QUARTERLY PROGRESS REPORT

Project Title: Hydrogen Systems Analysis

Covering Period: October 1, 2006 through December 31, 2006

Date of Report: January 5, 2007

Recipient: Sandia National Laboratories

Subcontractors: Names

Other Partners: Mark Ruth, NREL
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Project Team: Mark Ruth (NREL)
Keith Vanderveen (SNL)
Tim Sa (SNL)

Project Objective: The goal of this project is to support the DOE Hydrogen, Fuel Cells, and Infrastructure Technologies Program in the development of a Macro System Model (MSM) that will enable existing or new component models to be linked together to analyze crosscutting issues involved with 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 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 best, and looking for interdependencies between the technical targets.

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 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 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 SNL had expertise in integrating component models that would be useful for building the MSM. Consequently, beginning in FY 2006, SNL undertook to construct the MSM, with Mark Ruth providing guidance and requirements.

Comparison of Progress against Project Goals:

In the first quarter of FY2007, the SNL Hydrogen Systems Analysis team working together with Mark Ruth, completed design work on a new architecture for the MSM. The new architecture, which uses web services technologies to integrate geographically dispersed component models, will allow these models to be separated from the central server of the MSM and from each other by firewalls. Furthermore, the new architecture will allow greater control and flexibility in scheduling invocations on the different component models, and will allow capabilities not currently enabled by the first version of the MSM, such as iteration of operations on

models (i.e. have model x perform this computation until the value of parameter y is < z) and conditional operations (i.e. if model x returns result y, then invoke model z).   Finally, the new architecture will make the job of specifying inputs and outputs to and from each component model easier. The SNL team also continued to assist Mark with the operation of the first version of the MSM to obtain results validating the MSM approach. MSM development is keeping pace with milestones set in the FY2007 Annual Operating Plan.

Status: In the first quarter of FY2007, the Hydrogen Systems Analysis team spent most of its effort on design of a new architecture; design of a new user interface, and in supporting Mark Ruth in conducting analyses using the MSM, and in validation of the MSM results. Some work continued on improving the user interface, and on refining the format for the files which specify the data to be exchanged between models, and the order in which the MSM performs computations using different component models.

Plans for Next Quarter:
                     For the upcoming quarter, the Hydrogen Systems Analysis team plans to complete development of the new architecture, and resume integrating new models into the MSM. Specifically, we will integrate a model that examines deployment and build out of hydrogen production and delivery infrastructure, as well as hydrogen vehicles.   The team also plans to implement a feature in the MSM that automatically archives the results of an analysis run, as well as configuration information used for the run.

Patents: No patents were applied for during this last quarter.

Publications/Presentations:
                     M.F. Ruth, K.B. Vanderveen, T.J. Sa. "Use of Federated Object Modeling to Develop a Macro-System Model for the U.S. Department of Energy's Hydrogen Program"   Presented at *2006 Winter Simulation Conference*, Monterey, California, December 3-6, 2006

Websites: None.

Collaborations:

The SNL team continued fruitful collaborations with researchers from Argonne National Laboratories (ANL), NREL, and Oak Ridge National Laboratories (ORNL) in the process of conducting analyses and validating the MSM.

Other:

The team continued to improve the MSM software during this quarter.

Milestone Status Table:

Task/Milestone Description	Planned	Actual
1. Integration of Component Models into Macro System Model		
Integration of Deployment Optimization Model	4/07	On track
Integration of Mass/Energy Balance Model	8/07	On track
Integration of Exergy Calculator Model	10/07	On track
2. Development/Improvement of Graphical User Interface (GUI)	1/07	On track
3. Incorporation of Database to Save MSM Configurations, Runs, and Results	6/07	On track
4. Deployment of the MSM to be Web Accessible with Password Authentication	9/07	On track
5. Support Systems Analysis – Alpha & Beta Test	Ongoing	Ongoing
6. Program Management Support		
6.1 Program Management		
Progress Reports	Quarterly	Quarterly
Final Lab Review	5/07	On track
Lab Review Report	7/07	On track
AOP FY2008	7/07	On track
Prepare cost reports	15th ea. mo.	15th ea. mo.