

# UNIVERSITY OF WYOMING

## Carbon Management Institute, School of Energy Resources, UW 1 November 2010

[Pursuant to 2010 Laws, Chapter 39, Section 320(b)(ii)(C)]  
To the Joint Appropriations Interim Committee and  
Joint Minerals, Business and Economic Development Interim Committee

The 2010 Wyoming Legislature requires, "By November 1, 2010, the school of energy resources shall submit a progress report regarding the [carbon storage demonstration project] project to the joint appropriations interim committee and joint minerals, business and economic development interim committee;"

### PREFACE

This report responds to the progress UW has made toward accessing the \$45 million for purposes of the WY-CUSP, or Wyoming Carbon Underground Storage Project. Importantly, no funds have been expended to date from that appropriation and no funds are anticipated to be spent until after the final report and request for release (i.e., completion of WY-CUSP Phase I). The release of funds is contingent upon a number of factors such as: securing liability resolution, securing matching funds; securing carbon dioxide; addressing water quality issues; and determining the suitability of the site. This last issue is the priority topic of this report – determining the suitability of the site, or WY-CUSP Phase I.

### MISSION OF INSTITUTE

The primary objective of the Carbon Management Institute (CMI) is to ensure that the School of Energy Resources, the University of Wyoming, and relevant state agencies have the expertise, experience, and established relationships necessary to accelerate the collaborative development of the science, technology, and techniques required to effectively and efficiently capture, store, and utilize carbon dioxide in Wyoming and the Rocky Mountain region.

### ACTIVITIES

At present, CMI has three main projects:

1. Site characterization of the highest-priority geologic sites for CO<sub>2</sub> storage in Wyoming (WY-CUSP – Phase 1), Principal Investigator, R.C. Surdam, funded by DOE contracts with cost share provided by UW, WSGS, ExxonMobil, Baker Hughes, Geokinetics, and EMTEK,
2. Design and development of integrated energy development scenarios for each of the major Wyoming Laramide basins, Principal Investigators R.C. Surdam and Zunsheng Jiao, Carbon Management Institute and the Clean Coal Technologies Research Fund. The Wyoming State Geological Survey is a research partner.
3. Support for the Shaanxi/Wyoming Partnership's effort to establish a CO<sub>2</sub> storage demonstration in the Ordos Basin, China. This is supported by NETL and CMI is partnering with WSGS

In all three of these projects, CMI is working closely with colleagues at SER and the Wyoming State Geological Survey (WSGS).

### SUPPORTIVE PARTNERS

CMI's extramural supportive partners include, but are not limited to Baker Hughes, Inc., ExxonMobil, Geokinetics, EMTEK, Los Alamos and Lawrence Livermore National Laboratories, the National Energy

Technology Laboratory, the WSGS, the Shaanxi Provincial Institute of Energy Resources and Chemical Engineering, and the Shaanxi Provincial Development and Reform Commission.

### **PROGRESS ON PROJECT 1 (WY-CUSP)**

The most noteworthy recent activities of WY-CUSP Phase I are outlined in the following list:

1. Completed the contract with Geokinetics to acquire the 3-D seismic survey and EM survey (EMTEK field contractor) in the vicinity of the proposed Rock Springs Uplift stratigraphic test well;
2. Nearing the completion of the UW/Baker Hughes contract to drill the Rock Springs Uplift stratigraphic test well. The remaining issue lies with down hole liability
3. Prepared the WY-CUSP Phase I communication and outreach plan;
4. Collaborated with Baker Hughes (BH) in designing the stratigraphic test well by providing BH with stratigraphic tops, casing points, and selected log tools, and determined coring intervals;
5. Initiated data collection with respect to outcrop studies, regional structural determinations, detailed stratigraphic studies, evaluation of containment-mineralization-brine characteristics, and preliminary performance assessments; and
6. Preliminary work necessary to secure permits to drill.

### **PROGRESS:**

**PI:** Ronald C. Surdam, *Wyoming State Geological Survey and University of Wyoming*

### **Percent completed**

Estimated percent of Task 1.0 completed is 20%.

