
VII.6 IEA Hydrogen Task 18: Evaluation of Integrated Demonstration Systems

Susan M. Schoenung

Longitude 122 West, Inc.
1010 Doyle Street, Suite 10
Menlo Park, CA 94025
Phone: (650) 329-0845; Fax: (650) 329-9951
E-mail: schoenung@aol.com

DOE Technology Development Manager:

Pat Davis

Phone: (202) 586-8061; Fax: (202) 586-9811
E-mail: Patrick.Davis@ee.doe.gov

Technical Advisor: Jay Keller

Phone: (925) 294-3316; E-mail: jokelle@sandia.gov

Start Date: January 1, 2004

Project End Date: December 31, 2006

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
- Participate in the International Energy Agency 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 (3.5.4.2)

- (B) Storage
- (C) Hydrogen Refueling Infrastructure
- (E) Codes and Standards
- (H) Hydrogen from Renewable Resources
- (I) Hydrogen and Electricity Coproduction

Systems Analysis (4.5)

- (B) Lack of Consistent Data, Assumptions and Guidelines

Safety Codes and Standards (3.6.4.2)

- (I) Conflicts between Domestic and International Standards Objectives
- (P) Large footprint requirements for hydrogen fueling stations

Production by Electrolysis (3.1.4.2.2)

- (H) System Efficiency
- (J) Renewable Integration

Delivery (3.2.4.2)

- (B) Reliability and Costs of Hydrogen Compression

Storage (3.3.4.2)

- (J) Thermal Management

Accomplishments

- Completed analysis of six demonstration projects in six countries; including reviews of relevant permitting and development of enhanced component models for electrolyzer, compressor and thermal management of metal hydride storage.
- Incorporated modeling participation of Sandia personnel (Andy Lutz).
- Organized industry modeling workshop in Vancouver, Canada.
- Established international database of hydrogen production technologies, designed for use in the Hydrogen Resources Study: "Where will the hydrogen come from?"
- Supervised completion of two case studies: Ecological City Transport System (ECTOS) in Iceland and Hydrogen and Renewables Integration (HARI) project in the UK.
- Led two international experts meetings, one in Reykjavik, Iceland, and the second in Vancouver, Canada, 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 (HIA) Executive Committee meetings in

October 2005 and June 2006, including presentation of annual report and incorporation of new activities.

- Work from this task resulted in three paper presentations at the 16th World Hydrogen Energy Conference.
- Maintained task websites and public website 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. Specific objectives are:

- to provide information, data and analysis to the Task members and the hydrogen community in general,
- to use modeling and analysis tools to evaluate hydrogen demonstration projects, and
- to provide input to the HIA-sponsored Hydrogen Resources Study.

The Annex has two major subtasks:

- Subtask A: Information Base Development, and
- Subtask B: Demonstration Project Evaluation.

The leader for Subtask A is Mr. Jean Dubé of Services Mij Inc. of Canada. The leader for Subtask B is Dr. Øystein Ulleberg of IFE, Norway

Approach

The work of Task 18 is undertaken collaboratively by the thirteen member countries. It consists of participation in Subtask A, in which members have helped build a significant web interactive information database, and Subtask B, in which members model, analyze, and assist in design of integrated hydrogen systems. As noted in Table 1, the demonstration projects span the globe and also the spectrum of possible hydrogen uses. To date, most of the systems analyzed have been based on renewable sources of hydrogen. In these cases, the data have been easier to access than fossil-fuel based systems. We expect to include a fossil-fuel based system in the near future.

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 below. It includes those projects which are completely incorporated into the current phase of the work, plus those which will be carried out in Phase 2.

Results

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

The Information Base work now consists of searchable documents in the following sets:

- National documents
- National capabilities and vendor listings
- Demonstration projects
- Case studies and summaries of case studies
- A database of costs and performance of the Hydrogen Resource Study: “Where will the hydrogen come from?”
- Links to the HySociety database

The National documents sub-website will go public at the end of 2006.

