Department of Interior Bureau of Ocean Energy Management (BOEM)/Bureau of Safety and Environmental Enforcement (BSEE) Study:

Developing Environmental Protocols and Monitoring to Support Ocean Renewable Energy and Stewardship, Topic 5: Sub-Seabed Geologic Carbon Dioxide Sequestration Best Management Practices

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LONG-TERM GOALS

The primary goal of this project is to compile and evaluate all information needed to generate a Best Management Practices (BMPs) document for sub-seabed geologic carbon dioxide (CO2) sequestration (also known as geologic storage) in offshore areas subject to the U.S. Outer Continental Shelf Lands Act (OCSLA). The intent is for the BMPs to be used by the Bureau of Ocean Energy Management (BOEM) and the Bureau of Safety and Environmental Enforcement (BSEE) as the basis for future regulation of offshore geologic storage of CO2 on the outer continental shelf (OCS). The BMPs will incorporate as much as possible, existing U.S. regulations and relevant international policy. Suggestions will be provided to fill knowledge gaps and policy deficiencies identified during the study.

OBJECTIVES

There are scientific and technological objectives that need to be met to fulfill this multi-year effort. Primary scientific objectives are to (1) identify methodologies and data needed to assess the suitability of deep (1,000s of feet below the seafloor) geological strata underlying the OCS, referred to here as the subseabed, for long term storage of CO2, and (2) identify best methodologies for monitoring to show containment of injected CO2. Technological objectives include (1) adaptation of current offshore oil and gas practices, and (2) development of additional practices needed for safe and effective offshore geologic storage of CO2.

APPROACH AND WORK PLAN

The BMPs will begin with an introduction describing subseabed geologic carbon dioxide sequestration because details of this relatively new technology are not commonly known.

Key parties participating in this work are researchers at the Bureau of Economic Geology (BEG) and subcontractors from private industry, State government, and academia. The key individuals from BEG include the co-PI's, Rebecca Smyth and Timothy Meckel, Susan Hovorka, and Bob Hardage. Four of the original five subcontracting groups remain on the project:

1. Det Norsk Veritas (DNV) USA Inc.
2. Wood Group Mustang and Wood Group Kenny (Wood Group)
3. Texas General Land Office (GLO)
4. Dr. Richard McLaughlin, Harte Research Institute for Gulf of Mexico Studies at Texas A&M (HRI)
5. ~~Dr. David Adelman, The University of Texas at Austin School of Law (UT Law)~~

Work that would have been performed by UT Law is no longer needed or will be covered by other key personnel. Contract modification is in progress.

The revised subtopics, for which information will be included in the BMPs, are as follows:

<u>Subtopic 1</u> - site selection and characterization, including data collection, capacity assessment, and modeling requirements (BEG, DNV)

<u>Subtopic 2</u> - risk analysis (BEG, DNV, Wood Group, GLO, HRI)

- a. nearshore (State waters) and coastal habitats – Coastal division of GLO
- b. pipeline
- c. platform
- d. injection well
- e. seafloor (within area of estimated horizontal subseafloor CO2 migration, projected up to seafloor)
  - i. survey of benthic organisms
  - ii. ocean current identification
  - iii. archaeological resources
- f. subseafloor geological strata
  - i. overlying resources
  - ii. geohazards such as occurrence of hydrate formations

<u>Subtopic 3</u> – project planning and execution (BEG, Wood Group, GLO)

- a. project design and construction
  - i. nearshore
  - ii. pipeline
  - iii. platform
  - iv. injection well
- b. project operation, maintenance, and inspection
  - i. nearshore
  - ii. pipeline
  - iii. platform
  - iv. injection well

<u>Subtopic 4</u> – environmental monitoring (BEG, DNV, Wood Group, GLO, HRI)

- a. operational phase
  - i. nearshore
  - ii. pipeline
  - iii. platform
  - iv. subseafloor geological strata
  - v. injection well
- b. post-operational phase

i. seafloor
ii. subseafloor geological strata

Subtopic 5 - mitigation (BEG, DNV, Wood Group, GLO, HRI)

a. nearshore and coastal habitats
b. pipeline
c. injection well

Subtopic 6 – inspection and auditing (BEG, DNV)

a. pipeline
b. platform
c. injection well

Subtopic 7 – reporting requirements (BEG, Wood Group, GLO).

