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SANDIA NATIONAL LABORATORIES
HYDROGEN PROGRAM UTILITY SCALE PROJECTS

QUARTERLY PROGRESS REPORT FOR OCTOBER 1, 2010–DECEMBER 31, 2010

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RECIPIENT: SANDIA NATIONAL LABORATORIES

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Project Title : Geologic Storage of Hydrogen

Project Period: September 30, 2010 to December 31, 2010
Date of Report: January 11, 2011

Principal Investigator: Anna Snider Lord, 505-284-5588, acsnide@sandia.gov
Other Key National Lab Researchers: Peter H. Kobos, 505-845-7086, phkobos@sandia.gov , David J. Borns, 505-844-7333 djborns@sandia.gov

Sub-Contractors Funded through AOP Task: none

Industrial Partners: none

DOE Managers: Peter Devlin, DOE HQ Technology Manager,
Dan Sanchez, DOE Field Project Officer

Project Objective: To perform a geotechnical assessment of hydrogen storage within novel storage locations, specifically within igneous and metamorphic rocks. To study in detail the specific geological, hydrological, geomechanical conditions of these sites. The process will identify the advantages and disadvantage of site development.

Background: Geologic storage is used extensively in the oil, natural gas, and compressed air energy industries. To understand the scale of this utilization, 800 million barrels of oil and 100's of billion cubic feet of natural gas are stored geologically in the US. The basic drive for geological storage is that the cost per volume-stored is 3 to 5 times less than surface storage. With this relatively inexpensive way to store large volumes, storage can be situated to buffer seasonal demands, provide continuity in case of disruption in the supply chain, and control congestion in the pipeline system. For example, industry analysis estimates that the current natural gas storage in the US reduces the need for pipelines by 50%.

Geologic cavern storage of hydrogen for industrial use already exists at several locations in Texas. In addition, an evolving hydrogen economy and infrastructure raises similar needs as the natural gas and oil infrastructures. Analyses of the hydrogen infrastructure (Ogden, Williams, Simbeck and Chang, Lord) indicate that there may be an important role for geologic storage. This need, similar to fossil energy stocks, is to buffer seasonal demands, provide continuity in case of disruption in the supply chain, and control congestion in the pipeline system.

To date a white paper was written describing the various types of underground geologic storage options available for the storage of natural gas. The report includes four location maps showing the available underground storage sites in the U.S. The three most likely geologic candidates for the underground storage of hydrogen are 1) salt caverns, 2) depleted oil/gas reservoirs, and 3) aquifers. The report was published as a documentable internal report (i.e. SAND report).

In addition a model has been developed that characterizes the costs entailed in developing and operating three types of hydrogen underground storage facilities; 1) salt caverns, 2) depleted oil/gas reservoirs, and 3) aquifers. The work was presented at the 28th USAEE/IAEE North American Conference in New Orleans, December 2008. A summary report was completed as a documentable internal SAND report, which will allow for public distribution.

Status: The funding for the current task was received April 27, 2010.

This quarter a fourth storage option for hydrogen is being incorporated into the Sandia Energy and Demand model. The fourth option is hydrogen storage within igneous or metamorphic rock mined caverns.

Plans for Next Quarter and Key Issues:
Next quarter Sandia will continue work towards writing a final report which will also incorporate work completed in the Production and Delivery side of the geostorage project.

Patents: none

Publications / Presentations:

Lord, A.S., Investigating the Potential for Hydrogen Geostorage with Igneous and Metamorphic Rocks: A Status Report, SAND2010-6938, Sandia National Laboratories, Albuquerque, NM, 2010.

Task/Milestone Schedule:

Task Number	Project Milestones	Task Completion Date				Progress Notes
		Original Plan	Revised Planned	Actual	Percent Complete	
1.1.1	Identify appropriate geologies for hydrogen storage	3/2010		9/2010	100%	Funding received 4/2010
1.2.1	Assess and identify possible solutions to developing a cavern and infrastructure that will successfully contain hydrogen	6/2010		9/2010	100%	Funding received 4/2010
	Letter report: Status report	10/2010		10/2010	100%	
1.3.1	Create an economic model. Given the viable results of 1.1, 1.2, that will be used to develop the costs, both capital and operational, for the storage of hydrogen within novel locations (e.g., possibly in igneous rock).	9/2010	9/2011			
1.3.2	Report on Assessment, Analysis & Model Findings	9/2010	9/2011			
	SAND report: Summary report of tasks to date	12/2010	9/2011		50%	

Project Title: Economic Analysis of Large-Scale Hydrogen Storage for Renewable Utility Applications, SNL Contract # 1024882 to Longitude 122 West, Inc.