### **Key activities and accomplishments**

*Subtask 1.1:* As a result of the ARRA supplemental funding awarded to the project, the Project Management Plan was modified. The modifications reflect the additional work and funding associated with a within-scope modification (M003) to Financial Assistance Arrangement DE-FE0002142, which was awarded in September 2010. The additional work includes the following activities:

- Design and plan of a sub commercial CO<sub>2</sub> storage facility
- Research and identify commercial sources of CO<sub>2</sub>
- Design and use comparison of FEHM and Eclipse numerical simulations with Rock Springs Uplift data
- Design and drill a stratigraphic test well on the Rock Springs Uplift – further define tool suite to maximize optimal drilling conditions and to further minimize risk and uncertainty
- Acquire additional logs and cores – increase amount of downhole tests and cores to better define geophysical, structural, and stratigraphic characterization
- Design and complete stratigraphic test well as a monitoring well
- Design additional injection, monitoring, and production wells for a subsequent CO<sub>2</sub> injection and storage demonstration on the Rock Springs Uplift

Other management accomplishments are as follows. A communication and outreach plan for the

WY-CUSP project was developed and implemented. Presentations summarizing the WY-CUSP/CMI were given at the National League of Cities (Gillette), Southwest Partnership (Rock Springs), Global Competition for Energy Symposium (Jackson, Riverton, and Rock Springs), and the Wyoming Gas Fair (Jackson), as well as at preliminary meetings with community leaders in Superior, Rock Springs, and Green River, Wyoming. In addition, Lynne Boomgaarden, consultant to the WY-CUSP project, has briefed state regulators (Wyoming Oil and Gas Conservation Commission, Department of Environmental Quality, State Engineer's Office, Game and Fish Department, State Land Commission, and State Parks and Historic Site Preservation Division) on the WY-CUSP Phase I project. Outreach workshops have been planned for both state regulators and the environmental community (December 2010).

*Subtask 1.2:* Agendas of the monthly meetings include shared plans, data acquisition, and reporting of preliminary results; assessments of progress; and discussions directed toward problem definition and resolution. In the third quarter, special attention was given to improving teamwork, particularly with respect to task integration.

*Subtask 1.3:* Project reports were presented to the Wyoming Legislature's Joint Minerals, Economic Development, and Business Committee, the governor's energy advisor, and the UW School of Energy Resources Commission. Two presentations describing important aspects of the Rock Springs Uplift characterization work were given at the GHGT10 meetings in Amsterdam. Two other presentations resulting from the WY-CUSP work will be given at the annual National Geological Society of America meeting next month in Denver, Colorado. The WY-CUSP principal investigator (Ronald C. Surdam) gave a keynote address at the AAPG Geoscience Technology Workshop *Carbon capture and sequestration: New developments and applications, case studies, lessons learned* in Golden, Colorado. The address was titled *Displaced fluid management: An operational imperative in commercial-scale CO<sub>2</sub> sequestration projects*.

*Subtask 1.4:* The Carbon Management Institute (CMI), the lead UW department with respect to the Rock Springs Uplift characterization project, hired a science coordinator, Meg Ewald, to assist in project reporting, particularly with respect to reports, brochures, presentations, and publications. An important aspect of her responsibilities will be the integration of results from all seven of the project tasks. Most importantly, Meg Ewald will be a key element in the presentation of the Rock Springs Uplift characterization activities to the residents of Wyoming. The science coordinator was hired with funds from the DOE-NETL contract. The P.I. and Associate Director are managing the technical, financial, and contractual activities of the WY-CUSP project, including but not limited to interactions with collaborators and state agencies overseeing permitting and regulatory activities.

*Subtask 1.5:* The Wyoming Geographic Information Science Center continues to work with Professor Tim Carr and NATCARB Coordinator Maneesh Sharma of the University of West Virginia to develop protocol for WY-CUSP data transfer to the NATCARB database.

### **Problems encountered and solutions proposed**

Benefits of the supplemental ARRA (America Recovery and Reinvestment Act) funding for Wyoming and adjacent Rocky Mountain states are immense. Since the beginning of the NETL site characterization program, drill rig rates in the Rocky Mountain region have increased from \$15,000/day to \$25,000/day, and are predicted to go higher. The funds originally budgeted for data collection from the stratigraphic test well have rapidly eroded in order to cover the increasing rig costs. The additional funding will salvage the essential data retrieval and allow for expansion of

coring, logging tools, and fluid sampling – all vital to building a world-class characterization project that will substantially accelerate the transition from site characterization to CO<sub>2</sub> storage demonstration, and finally to commercial-scale CO<sub>2</sub> sequestration.