Much of this is already in existing regulations. As per Melissa Batum, this needs to include OSHA incidents, health and safety compliance monitoring, and operational/engineering/technical requirements

Subtopic 8 – emergency response and contingency planning (BEG, DNV, Wood Group, GLO)

a. nearshore (State waters), coastal habitats (will refer to existing GLO regulations)
b. pipeline
c. platform
d. injection well

Subtopic 9 – decommissioning and site closure (BEG, DNV, Wood Group, GLO, HRI)

a. pipeline
b. platform
c. injection well

Subtopic 10 – legal issues (BEG, GLO, DNV, and HRI)

a. liability and bonding
b. post-operational management/long-term stewardship issues

The primary contractor, Rebecca C. Smyth on behalf of the Bureau of Economic Geology at The University of Texas at Austin (BEG), has requested a no-cost extension for the project from the BSEE Contracting Officer. The proposed new schedule is:

December 31, 2012 – updated Draft Literature Survey submitted to BOEM for review
January 15, 2013 – report on analysis of existing BOEM and BSEE regulations
February 2013 – meeting with BOEM/BSEE in D.C. area
May 30, 2013 – subcontractor reports to BEG
August 15, 2013 – draft BMPs to external reviewers
September 15, 2013 – external reviewers comments due back to BEG
December 15, 2013 – draft BMPs and Data Gap analysis to BOEM
February 15, 2014 – BOEM to return BMPs comments back to BEG
March 15, 2014 – final Literature Survey to BOEM
March 31, 2014 – draft Final BMPs to BOEM
April 2014 – technology transfer with BOEM (Austin area)
June 15, 2014 – final report to BOEM

RESULTS

Introduction

Carbon capture and sequestration (CCS) is a process where CO_2 is captured from industrial facilities rather than being emitted to the atmosphere (e.g. coal-fired power plants), transported in a near-liquid (supercritical) phase to an appropriate location, and injected into deep geological strata for long term subsurface sequestration (also referred to as geological storage or GS). For over a decade the U.S. Department of Energy's National Energy Technology Laboratory, with assistance from private industry, has been funding research to support development of CO_2 capture technology, and to locate areas in the United States underlain by geological formations capable of long-term (hundreds to thousands of years) storage of CO_2. A suitable geological setting must have the following characteristics: (1) a permeable reservoir zone into which large quantities (millions of metric tons) of CO_2 can be injected without fracturing the host strata; this is the opposite of fracking, (2) a low permeability zone that will trap most of the CO_2 in the reservoir zone to prevent it's migration upward into drinking water zones or the atmosphere. Depth of the reservoir and confining system must be greater than ~2,600 ft below surface to maintain the CO_2 in a dense or supercritical phase.

Most of the worldwide, onshore experience with subsurface injection of CO_2 is in the Permian Basin of western Texas and southeastern New Mexico. Here oilfield operators have been injecting naturally occurring CO_2 (mostly produced from wells in southern Colorado and northern New Mexico) to enhance oil recovery since the 1970's. In this case CO_2 is a commodity that is produced and transported at cost so industrial operators recover and reuse as much as possible to maximize profits from increased oil production. However, much of the injectate CO_2 used for enhanced oil recovery (EOR) gets trapped in the subsurface; hence it cannot be recovered during routine separation of oil, gas, and brine at the surface. The inability to get CO_2 back out of the ground from EOR operations is referred to as incidental geologic sequestration. But "sequestration" of CO_2 is only valid if it is captured from an industrial (anthropogenic) source.

There are two types of sequestration of anthropogenic CO_2. One is incidental sequestration associated with CO_2 EOR, which is one part of a process called Carbon Capture Utilization and Storage (CCUS). The other type is sometimes called pure sequestration or just CCS. With CCS, CO_2 is injected at a suitable geologic setting where there has been little to no oil or gas accumulation, most likely due to a lack of hydrocarbon source rocks. Reservoirs used for CCS are called brine formations or saline aquifers.

Most of the detailed research at CCS and CCUS sites has been conducted in onshore settings to date. However researchers with the Gulf Coast Carbon Center at The University of Texas at Austin, Bureau of Economic Geology have identified much potential for offshore subseabed geologic storage of CO_2 in the western and central Gulf of Mexico and the western Atlantic offshore from the U.S. east coast (Meckel et al, 2012).

While there are many offshore facilities for producing oil from subseabed geological strata, offshore CO_2 EOR is not currently being practiced anywhere in the world. Offshore CCS is currently only being conducted by Statoil of Norway in the North Sea (http://www.statoil.com/annualreport2009/en/sustainability/climate/pages/ccs-ourhistory.aspx). England, Scotland, and the EU have been planning for subseabed GS of CO_2 in the North Sea for the not-too-distant-future. Australia has extensive plans for an offshore pipeline to source CO_2 injection below a barrier island. A schematic diagram of hypothetical offshore subseabed GS of CO_2 associated with CCS and CCUS is shown in fig. 1.

