PERMIAN CARBON CAPTURE AND STORAGE (CCS) CENTER

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Permian CCS Center

The Permian CCS Center (http://www.permianbasinccs.org/) was formed in 2009 to provide world class technology transfer, training, and Carbon Capture and Storage (and CO_2 Enhanced Oil Recovery) expertise. It is one of seven regional organization funded by the DOE through the American Recovery and Reinvestment Act (ARRA) of 2009 for a three year period. The mission of the Permian CCS Center is to impart the needed skill sets to realize CCS Opportunities. The deliverable is "World Class CCS Training for and by Industry Professionals." While the focus is the Permian basin, the information developed is applicable and available worldwide. The recipients and beneficiaries of the training include not just oil and gas professionals potentially engaged in CCS and CO_2 EOR, but the entire community of professionals engaged in some aspect of CCS, including the power generation industry, regulators, environmentalists, legislators, scientists and academics.

MEMBER ORGANIZATIONS

The training center is comprised of three strong organizations, each bringing different skill sets and strengths to the overall program:

- Applied Petroleum Technology Academy (APTA) http://www.aptapb.org/about.html**,** Midland, Texas provides practical training in the management of mature and gas producing fields, capturing industry and academic expertise found in the Permian Basin and delivering that information through short courses. With the Permian Basin being the heart of the CO_2 flooding industry, a central focus has been CO_2 flooding and carbon Management/CCS. APTA is a sponsor of the Annual CO_2 Conference held each December in Midland, Texas.

- Petroleum Technology Transfer Council (PTTC) (http://www.pttc.org/), Tulsa, Oklahoma focuses on transferring Oil and Gas Technology to the O & G industry. Since inception in 1993, working with six regions involving 10 different universities/geological surveys, PTTC has earned credibility in technology transfer and developed a national audience of 16,000 individuals for its newsletter, 10,000 for its email Tech Alerts, and maintains an active workshop program that delivers more than 70 workshops per year. To facilitate information transfer, PTTC has built and maintains Tech Centers (http://www.pttc.org/tech_centers/tech_centers_home.htm) for a number of core DOE technical programs, including EOR.

- American Association of Petroleum Geologists (AAPG) http://www.aapg.org/, Tulsa, Oklahoma is the world's largest scientific and professional geological association, with 37,000 members worldwide. AAPG brings online/distance learning, publications, conference capabilities and, through volunteers/members active in CCS, technical expertise to the program. Recent initiatives include webinars/e-symposia, CCS Open Courseware instruction, and Geoscience Technology Workshops on CCS and other technical topics. AAPG has led a multi-society international research conference on "Geological Carbon Sequestration: Prediction and Verification" and it's Division of Environmental Geology has developed CCS-oriented products. AAPG has also developed a number of energy e-certificate programs for self-paced learning and certification.

PRODUCTS AND DELIVERY MEDIA

PBCCS Center has developed a number of training products to deliver information, many available at no charge:

- Website – an informative site for news, description and schedule of products, references and more
- Newsletter and e-alert of upcoming CCS activities, delivered electronically, quarterly
- Webinars and Free OpenCourseware – provides online, higher level treatment of CCS topics
- One Day Workshops – four "standalone" workshops will be available to tailor and present to diverse audiences. Topics are overview, the reservoir, operations and the business model.
- CCS e-certification granted by AAPG equivalent to a three-hour graduate course

- Research Conference to be scheduled in late 2011

Evolution of Products and Market

The products, their timing, delivery media and targeted audience have been evolving since the training contract was awarded in late 2009. At that time, global interest in carbon management was high. And while not a signatory to the Kyota Accord, there was a significant effort underway in the U.S. to develop the technology for carbon management and storage, particularly from carbon emissions of coal burning power plants. This effort was encouraged by significant investment by DOE in capture research and storage demonstration projects conducted by the regional partnerships, environmental encouragement and the belief that one of the two Climate Control bills that cleared their respective House and Senate committees would provide a mechanism to help monetize the captured and stored carbon. The presumption was that one of those bills would pass and technology would advance so that in the foreseeable future, demonstration projects, would go forward and be followed by commercial application, creating the need for a workforce with the skills to develop and implement these CCS projects. Hence, the awarding of the seven regional training contracts.

