VIII.8 IEA Hydrogen Task 18: Evaluation of Integrated Demonstration Systems

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Start Date: January 1, 2004
Project End Date: December 31, 2009

Objectives

- Operate international working group to address hydrogen technology integration in member countries.
- Establish database of international hydrogen development activities, capabilities and demonstrations.
- Evaluate integrated hydrogen systems for performance, cost, safety and codes and standards permitting policies.
- Synthesize lessons learned from projects and prepare trend analysis for dissemination.
- Participate in the International Energy Agency (IEA) Hydrogen Implementing Agreement hydrogen resources study: "Where will the hydrogen come from?"

Technical Barriers

This project addresses the following technical barriers of the Hydrogen, Fuel Cells and Infrastructure Technologies Program Multi-Year Research, Development and Demonstration Plan:

Technology Validation (3.6.4)

(C) Lack of Hydrogen Refueling Infrastructure Performance and Availability Data
(E) Codes and Standards
(H) Hydrogen from Renewable Resources
(I) Hydrogen and Electricity Co-Production

Systems Analysis (4.5)

(C) Inconsistent Data, Assumptions and Guidelines
(D) Suite of Models and Tools
(E) Unplanned Studies and Analyses

Hydrogen Safety (3.8.4)

(A) Limited Historical Database
(H) Lack of Hydrogen Knowledge by Authorities Having Jurisdiction

Hydrogen Codes and Standards (3.7.4)

(D) Large Number of Local Government Jurisdictions (approximately 44,000)
(I) Conflicts between Domestic and International Standards
(N) Insufficient Technical Data to Revise Standards
(P) Large Footprint Requirements for Hydrogen Fueling Stations

Hydrogen Production (3.1.4)

(A) Reformer Capital Costs
(H) System Efficiency
(J) Renewable Electricity Generation Integration

Hydrogen Delivery (3.2.4)

(J) Other Refueling Site/Terminal Operations
(K) Safety, Codes and Standards, Permitting

Contribution to Achievement of DOE Safety or Codes and Standards Milestones

This project will contribute to achievement of the following DOE Hydrogen Safety or Hydrogen Codes and Standards milestones from the Hydrogen Safety or Hydrogen Codes and Standards section of the Hydrogen, Fuel Cells and Infrastructure Technologies Program Multi-Year Research, Development and Demonstration Plan:

- **Safety Milestone 20:** Update a Best Practices Handbook. (1Q, 2008)
- **Codes and Standards Milestone 21:** Completion of necessary codes and standards needed for the early commercialization and market entry of hydrogen energy technologies. (4Q, 2012)
- **Codes and Standards Milestone 25:** Draft regulation for comprehensive hydrogen fuel cell vehicle requirements as a GTR approved (UN Global Technical Regulation). (4Q, 2010)

Accomplishments for the Period June 2007 – June 2008

- Continued information base development: contains over 300 documents, now publicly accessible.
  - National documents
  - National organizations and capabilities
  - National demonstration projects
- Initiated analysis of eight demonstration projects in seven countries, including reviews of relevant permitting and development of enhanced component models for electrolyzer, compressor and thermal management of metal hydride storage:
  - Spain - Renewables to Hydrogen project (RES2H2)
  - Greece - Center for Renewable Energy Studies
  - Italy - Ecological House
  - Hawaii - Hydrogen wind farm and hydrogen for national park buses
  - Denmark - Lolland hydrogen community
  - Spain - Expo 2008 buses and fueling station
  - Norway - HyNor fueling station, hydrogen highway node
  - US/UK - Intelligent Energy bio-reformer/fuel cell system.
- All assessments include documentation of safety, codes and standards, and permitting requirements.
- Case studies: one new underway within the last year, others underway:
  - UK – Peterhead power station with carbon capture (completed)
- Led two international experts meetings, one in Gran Canaria, Spain, and one in Athens, Greece, to address the modeling and evaluation of demonstration projects, and to continue building of a database on hydrogen experiences worldwide.
- Participated in two Hydrogen Implementing Agreement Executive Committee meetings in November 2007 and June 2008, including presentation of annual report and incorporation of new activities.
- Maintained task Web sites and public Web site for dissemination of information from Task 18.

