 13, 2008

Project ID# AN10

DOE Hydrogen Program

MISSOURI S&T

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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

- **Barriers**
- Cost & Performance
- Stationary and other Early Market Fuel Cells
- Innovative Concepts for Fuel Cell Systems

- **Partners**
- Missouri S&T, Lead
- Unofficial Partners
  - DoD ERDC/CERL
  - Ameren
  - St. Louis Science Center

Project Objectives

- to consider opportunities for hydrogen in **stationary 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 power generation systems and identify the different **challenges** and **opportunities** for producing and using hydrogen as an energy carrier.

Milestones

Month/Year	Milestone
March 08	Milestone: Completed compilation of projects and programs, began data collection.
July 08	Milestone: Complete data collection in order to proceed with lessons learned and best practices.
October 08	Milestone: Workshop on Development Strategies for Hydrogen Technologies.
March 09	Milestone: Draft Recommendations.

Approach

Task	Description	% Complete
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	50%
3. Analysis of Lessons Learned and Best Practices	•What has worked well, what has not?	10%

Approach

Task	Description	% Complete
4. Pathways Analysis	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.	50%
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?	10%

Accomplishments

- Task 1: Compilation and Classification of Programs & Task 2: Data Collection
  - Over 2500 Projects
  - State, National, International and Multinational Programs
  - Over 1000 Fuel Cell Developers
- Task 3: Analysis of Lessons Learned and Best Practices
- On-going with Data Collection
  - What has worked well, what has not?
  - Fuel Cell problems?
  - Feedstock problems?

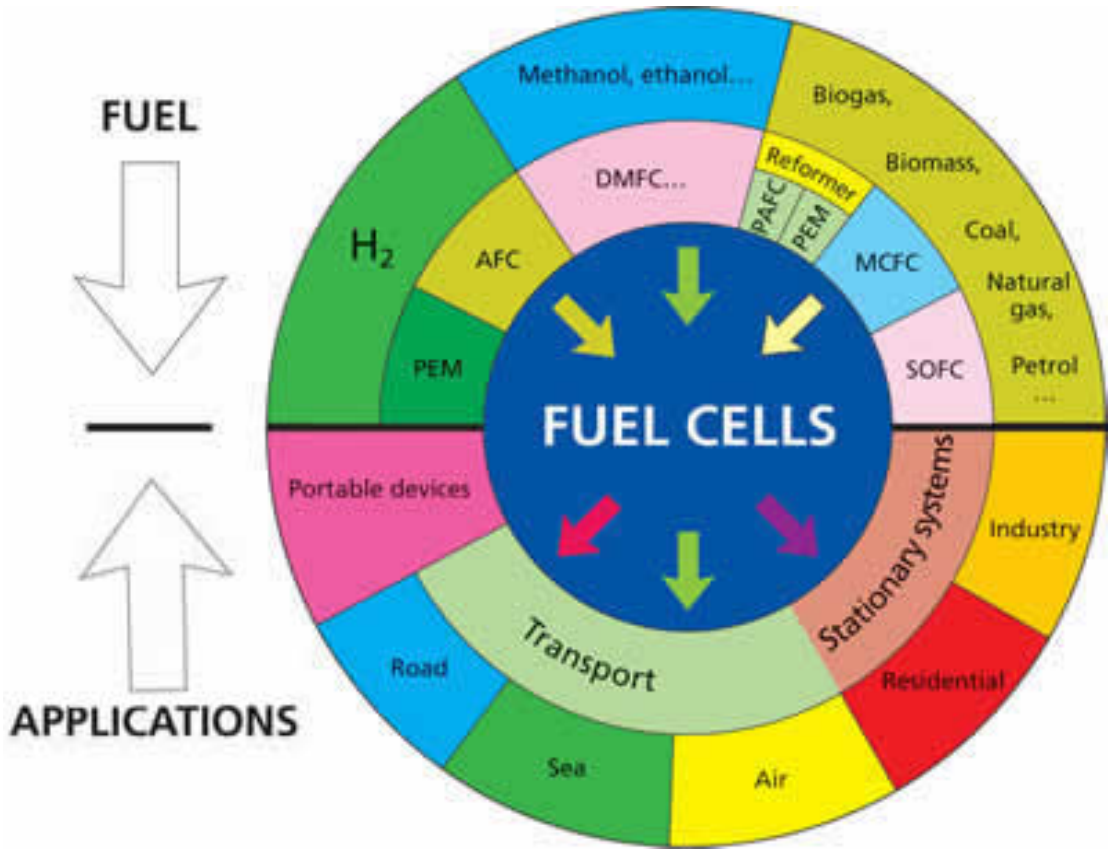
Accomplishments

- Task 5: Strategy Recommendation

1. Early Market Penetration
   - PEM fuel cells, H_2 or reformed feedstocks
   - stationary or portable systems
2. Market Transformation
   - co-generation (CHP)
   - integrated systems for transportation fuel