Significant work has been done to verify the models for the demonstration projects in Iceland, Sweden, Canada, Japan, UK and Spain. A diagram of the simulator for hydrogen fueling stations is shown in Figure 1. This model is based on “Hydrogems” which was developed in Norway. It has proven compatible with models operated at Sandia National Laboratories. In fact, the modelers at Sandia and the Institute for Energy Research in Norway are exchanging approaches to improve both their platforms. These skills are being passed along to other members of the Task.

Most importantly, having validated the models with actual system performance data, now the models are being used to recommend optimized design and performance in planned expansion at several sites. For example, in Iceland, the models are being used to analyze potential system efficiency and operation of the electrolyzer as the load factor grows with the introduction of additional vehicles. Also, in Sweden, the modeling work is being used to design an expanded system of city buses running on a mixture of natural gas and hydrogen, from two buses to as many as two hundred. In another example, the modeling tools are being used to design an optimal thermal management strategy for metal hydride storage in a hydrogen load-leveling system in Japan.

Efforts have begun this year to perform trend analysis on the demonstrations being evaluated. For example, a careful comparison of operations and features of three refueling stations was completed. Among the attributes compared were the permitting requirements at each site.

TABLE 1. Project Portfolio for the International Energy Agency (IEA) Hydrogen Task 18

Country	Projects	Location	Modeling focus	Evaluation status
Refueling Stations				
Sweden	Hydrogen filling station (re grid/electrolysis)	Malmö	System sizing	Completing
Iceland	Hydrogen filling station (grid/electrolysis)	Reykjavik	Electrolyzer performance	Completing
Canada	Hydrogen filling station (grid/electrolysis)	Vancouver	Compressor performance	In progress
Grid-connected or stand-alone power systems				
Spain	PV/MH-telecom showcase (RE)	Madrid	Storage sizing	Done
Japan	Regenerative PEM FC-power system (grid)	Aichi	Storage thermal control	Almost done
UK	RE/H2-project	Loughborough	Economic performance	In progress
Italy	Hydrogen from the Sun	Brescia	System efficiency	Phase 2
Combined fuel and electricity generation				
USA	Hydrogen energy/refuelling station (NG)	Las Vegas	System performance	Done
USA	Hydrogen power park (RE)	DTE or HI	Compressor and storage optimization	Phase 2
Infrastructure demonstrations				
Denmark	Natural gas / hydrogen pipeline, boiler	Copenhagen	Economics	In negotiation
Residential heat and power				
France	Building fuel cell evaluation	5 sites	Fuel cell / system performance	Case Study
Other Potential Phase 2 projects				
New Zealand	Renewable hydrogen at remote site	Totara Valley	Renewables integration	Phase 2
Spain	Renewable hydrogen for desalination plant	Canary Islands	System sizing and optimization	Phase 2
Germany	Refueling station	Munich or Berlin	Station sizing and economics	Phase 2

Conclusions and Future Directions

IEA Hydrogen Task 18 has been successful in implementing two 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:

- Task 18 is scheduled to continue through December 2006; an extension through December 2009 has been approved in principle by the Executive Committee.
- Meetings will be held semi-annually, fall and spring. The fall 2006 meeting will be held in the UK, in conjunction with a visit to the Hydrogen and Renewables Integration site in Loughborough. The spring 2007 meeting will be held in Italy, in conjunction with the “Hydrogen from the Sun” project.
- Final reports on Phase 1 of Subtasks A and B will be produced.
- Task 18 will manage the collaborative international Hydrogen Resources Study: “Where will the hydrogen come from?”
- Summary of comparative codes and standards will be completed.
- Plan modeling workshop for spring 2006 in Italy.
- Prepare extension proposal for Executive Committee approval in fall 2006.
- Participate in IEA Executive Committee activities, including annual and semi-annual reporting. Fall