#### *ARRA and State matching fund Expenditures*

Baker Hughes, Inc. is the contractor selected to drill the Rock Springs Uplift stratigraphic test well. Initially, the plan was to spud the stratigraphic test well in early October. However, due to contractual problems (i.e., available downhole liability coverage), the spud date has been delayed. Therefore, the expenditure of the ARRA funds dedicated to drilling the test well has also been delayed. The ARRA funds dedicated to drilling the well from the initial DOE/NETL contract amounts to \$4,975,000; the additional ARRA funds dedicated to the well from the supplemental contract amount to \$3,700,000. The well design developed by Baker Hughes and provided to WY-CUSP shows that the schedule from spud date to plug and abandonment is 115 days). Therefore, in 115 to 120 days after the well is spudded, \$8,675,000 of ARRA funds will be spent. The WY-CUSP management team is meeting in Laramie with Baker Hughes, Inc. officials on October 15, 2010 to finalize the contract for drilling the stratigraphic test well on the Rock Springs Uplift.

The next problem we face in drilling the well is to find a weather window where 600 feet of core, and a wide variety of wireline log and fluid sampling data can be retrieved safely and without damage. It will take 10 to 12 hours to retrieve each core barrel (7 segments at 30 to 60 feet), and each core (some may contain H<sub>2</sub>S) must be handled at the surface in an environment that maximizes data quality and ensures the safety of all team members. Potential -30°F temperatures in January and February in southwestern Wyoming are not ideal for effectively and efficiently achieving WY-CUSP goals. Therefore, there is a high probability that the stratigraphic test well spud date will be delayed until early March of 2011. A March spud date would put the coring and wireline logging into a May/June timeframe when the weather is less likely to cause costly delays and more conducive to meeting project goals. The final timeframe for drilling the stratigraphic test well was discussed at the October 15 meeting with Baker Hughes. Baker Hughes, Inc. has completed the well design, including hole size targets, casing points, drilling fluid strategy, logging tool selection (i.e., gamma and resistivity logs; neutron density logs – caliper corrected; sonic logs; resistivity imaging logs – fracture identification as well as dip analysis; RCI logs and sampling), cement plans, and drilling schedule. In addition, other technology that will be used in drilling the well are Veritrak/TruTrak non-rotating vertical drilling systems to minimize wellbore degradation and eliminate downhole directional corrections, and PDC bit technology to reduce trips and increase rates of penetration.

The object of this discussion is to illustrate that WY-CUSP is very close to selecting a spud date, and to demonstrate that once drilling starts, \$8,675,000 of ARRA funds will be spent in 115 to 120 days.

#### **Plans for the coming quarter**

*Subtask 1.1:* The revised project management plan resulting from supplemental ARRA funding will be implemented during the next quarter.

*Subtask 1.2:* The UW/WSGS/CMI team is meeting quarterly. In addition, the WY-CUSP team is meeting with Baker Hughes, Inc. (drilling contractor) biweekly until the stratigraphic test well is spudded. During the month of October, the WY-CUSP management team is receiving daily reports on the progress of the ongoing 3-D seismic survey on the Rock Springs Uplift.

*Subtask 1.3:* UW will prepare and deliver reports and briefings as outlined in the original proposal. Progress and results from WY-CUSP were presented at the NETL annual meeting.

*Subtask 1.4:* The Carbon Management Institute, part of the School of Energy Resources at the University of Wyoming, is managing and coordinating all technical, financial, and contractual activities for the RSU characterization project. In the next quarter, particular attention will be devoted to integrating seven new subtasks into the WY-CUSP framework. Four of the seven new subtasks will be managed within Task 1 (Ron Surdam). These four subtasks will include design and plans for a sub-commercial CO<sub>2</sub> storage facility demonstration (1.6), identification of sources of CO<sub>2</sub> (1.7), comparison of FEHM and Eclipse simulation software results (1.8), and design of a customized displaced water treatment facility (1.9).

*Subtask 1.5:* The WY-CUSP team will continue to work with T. Carr and M. Sharma of the University of West Virginia on data transfer from WY-CUSP to the NATCARB database.

### **Presentations and publications this quarter**

WY-CUSP team members presented the following four carbon storage papers (including publications) at the GHGT10 meeting in Amsterdam:

Surdam, R.C., Jiao, Z., Stauffer, P., and Miller, T., 2010, The key to commercial-scale geological CO<sub>2</sub> sequestration: Displaced fluid management: Energy Procedia, Elsevier Ltd., 6 p.

Jiao, Z., Surdam, R.C., Zhou, L., Stauffer, P.H., and Luo, T., 2010, A feasibility study of geological CO<sub>2</sub> sequestration in the Ordos Basin, China: Energy Procedia, Elsevier Ltd., 8 p.

Campbell-Stone, E., Lynds, R., Frost, C., Becker, T.P., and Diem, B., 2010, The Wyoming Carbon Underground Storage Project: Geologic characterization of the Moxa Arch and Rock Springs Uplift: Energy Procedia, Elsevier Ltd., 8 p.