At the time of the award, the Permian CCS Center began with a regional focus, planning a number of face-to-face workshops for engineers and geoscientists working for companies interested in CCS in the Permian Basin, primarily the CO_2 Enhanced Oil Recovery (EOR) project operators. During the first year the PBCCS focused on organizing a board of directors, designing and developing the suite of products, and initializing and populating the website. At the end of that year, several stand-alone workshops were scheduled and promoted for delivery in Midland and Houston. In spite of a heavy promotion, there were few takers causing a rethinking of direction. It was determined that:

- There was a substantial reduction in CCS interest and sense of immediate need when no Climate Change bills were passed and the likelihood of any passing any time soon was remote.
- Attending a stand- alone course, priced to compete with SPE and industry offerings and requiring travel was too expensive.
- The focus of O&G industry personnel only, and in a relatively smaller geographic area substantially reduced the potential audience. That coupled with the competition from a number of groups in and beyond the Permian Basin offering courses in EOR and CCS.

In response, there was a shift in the focus audience and delivery of the information developed by PBCCS Center:

- Less emphasis on four-day extended workshops in favor of tailored workshops in conjunction with professional meetings (e.g. IOGCC and AAPG) and more emphasis on distance learning (e.g. the Open Course offering and the e-certificate online self paced education)
- Expanding the promotion of the products beyond oil and gas professionals to include the broader CCS community including the power generation sector, regulators, legislators, environmentalists, research scientists and academics.
- Shifting the delivery of information on all aspects of CCS away from the face-to-face short courses to more distance learning: website information, Open Courseware, electronic newsletter and e-Alert and the comprehensive, self-paced online CCS e-certification.

Outreach Activities

During November and December 2010 the project team began several initiatives to expand the audience. Some initiatives were brought to fruition, others are in progress. Information about the different initiatives and their status follows:

- Outreach to the Regulatory Community (Nationally and in Texas)
  Interstate Oil and Gas Compact Commission (IOGCC): IOGCC is a multi-state government agency that works to ensure America's oil and natural gas resources are conserved and maximized while protecting health, safety and the environment. IOGCC assists states in balancing a multitude of interests through sound regulatory practices. The the PBCCS Center coordinated with IOGCC to deliver a free "lunch and learn" session on November 15, 2010 preceding IOGCC's Annual Meeting in Tucson, AZ. Presentations focused on the true status of CCS field projects.

Texas Railroad Commission (RRC):. Victor Carrillo, Chairman of the Texas RRC, attended the IOGCC "lunch and learn" session. He indicated a willingness of the RRC to work with PTTC. RRC staff is currently considering a proposal for providing CCS training specifically for RRC staff.

- Outreach to the Carbon Storage and CO2 Flooding Industry
  Each year in December a CO_2 Conference Week is conducted in Texas. It consists of an EOR Carbon Management workshop in Houston, followed by a CO_2 Flooding Conference in Midland. This year's event was held from Dec. 6 – 10. PBCCS was a sponsor and exhibitor in both Houston and Midland to promote CCS training products. CO_2 Conference Week is the premier CO2 flooding event in the U.S.

- Outreach to the Broader Geological Community
  AAPG Annual Meeting, Apr. 10-13, 2011, Houston, TX. AAPG's Annual Meeting draws geologists from across the world, both from industry and academia. The shortcourse "CCS: The Reservoir – Characterization, Modeling and Monitoring" will be conducted in conjunction with this meeting and is scheduled for Saturday, April 9, 2011.
  AAPG Eastern Section Annual Meeting, Sep. 25-27, 2011, Washington, DC. The Reservoir short course above will also be conducted in conjunction with this sectional meeting.

- Outreach to the Power Sector
  PennWell, a magazine/conference firm, is well known within the O&G industry for its prestigious *Oil & Gas Journal*. PennWell has an even more prominent presence within the power sector, publishing 14 journals with 67,000 readers of their flagship *Power Engineering*. PBCCS plans to "rent" one-time usage of a PennWell "power sector" email list to promote a CCS webinar. Content will highlight O&G sector demand for CO_2 for CO_2 enhanced oil recovery, and aspects of the business model for the power sector and the CO_2 EOR industry to work together. Training opportunities through the e-certificate and workshop elements of the program will be stressed in the webinar. It is anticipated that power sector interest will be stimulated by the Environmental Protection Agency's announcement in December 2010 that it plans to propose standards to limit greenhouse gas emissions from refineries and electric generating plants.

