

SANDIA NATIONAL LABORATORIES HYDROGEN AND FUEL CELLS PROGRAM—SYSTEMS ANALYSIS

QUARTERLY PROGRESS REPORT FOR JANUARY 1, 2013–MARCH 31, 2013

SUBMITTED BY: DANIEL DEDRICK, (925) 294-1552, DEDEDRI@SANDIA.GOV
TODD WEST, (925) 294-3145, THWEST@SANDIA.GOV

RECIPIENT: SANDIA NATIONAL LABORATORIES

PRINCIPAL INVESTIGATORS: TIMOTHY SA, (925) 294-3174, TJSA@SANDIA.GOV
TOM DRENNEN, (315) 781-3419, DRENNEN@HWS.EDU
SUSAN SCHOENUNG, (650) 329-0845, SUSAN.SCHOENUNG@SBCGLOBAL.NET

OTHER PARTNERS: MARK RUTH, NREL, (303) 384-6874, MARK_RUTH@NREL.GOV

PROJECT TEAM: MARK RUTH (NREL), VICTOR DIAKOV (NREL), MIKE GOLDSBY (SNL)

CONTENTS

FY 2013 MILESTONES/DELIVERABLES	2
TASK 1: MACRO SYSTEM MODEL.....	4
BACKGROUND	4
OBJECTIVE.....	4
PROJECT STATUS	5
PLANS FOR NEXT QUARTER AND KEY ISSUES	5
PUBLICATIONS/PRESENTATIONS	5
TASK 2: IEA HIA ANNEX 30, “GLOBAL HYDROGEN SYSTEMS ANALYSIS,” SUBTASK A	
LEADER AND DETAILED SYSTEMS ANALYSIS.....	5
BACKGROUND	5
OBJECTIVE.....	6
PROJECT STATUS	6
PLANS FOR NEXT QUARTER AND KEY ISSUES	7
PUBLICATIONS/PRESENTATIONS	7
TASK 3: IEA HIA ANNEX 30, “GLOBAL HYDROGEN SYSTEMS ANALYSIS” CO-	
OPERATING AGENT	7
PROJECT STATUS	8
PLANS FOR NEXT QUARTER AND KEY ISSUES	8
PUBLICATIONS/PRESENTATIONS	8



Sandia National Laboratories is a multi-program laboratory managed and operated by Sandia Corporation, a wholly owned subsidiary of Lockheed Martin Corporation, for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.

FY 2013 MILESTONES/DELIVERABLES

Task/Milestone Description	Planned	Status
Task 1: Macro System Model (MSM)		
Subtask 1.1: Add report generation and output capability		
Add new charts and text.	9/13	Ongoing
Subtask 1.2: Provide ongoing maintenance and support		
Update the MSM's links to component models as new versions are released.		Ongoing
Provide limited technical support to the MSM user community.		Ongoing
Subtask 1.3: Provide a report that summarizes status of the MSM	9/13	Ongoing
Task 2: IEA HIA Annex 30, "Global Hydrogen Systems Analysis," Subtask A Leader and Detailed Systems Analysis		
In collaboration with the experts of Subtask A, continue development of the "Global Hydrogen Resource Outlook." This Outlook will be a compilation of the analysis and interpretation of the analysis based on results of a consistent set of input from as many of the Hydrogen Implementing Agreement (HIA) member countries as possible, following a methodology agreed to by the experts. To the extent possible, this analysis will incorporate data supplied by IPHE ¹ countries, including China. Specific deliverables include the following:		
<ul style="list-style-type: none"> Briefing to DOE of updated study results for all HIA countries that have supplied data, with an assessment of data quality and implications for global study. 	12/12	Completed
<ul style="list-style-type: none"> Preliminary report to DOE on key findings of global hydrogen resource analysis (timed to coincide with the Spring meeting of Task 30A). 	3/13	Scheduled web meeting 4/19
<ul style="list-style-type: none"> End of year report on status of global hydrogen resource analysis. Will include status of all HIA and IPHE country submissions and assessment of overall data quality and implications for global analysis. 	9/13	Ongoing

¹ International Partnership for Hydrogen and Fuel Cells in the Economy, an organization formed in 2003 as an international institution to accelerate the transition to a hydrogen economy.