Project Period: October 1, 2010 to December 30, 2010
Date of Report: October 8, 2010

Principal Investigator: Susan Schoenung, Longitude 122 West, Inc.

Other Key National Lab Researchers: Anna Snider Lord, 505-284-5588, acsnide@sandia.gov

Sub-Contractors Funded through AOP Task: none

Industrial Partners: none

DOE Managers: Peter Devlin, DOE HQ Technology Manager,
Dan Sanchez, DOE Field Project Officer

LONGITUDE 122 WEST, INC.
AUTHOR: SUSAN SCHOENUNG

Economic Analysis of Large-Scale Hydrogen Storage for Renewable Utility Applications
SNL Contract # 1024882 to Longitude 122 West, Inc.

Work continued on this contract during this quarter.

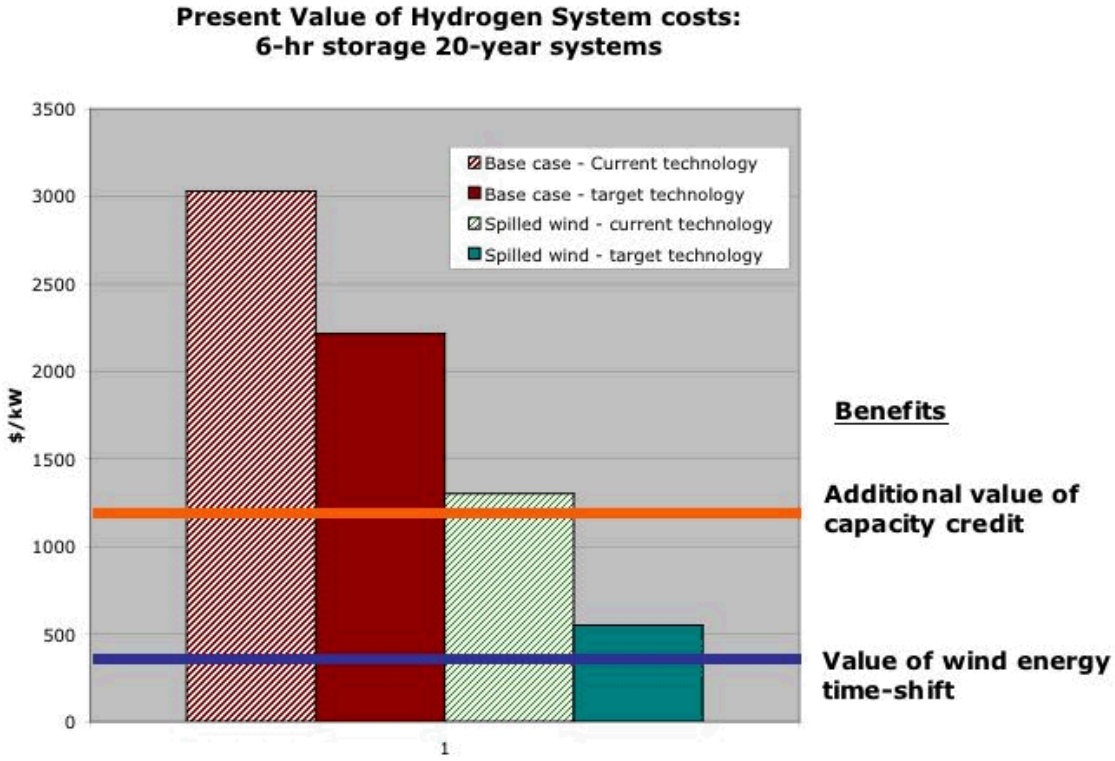
The objective is to model the use of bulk hydrogen storage, integrated with intermittent renewable energy production of hydrogen via electrolysis, to determine cost-effective scale and design characteristics, and to explore potential attractive business models

The work is being performed by Dr. Susan Schoenung of Longitude 122 West, with input from Anna Lord of Sandia Albuquerque.