Introduction

The overall goal of Task 18 is to provide information about hydrogen integration into society around the world. The operating agent for Annex 18 is Dr. Susan Schoenung of Longitude 122 West, Inc. Her work is sponsored by the U.S. Department of Energy, which has sponsored two previous tasks on integrated hydrogen systems.

The Annex has three major subtasks:

- Subtask A: Information Base Development
- Subtask B: Demonstration Project Evaluation
- Subtask C: Synthesis and Learning

The leader for Subtask A is Ms. Emma Stewart of the University of Strathclyde, currently at Sandia. The leaders for Subtask B are Dr. Maria Argumosa and Mr. Ismael Aso Aguarta of Spain. The leader for Subtask C is Ms. Shannon Miles of Natural Resources Canada.

Approach

The work of Task 18 is undertaken collaboratively by the 16 member countries. It consists of participation in all three subtasks. In Subtask A, members have helped build a significant Web interactive information database, focusing on national documents, national capabilities, and demonstration projects. In Subtask B, members model, analyze, and assist in design of integrated hydrogen systems. In Subtask C, members synthesize the lessons learned from case studies and projects, and perform trend analysis based on exploration of hydrogen work from earlier dates to the present. As noted in Table 1, the demonstration projects span the globe and also the spectrum of possible hydrogen uses. Participants work in their home institutions and meet twice per year to report results and plan for future activities. Between meetings, participants also work collaboratively, either from a distance or by occasional separate meetings. The project portfolio for Task 18 is shown in Table 1.

Results

This effort, carried out in collaboration with the 16 members of the IEA Hydrogen Implementing Agreement Task 18, has resulted in several significant sets of accomplishments this year.

1. The Information Base work consists of searchable documents, including national documents. The national capabilities and projects sub-Web sites went public at the end of 2007.
2. The Phase 1 modeling and analysis report: "Hydrogen Demonstration Systems Evaluations," a major document, was published in 2007.
3. Sandia began innovative new modeling with Intelligent Energy to assess a new bio-reformer-based project funded by the Fuel Cell program. The system diagram is included in Figure 1.
4. Subtask C is well underway with additional case studies, comparative studies, several survey projects, and synthesis of lessons learned.

TABLE 1. Project Portfolio for IEA Hydrogen Task 18

Country	Project	Location	Modeling focus	Modeling being done by	Simulation/ model in use	Evaluation status	Estimated completion date
Refueling Stations							
Sweden	Hydrogen filling station (re grid/ electrolysis)	Malmö	System sizing	IFE	Hydrogems	Expansion in progress	End 2008
Spain	Hydrogen filling station at Expo 2008 (grid/electrolysis)	Zaragosa	Station and bus performance	Zaragosa Universtiy	HYSYS	Data acquisition system in design	End 2009
Norway	Hydrogen filling station (grid/ electrolysis), HyNor node	Romerike (Oslo)	System performance	IFE	Hydrogems	Initial stages	2009
Canada	Pacific Spirit station	Vancouver	Compressor/ Performance	IFE	Hydrogems	In negotiation	2008
Grid-Connected or Stand-Alone Power Systems							
Spain	RES2H2 (combined wind power and desalination)	Gran Canaria	System performance	INTA	HYSYS/HOGA	In progress	2009
Denmark	Island power	Lolland	System performance	HidrogenAragon	HOGA	In progress	2009
Italy	Hydrogen from the Sun	Brunate	Control strategy	Sandia, Emma Stewart	Simulink	In progress	2008
UK	RE/H2-project (HARI)	Loughborough	Economic performance	EA	Transys	Data analysis and dispatch strategy	2009
Combined Fuel and Electricity Generation							
USA/UK	Hydrogen, energy, CHP refuelling station (bio fuels)	US/UK	System performance	Sandia, Intelligent Energy	Simulink	In definition	2009
USA	Hydrogen power park (RE)	Hawaii	Performance, economics	Sandia, Andy Lutz	Simulink/H2A	In progress	2009