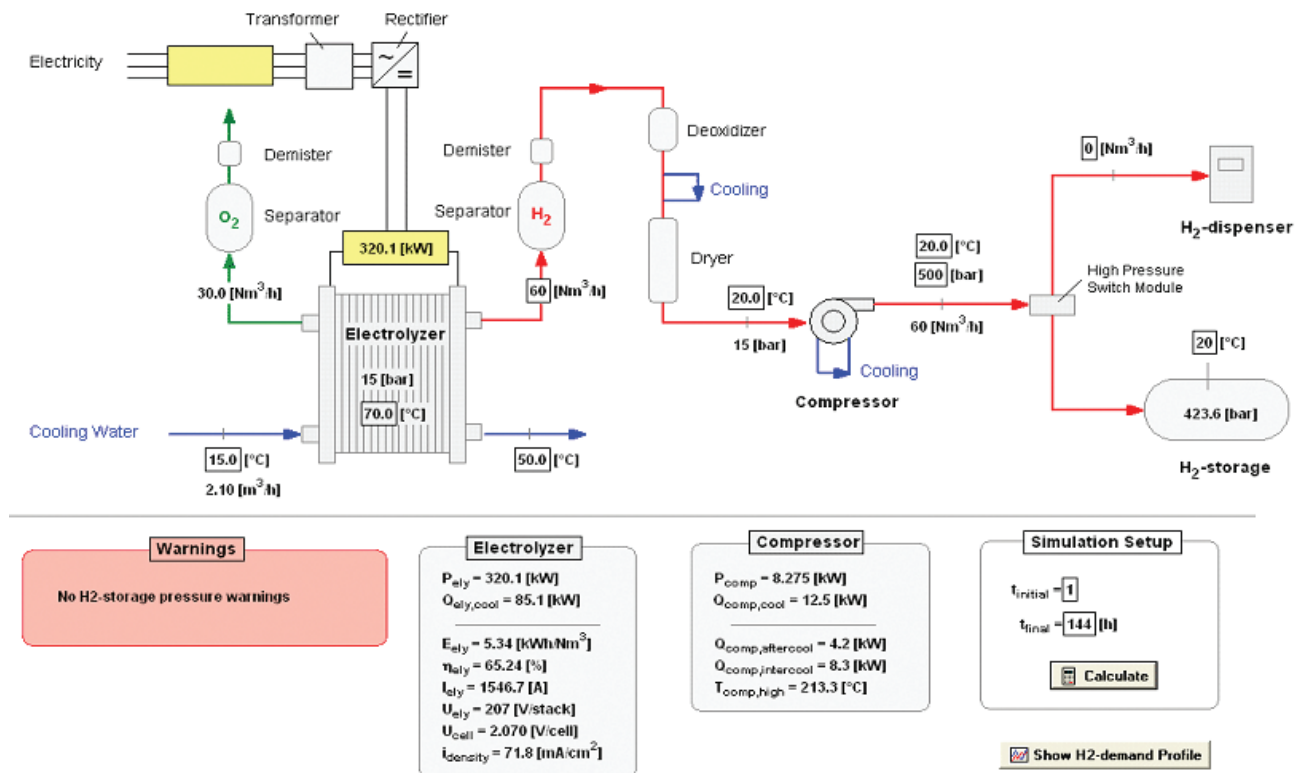


FIGURE 1. Example Diagram of Hydrogen Station Simulator used for Refueling Station Analysis and Optimization

2006 meeting is planned for the Netherlands and the spring 2007 meeting is planned in conjunction with the World Hydrogen Technology Conference in Rome.

FY 2006 Publications/Presentations

The following papers were presented at the 16th World Hydrogen Energy Conference and are published in the proceedings.

1. "A Comparative Study of Refueling Station Experience," by Schoenung, et al.
2. "Modeling and Evaluation of Hydrogen Demonstration Systems," by Ulleberg, et al.
3. "Malmö Hydrogen and CNG/Hydrogen Filling station and Hythane bus project," by Ridell and Nilsson.