There are physical and economic advantages and disadvantages to CCUS and CCS, both onshore and offshore. Reasons to move forward with CCS and CCUS in both onshore and offshore settings include:

1. Reduce emissions of anthropogenic CO_2 to the atmosphere thereby mitigating global warming and ocean acidification
2. More fully utilize existing oilfield infrastructure to minimize environmental risk and impact at minimal cost
3. Increase energy security through enhanced domestic oil production.

One of the biggest concerns about conducting CCS and CCUS in onshore settings is the potential to impact drinking water resources. Careful planning and construction will be needed to assure that CO_2 injected into the subseabed will not leak at the seafloor. However, if a worst-case scenario is realized, there are no drinking water resources under the OCS.

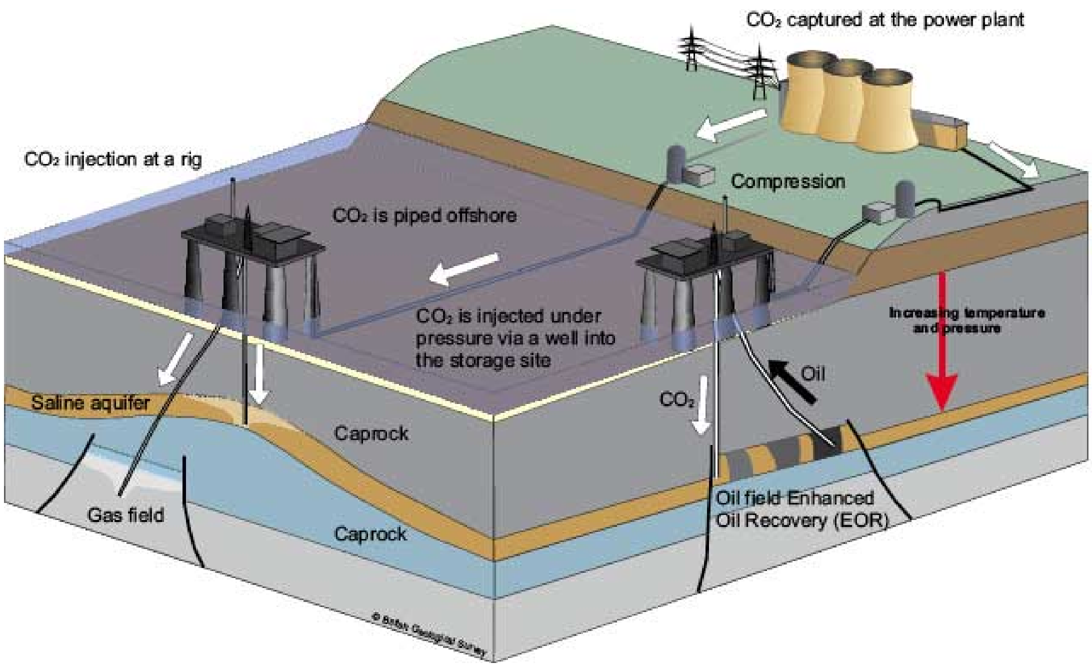

Figure 1. Schematic of offshore CO_2 injection operations. Transport/injection of CO_2 indicated by white arrows. Source of image: http://www.scotland.gov.uk/publications/2009/04/28114540/4

Other Results

The primary results to present at this time are the Literature Survey, an annotated version of which will be provided to the BOEM Contracting Officer's Representative by the end of December 2012. A current web version of the EndNotes reference databases for the project can be accessed via the following web address: http://www.myendnoteweb.com. The e-mail address to use for login is: rebecca.smyth@beg.utexas.edu. The password is: OCS_GS_beg4boem.

Since the BMPs will incorporate as much as possible, existing U.S. regulations and relevant international policy, it has been necessary to analyze pertinent documents. Issues that are in the process of being clarified include Department of Interior (DOI) jurisdiction over subseabed GS (for both CCS and CCUS) of CO_2 below the U.S. OCS. Results to date are that DOI should have jurisdiction under the Outer Continental Shelf Lands Act (i.e., Title 43, Chapter 29, Subchapter III – Outer Continental Shelf Lands, Section 1337(p)(1)).

IMPACT AND APPLICATIONS

National Security

National Security could be increased if offshore enhanced oil recovery using CO_2 becomes common practice and reduces our Nation's reliance on imports of foreign oil

Quality of Life

CCS and CCUS have the potential to reduce emissions of CO_2 to our atmosphere and possibly mitigate global warming.