HARI - Hydrogen and Renewables Integration; CHP - Combined heat and power

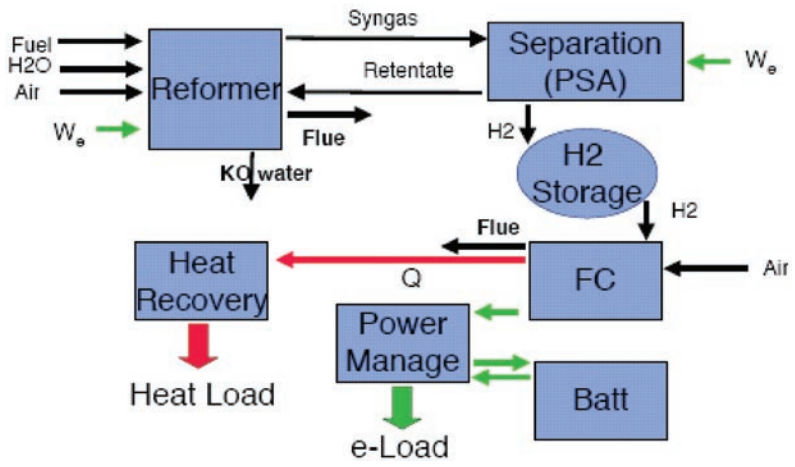

FIGURE 1. System Diagram for Intelligent Energy Bio-Reformer-Based Fuel Cell Combined Heat and Power System

Conclusions and Future Directions

IEA Hydrogen Task 18 has been successful in implementing three subtasks to address international development of hydrogen demonstration projects, hydrogen directions, and specific issues including permitting and safety codes and standards. For the coming year, the members of Task 18 foresee the following activities:

- Completion of analysis: "The Ecological House" in Brunate, Italy (Joint with Sandia National Laboratories); RES2H2, Spain.
- Continue analysis: Intelligent Energy and Hawaii projects; HyNOR and Zaragosa bus refueling stations.
- Complete case studies: German Clean Energy Project; Lolland Hydrogen Community.
- Carry out "Lessons Learned" tasks; trend analysis; guidebook assessment.
- Perform hydrogen resources literature review for Hydrogen Implementing Agreement (HIA).
- Complete financial survey and remote communities survey.
- Lead fall 2008 experts meeting, scheduled for Copenhagen, and spring 2009 meeting, tentatively planned for Norway.
- Report to HIA Executive Committee: November 2008 meeting in Greece, May 2009 meeting in US.

FY 2008 Publications/Presentations

1. Schoenung, S. M. et al, "Pioneering Experiences by Users of Integrated Hydrogen Systems," 2007 Fuel Cell Seminar, San Antonio, Texas.

2. Ulleberg Ø., Ito H., Maack M.H., Ridell B., Miles S., Kelly N., Iacobazzi A., Argumosa, M., and Schoenung S. (2007) Hydrogen Implementing Agreement, Task 18 - Integrated Systems Evaluation, Subtask B - Demonstration Project Evaluations. Final Report (ISBN #978-0-9815041-0-0) IEA Publications, Paris.

3. Proceedings of the 17th World Hydrogen Energy Conference, Brisbane Australia, June 2008:

- Susan M. Schoenung, Jean Dubé, Ismael Aso, and Shannon Miles, "An Evaluation of Integrated Hydrogen Systems: Overview of IEA Hydrogen Task 18."
- Emma M. Stewart, Susan Schoenung, Maria Chiesa, Andy Lutz, and Andrew Cruden, "Modeling, Analysis and Control System Development for the Italian Hydrogen House."
- Ismael Aso, Luis Correas, Rodolfo Dufo, José Luis Bernal, and Susan Schoenung, "Demand side management in hybrid systems with hydrogen storage in several demand scenarios."
- Ismael Aso, Luis Correas, Leire Romero, Jose Angel Peña, and Pablo Marcuello, "Zaragoza EXPO 2008 hydrogen fuelling station: Simulation and optimization of process variables and strategies in different scenarios."
- Øystein Ulleberg, Torgeir Nakken, and Arnaud Eté, "The Utsira Wind/Hydrogen Demonstration System in Norway: An Evaluation of the System Design and Operation."