Task/Milestone Description	Planned	Status
Task 3: IEA HIA Annex 30, “Global Hydrogen Systems Analysis” Co-Operating Agent		
<p>Milestones / deliverables to DOE include quarterly review meetings and reports, an annual report, and, if requested, a presentation at the annual peer review meeting. The Operating Agent also has numerous other deliverables including planning, executing, and preparing minutes for two Expert meetings per year, preparing two semi-annual reports and an annual report, and attending and making presentations at Executive Committee (ExCo) meetings. Outcomes from the work of the task will also be delivered to the DOE. These will consist of the “Global Hydrogen Resource Outlook” (defined by Subtask A) and the updated Hydrogen Systems database (defined by Subtask B). Specific deliverables for the quarterly review meetings will be slides summarizing current task status. These will be revised based on review meeting feedback as necessary.</p>	9/13	
Quarterly review meeting—Q1/FY13	12/12	Complete
Semi-annual report to HIA ExCo	3/13	Complete
Spring Experts meeting	3/13	Complete
Spring Executive Committee meeting & presentation	3/13	Complete
Quarterly review meeting—Q2/FY13	3/13	To be scheduled
Quarterly review meeting—Q3/FY13	6/13	
Presentation at Zing Hydrogen and Fuel Cells Conference (California)	7/13	
Quarterly review meeting—Q4/FY13	9/13	

TASK 1: MACRO SYSTEM MODEL

Point of contact: Timothy Sa

BACKGROUND

In a 2004 report, the National Research Council recommended that a systems analysis function be formed within the DOE to analyze the systems and subsystems under development, the character of competitive approaches for providing energy services, potential future energy scenarios, and how proposed technologies might fit into a national system. When this systems analysis function was stood up, it was recognized that the Hydrogen Initiative had already developed or had begun developing many models covering different aspects of a possible hydrogen infrastructure for light-duty vehicle transportation.

The systems analysis function determined that a macro-system model (MSM) would be necessary for analyzing cross-cutting issues because no existing model encompasses the entire system sufficiently. For example, no single model adequately represented all of the phenomena involved in the early stages of deployment of a hydrogen fuel infrastructure and hydrogen fueled vehicles. In addition, developing the MSM was expected to expose inconsistencies in methodologies and assumptions between different component models that arose because the individual models were developed under different philosophies and without thought of eventually integrating them.

In 2005, the systems analysis function of the DOE Hydrogen Program designated an investigator from the National Renewable Energy Laboratory (NREL), Mark Ruth, as the Macro-System Model Engineer, responsible for developing and implementing a plan for building the MSM. Mark Ruth and the DOE Hydrogen Program also determined in late 2005 that Sandia had expertise in integrating component models that would be useful for building the MSM. Consequently, beginning in FY 2006, Sandia undertook to construct the MSM, with Mark Ruth providing guidance and requirements.

OBJECTIVE

The goal of this project is to support the DOE Fuel Cell Technologies Program in the development of an MSM that will enable existing or new component models to be linked together to analyze crosscutting issues regarding the production, distribution, or use of hydrogen for light-duty vehicle transportation. Among the many types of models to be linked are models that determine feasible or desirable schedules for deployment of hydrogen infrastructure; models that compute the costs for producing hydrogen; models that determine the costs of building a delivery and distribution infrastructure; and models that determine the emissions produced from various pathways for producing, distributing, and using hydrogen. Some of the crosscutting issues the MSM is being used to examine include identifying critical/risky links in potential hydrogen pathways, determining if the program's current technical targets are appropriate or the best available, and looking for interdependencies between the technical targets.