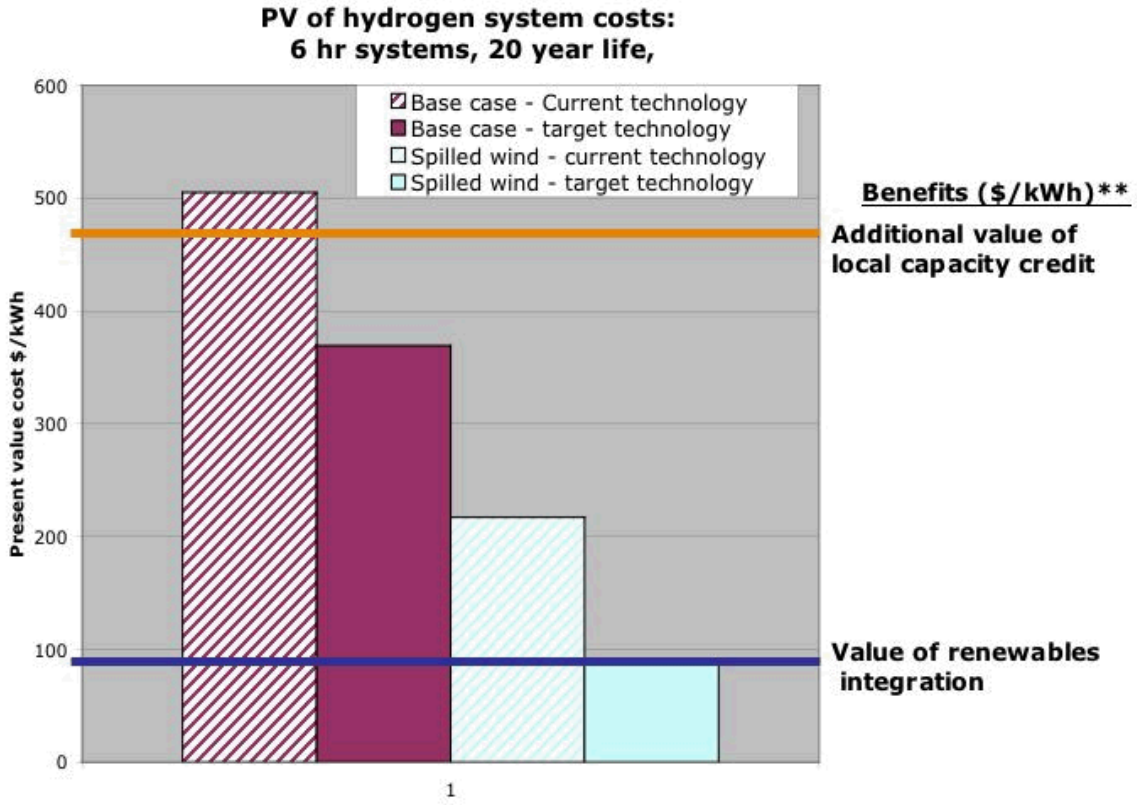
The following activities took place during this quarter:

- Sensitivity analysis continued to look at other parameters relative to storage of hydrogen and zero off-peak costs for “spilled” wind energy.

- Dr. Schoenung updated the present value calculations to consider costs on a $/kWh basis for comparison with recently published EPRI estimates of benefits on a $/kWh basis.
- Costs for several cases were then compared with published values of benefits. (See figures below.)
- An abstract was submitted and accepted for presentation at the 11th International Conference on Environmentally Preferred Advanced Power Generation (ICEPAG) in Costa Mesa in February.
- Discussions were held with a Hawaii-based company interested in responding to the recent DOE RFI relative to bulk hydrogen storage business plan.



Benefits on a $/kW basis (Ref. Eyer and Corey)



Benefits estimated on a $/kWh basis (Ref. Rastler)

Plans for the next quarter (January – March 2011):

The paper prepared for the ICEPAG meeting will be presented. Dr. Schoenung will also participate in an energy storage workshop sponsored by Electric Utility Consultants, Inc. and present the opportunity for hydrogen storage.

Additionally, all the pieces of the phase 1 report will be compiled, including

- discussions of the analysis approach and reference cost and performance values,
- the background / literature review, and
- a section on recommendations for approaching utility companies with an appropriate business model.

In addition, future work includes preparation for the 2011 DOE Annual Merit Review.

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