CURRENT PRODUCT OFFERING AND SCHEDULE

Website

The Permian CCS Center is the starting point for all the products and industry information. http://www.permianbasinccs.org/ There you will find links to:

- Elements of the program – description and links to the webinars and e-symposia, research conference and e-certification program
- Calendar of CCS events – in-house and industry
- Newsletter and Tech alerts – past issues (3 to date) and Tech Alerts and sign area for both
- Recent CCS News of Interest
- Links to the other Regional CCS Training programs, the Regional Sequestration Partnerships, relevant CCS publications and references, other industry links, and an "about us" site for the three organizations

Webinars and e-symposia

For each of the scheduled one day short courses, there will be a one hour webinar with short course highlight broadcast in advance of the course. Topical webinars will be produced from time to time. Once they are over, the slides and audio will be available for free. Currently available are webinars "Overview of CCS" (Melzer and Rychel), "CCS Reservoir Characterization, Modeling and Monitoring", Melzer and Trentham, and "Next Generation CO_2-EOR" (Kuuskaa and Godec, Advanced Resources International)

AAPG has made available four Open Courseware CCS topics. They are free, but require registration. The topics are: "Carbon Capture and Sequestration: An Introduction," "Geological Models in CO_2 Sequestration," "CO_2 Supply, Demand; Legal and Regulatory Issues," and "CO_2 Separation, Compression, Transportation and Monitoring." To date, several hundred individuals have registered and completed one or more of these offerings.

Newsletter and E-Alert

Catch & Store, a four-page newsletter, is issued four times per year and is designed to provide oil and gas professionals with the latest information on new and existing sequestration technologies. Past issues have contained a topical column by Steve Melzer, in-depth articles on topics such as the Residual Oil Zone, by Bob Trentham, relevant news and upcoming events. The E-Alert provides information on upcoming PBCCS offerings, industry event and news flashes. Individuals can sign up to receive both the newsletter and e-alert electronically as issued.

e-Certification Program

The e-Certificate program has been developed as a self-paced online learning system. It is modeled after the AAPG Renewable Energy Certificate Course Program recently developed and executed. The content is similar to that offered in the One-Day Workshops. (See Table 1) It is structured as a four-module online course with each module containing four sessions that involve readings, multimedia, guiding questions and assignment for the enrollee to complete and email to the instructor. Each module is structured to require around 25 hours of study. The enrollee will receive feedback from the instructor, and upon successful completion of the course will receive the Certificate in Carbon Capture and Storage. PDH credits will be offered at an appropriate level. The Course Development Team for the Certificate Program consists of:

Subject Matter Expert (SME) to generate and structure content
Instructor (Generally the same SME)
Instructional Designer
Web Designer and Registrar

There are many benefits of Asynchronous e-Learning

- Can access content any time, any place
- Cohort start and stop (motivating)
- Can study when convenient
- Interaction with fellow students via discussion board
- Can supplement with synchronous productivity enhancers – Twitter, text-messaging, social networking
- Blend field-based work with at home / office / lab
- Accessible and convenient across time zones
- Instructor is available for direct interaction with the student

One Day Short Courses

The One-Day Workshops will each be offered once or more annually either as a stand-alone course or in conjunction with other professional meetings as described in the Outreach section above. Each will be tailored to the particular audience. The One-Day topics and abstracts are shown below. As an example, the flyer for the CO_2 Operations short course is shown in Figure 2.

CCS (and CO_2 Flooding) in the Permian Basin: A comprehensive, high level overview of Carbon Capture and Storage and CO_2 Enhanced Oil Recovery (EOR) related to the Permian Basin: Natural and Anthropogenic sources, capture technologies, transportation, saline and depleted oil reservoir injection, monitoring, EOR surface and downhole equipment, public policy and economics.