PROJECT STATUS

In the second quarter of FY2013, the SNL Hydrogen Systems Analysis team, continuing in a reduced budget environment and working together with Victor Diakov from NREL, performed routine maintenance and made minor changes to the MSM. Specifically the team:

1. Improved numeric display in output.
2. Continued beta testing and development of the enhanced reporting feature.
3. Added new users.

PLANS FOR NEXT QUARTER AND KEY ISSUES

In the next quarter of FY2013, the team plans to:

- Continue beta testing and development of the enhanced reporting feature.
- Release a new version of the H2MSM.

PUBLICATIONS/PRESENTATIONS

None this quarter.

TASK 2: IEA HIA ANNEX 30, “GLOBAL HYDROGEN SYSTEMS ANALYSIS,” SUBTASK A LEADER AND DETAILED SYSTEMS ANALYSIS

Point of contact: Tom Drennen

BACKGROUND

In FY09, Sandia developed a system dynamics model for the penetration of electric and hydrogen vehicles and the response of markets for natural gas, refined gasoline, and electricity generation within the state of California. FY10 research included the use of stationary fuel cell systems in distributed applications to begin the transition to hydrogen. In FY11, we completed changes to our model that allow simultaneous analysis of multiple regions. We chose to use NERC (North American Electric Reliability Corporation) electricity grid areas for the regions, dividing the country into 8 regions. We also expanded the model to include 3 sizes of vehicles (small cars, large cars, and trucks) and more powertrains (gasoline ICE, PHEV10, PHEV40, battery EV, and hydrogen fuel cell), providing the ability to model 15 possible vehicle types.

The International Energy Agency (IEA)/Hydrogen Implementing Agreement (HIA) Task 30 began in September 2010 with a kick-off meeting with Task 30 participants. Since that meeting, the U.S./Sandia expert team has modified existing hydrogen delivery and use models to address the needs of the Task 30 analysis. Specifically, the goal is to perform comprehensive technical and market analysis of hydrogen technologies and resources, including projected supply and demand of hydrogen in a low-carbon world.

OBJECTIVE

This project supports the DOE Fuel Cell Technologies Program by analyzing the potential impact of hydrogen-fueled personal transportation. The adoption of hydrogen fuel cell electric vehicles (HFC-EV) could have impacts on important energy and environment metrics such as petroleum consumption and greenhouse gas emissions. Competing technologies such as improved gasoline-powered vehicles and battery electric vehicles must be considered when evaluating the likelihood of adoption of HFC-EV. Also, there is considerable uncertainty in projections of future energy costs and availability and in the performance of new fuel and vehicle technologies. To assess the impact of HFC-EV technologies, this project uses multivariate sensitivity analysis to determine factors that could have the largest impact on energy and environmental metrics. The analysis is enabled by the use of a dynamic, regionally differentiated model of light-duty vehicles, fuels, and energy sources.

The existing U.S. analysis framework developed in this work can evaluate HFC-EV impacts on a regional level, which is required to analyze technologies that may have a geographic variance, such as hydrogen production from wind power. This capability is also being used to inform IEA/HIA Annex 30 analysis activities. The specific objectives of this task are to prepare authoritative analyses that can be used to answer questions about hydrogen sources and utilization posed by the IEA HIA, the task members, the IEA, and government institutions.

PROJECT STATUS

The team presented a final draft of the pathways analysis tool at the March meeting of the Task 30 experts in Paris. The presentation included detailed discussion of model structure and assumptions followed by an interactive sensitivity session with the experts. Experts were asked to review country-level results and provide comments by March 31. The results from the experts meeting were briefed to the HIA Executive Committee and IEA analysts on March 11, and S Results from this Paris meeting were used for preparation of the AMR package that will be presented on May 14.

Several key lessons have been derived from this collaborative, international analysis to date. First, the iterative data collection and pathway analysis has been a valuable exercise. Oftentimes, countries have had to rethink their own data after considering inputs from other countries. For example, some countries had not included the potential role of imports of feedstocks in their initial data submissions. Second, the process led to valuable discussion about the role of off-peak electricity, integration of renewables, trade-offs between alternative uses of feedstocks, and the role of imports of natural gas and other fossil fuels. Third, the results show that a large number of potential pathways exist for providing hydrogen to fuel a significant HFV fleet and, most importantly, that resource availability is not the limiting factor in a hydrogen economy. Every country has identified multiple options for producing hydrogen domestically.