Stauffer, P.H., Pawar, R.J., Surdam, R.C., Jiao, Z., Deng, H., Letteher, B.C., Veswanathan, H.S., Sanzo, D.L., and Keating, G.N., 2010, Application of the CO<sub>2</sub>-PENS risk analysis tool to the Rock Springs Uplift, Wyoming: Energy Procedia, Elsevier, Ltd., 8 p.

### **Schedule/Milestone status**

Two milestones were scheduled for the third quarter of 2010 (milestones 1.4 and 2.1). For milestone 1.4, subcontractors for drilling/field service operations have been identified, but the final contract is not in place. The contract (UW-Baker Hughes, Inc.) should be completed by October 30, 2010. As soon as the contract is complete, WY-CUSP will notify the Project Manager Bill Aljoe and fulfill milestone 1.4. Milestone 2.1 was due on 9/1/10, but until the UW-Baker Hughes contract is in place, WY-CUSP cannot complete milestone 2.1. Both of these milestones should be completed in the fourth quarter of 2010.

### **CARBON MANAGEMENT INSTITUTE UPDATE**

Director Ron Surdam began full-time on July 1. Associate Director Shanna Dahl began in March. Business Manager, Shauna Bury, began the end of June. Contracted Outreach Coordinator, Lynne Boomgaarden, began in April. The team is working together to further define the mission and goals of the institute as well to oversee the WY-CUSP project. Budget information is shown in the table

below. Importantly, none of the \$45 million in AML funds appropriated by the Legislature in the 2010 Budget Session ('10 Laws, Ch. 39, Section 320(c)(ii) will be expended on Phase I of WY-CUSP.

	<i>Budgeted</i>	<i>Spent</i>	<i>Remaining</i>
DOE	\$9,975,000		\$9,975,000
WY-CUSP	\$6,997,526	\$810,697	\$6,186,829
<b>Totals</b>	\$16,972,526	\$810,697	\$16,161,829

## **WY-CUSP PHASE I PROJECT UPDATE**

*Task 2 – Design and construct a Stratigraphic Test Well on the RSU*

Task Manager - Baker Hughes Oilfield Operations Inc.

### **Task Update**

- The final contract for Baker Hughes Oilfield Operations, Inc. is being reviewed by Baker Hughes; the University of Wyoming legal department has approved the latest draft. Anticipated completion date is Nov. 1, 2010.
- A meeting was held with Baker Hughes to finalize the core.
- Representatives from Baker Hughes have made multiple visits to Laramie to establish good working relationships with the University of Wyoming.
- The BLM right-of-way access permit for the use of the existing Black-Butte haul road has been approved.
- A site has been chosen for the stratigraphic test well.
- Once the contract is approved Baker Hughes will solidify the lease of a rig and finalize the well design of the stratigraphic test well.
- The University will be the owner of the stratigraphic test well.

*Task 3 – Geophysical characterization of the RSU Test Well site*

Task Manager - Subhashis Mallick

### **Task Update**

- The contract with Geokinetics, the company shooting the 3-D seismic survey, has been completed, and the seismic survey will be complete by Nov. 1, 2010.
- Geokinetics is currently completing the required EA for the BLM.
- The contract with EMTEK America, Inc. has been signed.
- Supporting personnel have been hired.

*Task 4 – Development of Well catalog and borehole risk assessment*

Task Manager - Jimm Myers

### **Task Update**

- The review of pending EPA/WDEQ CCS permit requirements relative to boreholes has been completed.
- Most of the supporting personnel have been hired; we expect that all remaining personnel will be hired with anticipated start dates of late summer or early fall.

*Task 5 – Structural and stratigraphic characterization*

Task Manager – Erin Campbell-Stone

### **Task Update**

- Existing, available data on the Rock Springs Uplift has been located and reviewed.
- All personnel have been hired.
- Work with ExxonMobil has started with plans to continue through the fall.
- A trip is planned in November to Anadarko in Denver to utilize existing 2-D and 3-D seismic lines for the well area.

*Task 6 – Laboratory measurement of containment – mineralization and brine*

Task Manager – John Kaszuba

### **Task Update**

- All personnel have been hired and trained on laboratory equipment.
- Preliminary tests have been run using the equipment.

*Task 7 – Design the commercial scale sequestration project and complete performance risk assessment*

Task Manager – Zunsheng (John) Jiao

### **Task Update**

- Preliminary work has begun on each of the subtasks to expedite the risk assessment as each of the tasks is completed.

#### **Prepared by:**

Ronald C. Surdam

October 25, 2010

*Director, Carbon Management Institute*