The Reservoir – Characterization, Modeling and Monitoring: A detailed discussion of the process of screening CCS candidate reservoirs, (saline and depleted oil), reservoir characterization (engineering, geological and geophysical modeling), modeling fluid injection and withdrawal, monitoring technologies and plume management and hybrid projects (saline with residual oil zones).

Optimized CO_2 Flooding Operations: CO_2 Enhanced Oil Recovery (EOR) is a special case of CCS as it generates a revenues stream (oil) before ultimately sequestering the CO_2. Because there is an operational phase before the storage phase in which the gas and produced water are recycled, there are a number of operations issues not found in storage in saline reservoirs. Material includes a discussion of anthropogenic sources, separation technologies (capture) and transportation.

Business of CO_2 Flooding and Moving Forward with CCS: CO_2 Enhanced Oil Recovery (EOR) projects are unique in that the cost to acquire the depleted field; replace wellbores, surface equipment; build the processing plant; and secure the CO_2 supply is considerable and paid up front. The revenue stream is unpredictable and stretches out over decades. Recognizing all the costs, contingencies and sensitivities is vital in planning the EOR project.

Week-long Short Course

Depending on demand, a week-long short course may be offered. The topics will essentially be the same as those listed in Table 1 describing the e-certification curriculum and the aggregate of the four one-day courses. In addition, it will include a field trip to one of the larger CO_2 EOR projects in the Midland-Odessa area.

Conclusions

The Permian CCS team has learned a number of lessons since the inception of the CCS training project:

- A one-day stand-alone workshop, particularly if it involves travel or hotel is a large economic hurdle for most attendees. A more efficient delivery of short course information and interaction is as an add-on to scheduled professional meetings or an in-house group.
- Most CCS professionals are busy and more amenable to distance learning with a number of online resources, including webinars, open courseware, e-Certification and other self-paced online resources.
- CO_2 EOR is a natural, technically feasible, and economic bridge to carbon capture and geologic storage. There is a strong need to get that message and the supporting technical education to those beyond the oil and gas industry, including power generators, regulators, legislators, environmentalists, educators and research scientists.

Table 1
e-Certification Topics

Module One	CCS (and CO_2 Flooding) in the Permian Basin • Course and Industry Overview • CO_2 Industry, Sequestration, and Public Policy • CO_2 Capture, Transportation and Injection • Monitoring, Modeling and Equipment Requirements
Module Two	The Reservoir: Characterization, Modeling and Monitoring • Reservoir Screening and Characterization • Reservoir Screening and Characterization (Continued) • Plume Modeling and Management • Hybrid Projects: Saline Formations with Residual Oil
Module Three	CO_2 Sources, Marketing and Legal and Regulatory • Natural Sources of CO_2 • Anthropogenic Sources • Marketing and Transportation • Federal and State Regulatory
Module Four	Capture, Transportation and Operations • CO_2 Capture • Transportation and Processing • CO_2 Flood Operations and Well Equipment • Monitoring, Reporting and Verification

Figure 1 – Highlights of CO_2 Operations Short Course
CCS in the Permian Basin
Optimized CO_2 Flooding Operations

Content (abstract): CO_2 Enhanced Oil Recovery (EOR) is a special case of CCS as it generates a revenues stream (oil) before ultimately sequestering the CO_2. Because there is an operational phase before the storage phase in which the gas and produced water are recycled, there are a number of operations issues not found in storage in saline reservoirs.

Learning Outcome(s): Attendees will know what facilities and operations considerations are required and unique to CO_2 EOR operations and how operations vary from operator to operator and field to field.

Who Should Attend? All professionals and technicians engaged in the operation of a CO_2 EOR project. Professionals and management involved in the screening, evaluation, and construction of a CO_2 EOR project.

Session One	CO_2 Flood Operations Overview Well site Surface Equipment Downhole Design and Considerations
AM Break	
Session Two	Operational Features Peculiar to CO_2 Injection Projects Examples of Operator Differences
Lunch	
Session Three	Review of Anthropogenic Sources and Existing and Future Capture Technologies Dehydration Processes Compression Facilities Sulfur Removal
PM Break	
Session Four	Recycle Plants Monitoring- MVA
Wrap-up	Attendee feedback (forms & overall verbal), certificates • Preview of next workshop in series