In summary, country experts agree that the tool facilitates discussion, providing insight about the myriad of available pathways for producing significant quantities of H₂ for fueling domestic passenger vehicle fleets and, in the process, offsetting large quantities of greenhouse gases.

PLANS FOR NEXT QUARTER AND KEY ISSUES

The following work plan for the remainder of the year was presented at the March meeting:

- Replace all U.S.-supplied production and distribution costs with country- or region-specific data. The production costs will come from Task 30 B (Harmonized Hydrogen Production Database); and the delivery costs will come from Task 28 (Large-Scale Hydrogen Delivery Infrastructure) (June 2013).
- Present preliminary results at AMR (May 2013).
- Present a draft report to the DOE program office and Task 30 participants (October 2013).
- Present the final report to Task 30 participants and DOE (December 2013).
- Share results and insights with IEA Hydrogen Analysts (December 2013).
- Prepare a paper for journal publication (December 2013).

The first item on the above list requires input from other subtask or tasks. If this additional data is not forthcoming, the analysis will be completed with U.S.-based results (the current situation). If countries not currently in the tool provide data, we will attempt to include their data as well, but this may not be possible, particularly if the data is not consistent with specified data requirements.

PUBLICATIONS/PRESENTATIONS

T. Drennen and S. Schoenung, “Hydrogen Resource Analysis Update,” HIA Task 30, Spring meeting, Paris, March 10, 2013.

T. Drennen and S. Schoenung, “Task 30, Subtask A Update for HIA ExCo,” Paris, March 11, 2013.

TASK 3: IEA HIA ANNEX 30, “GLOBAL HYDROGEN SYSTEMS ANALYSIS” CO-OPERATING AGENT

Point of contact: Susan Schoenung

As Co-Operating Agent for IEA Hydrogen Annex 30—Global Hydrogen Systems Analysis, Dr. Schoenung continued the work of co-managing a group of experts from 10 countries. As Operating Agents, Dr. Schoenung and Mr. Linssen (of Research Center Jülich, Germany) are responsible for day-to-day management of the task, as well as planning and leading two Expert meetings per year, preparing one annual report and two semi-annual reports and presentations to the Executive Committee, along with other duties related to the Hydrogen Implementing Agreement.

In addition, the co-operating agents direct the work of the subtasks, each having an individual subtask leader: Subtask A: Global Hydrogen Resource Study; Subtask B: Database development and trend analysis; Subtask C: Collaboration with IEA; Subtask D: Hydrogen Energy Storage for the Smart Grid.

PROJECT STATUS

During this quarter, Dr. Schoenung has prepared a semi-annual report for the HIA Executive Committee, led a web conference with experts to discuss project status and prepare for major meetings in Paris. Dr. Schoenung participated in the following activities:

- Co-led the spring meeting of Task 30 Experts, including preparation for a joint session with IEA analysts and the HIA.
- Prepared an agenda and facilitated the joint session with IEA analysts from the World Energy Outlook, Energy Technology Perspectives, and Renewable Energy Division.
- Participated in the Spring Executive Committee meeting and presented for Task 30.

Prepared a draft briefing on hydrogen resources in Pacific Rim countries.

Delivered data to Subtask B, database development, based on the US H2A database.

PLANS FOR NEXT QUARTER AND KEY ISSUES

Prepare Task 30 annual report for the HIA. Complete documentation and follow-up from spring meetings in Paris.

Prepare a draft report on hydrogen resources in Pacific Rim countries, for possible webinar with IPHE members.

Work with Subtask leaders to complete data gathering, analysis and plans for final reporting of Task 30.

PUBLICATIONS/PRESENTATIONS

None this quarter.