Early Market Penetration

- *Technical Considerations*
- *Cost Competitiveness*
- *Fuel Flexibility*
- *Performance and Reliability*
- *Public Acceptance*
- *Niche Markets*



SOURCE: European Hydrogen and Fuel Cell Technology Platform High Level Group on Hydrogen and Fuel Cells

Early Market Applications

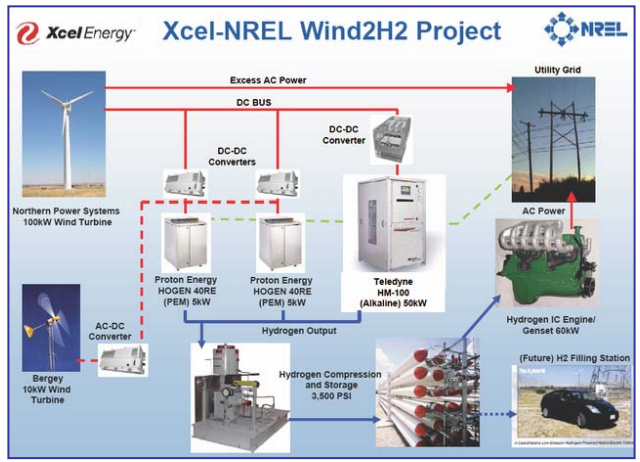
- Niche/Portable Market
  - consumer electronics military/security/first responders
  - material handling equipment
- Backup/Auxillary Power Units
  - communications/wireless networks & sensors
  - data centers
  - emergency power
- Stationary Heating and Power (CHP) and Distributed Generation (DG)
  - green office buildings, commercial
  - residential
  - co-generation
- Transportation Demonstration Projects → Integrated Systems for H_2 Fuel

Integrated Renewable Power and H_2 Production Examples

- DTE Energy

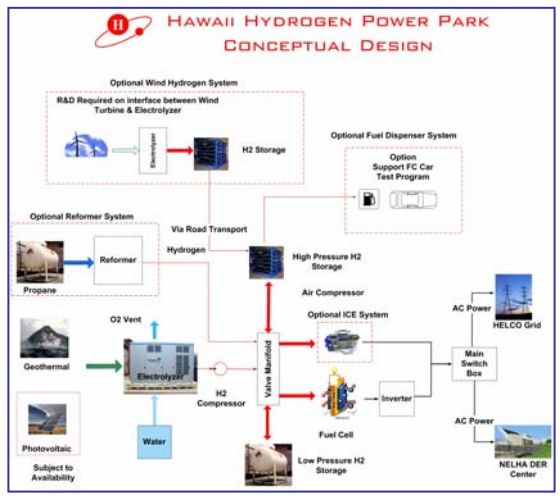
SOURCE: DTE Energy

- Xcel/NREL Wind2H_2 Project



SOURCE: NREL/XcelEnergy

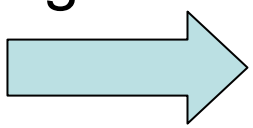
- Hawaii



SOURCE: DOE EERE

Future Work FY08/09

- Complete On-Going Tasks:
  - Program Data Collection
  - Analysis of Lessons Learned and Best Practices
  - Pathways Analysis
  - Strategy Recommendation
- Workshop on Development Strategies for Hydrogen Technologies



- **Introduction and Keynote**
- **Session I: Fuel Cell Technology Status and R&D Programs for Fuel Cell Technology**
- **Session II: Early Market Applications**
- **Session III: Breakout Sessions**
  - **A: Early Market Applications**
  - **B: Policy Instruments**
- **Session IV: Presentation from Breakout Sessions and Discussion**
- **Optional Tours**

Summary

- **Relevance:**
- The role and use of hydrogen fuel cells in stationary applications can be significant in portable applications, niche markets, distributed generation or co-generation.

- **Approach:**
- Market penetration is the ultimate goal of the energy related industries, but early markets must be strategically aligned with balancing near term and long term objectives.
- Focus on demonstrating that cost, durability, and reliability can be met for early markets (with incentives, if necessary).
- Consider opportunities and trade-offs for stationary applications in conjunction with the other application sectors, e.g., providing fuel for transportation applications.
- Take a systems perspective – components should address multiple systems.