An Update on Market Mechanisms for CO2: Issues and Opportunities

SECA 2008

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CO₂ Markets
Two Markets for Same Molecule

Commodity CO₂ for use in Enhanced Oil Recovery in the US and Globally

Sequestered CO₂ or Greenhouse Gas and resulting tradable offsets

Carbon Capture Storage (CCS) can readily optimize values from both markets
**CO₂ EOR**

Use of CO₂ for third step or tertiary recovery of oil in mature fields

Ongoing in West Texas last 35 yrs-well understood 1 billionth bbl produced this way December 2006

Exxon, Kinder Morgan, Chevron, Marathon, Apache, Anadarko, BP, Conoco-Phillips, EnCana, Oxy, Shell, Sandridge, Trinity, Ranger, CORE Energy and Chaparral all engaged in addition to Denbury

- North America currently produces ~250,000 bbl/d this way
- 89 billion bbls identified as potentially recoverable in US alone
- Current shortage of CO₂ makes expansion problematic and $120/bbl oil makes CO₂ valuable
- Hence massive commercial value today
10 year WTI/Brent Oil price ~$122.00/bbl. Value of CO₂ created by oil price. In US rule of thumb: 1000 cubic ft of CO₂ is valued as 2.0% of bbl of oil value. (Note: Rising EPC costs are lowering % rule of thumb)

$122. X 2.0% = 2.44/mcf, hence
*Implied value* delivered to wellhead: 19.3 X 2.44 = $47.10/US ton.

One US ton (19,300 cubic feet) will produce ~2.5 bbls of oil

*Crude oil quality, field characteristics, distance to/from markets and EPA definition will influence ultimate CO₂ value*
Physical CO₂ Pricing Matrix
Source: Steve Melzer-Melzer Consulting

Concepts of Added CO₂ Value in Proven CO₂ EOR Regions and Reservoirs Over That for an Unproven Reservoir and for a New Area

- "Mature" EOR Area
- "Unproven" EOR Area
- "Unproven" EOR Reservoir

Area Risk "Differential"
Unproven Reservoir "Differential"
OUTLOOK FOR CO$_2$-EOR

Recently completed “basin studies” of applying “state-of-the-art” CO$_2$-EOR in the U.S. indicate:

- Nearly 89 billion barrels of technically recoverable resource,
- From 4 to 47 billion barrels of economically recoverable resource.

Results are based on applying streamline reservoir simulation to 1,581 large oil reservoirs (two thirds of U.S. oil production).

Available on the U.S. DOE web site.
http://www.fe.doe.gov/programs/oilgas/eor/Ten_Basin-Oriented_CO2-EOR_Assessments.html
Geologic Sequestration

Expected to manage massive amounts of CO₂ output starting next decade

- Massive research work underway
- Most oil fields overlay target/desirable storage medium-brine aquifers
- No commercial value to date
Kyoto Market Size 2007  40 bln euros

Still dominated by the EU ETS

Distribution of 2007 traded volume (left) and financial value (right) across the main market segments.

Total volume: 2.7 Gt
- CDM primary: 22%
- CDM secondary: 13%
- EU ETS: 62%
- Other: 2%
- JI: 1%

Total financial value: €40bn
- CDM primary: 15%
- CDM secondary: 14%
- EU ETS: 70%
- Other: 0.5%
- JI: 1%

Source: Carbon 2008, "Post-2012 is now": Figure 2.2, page 4, 11 March 2008
European Exchanges 2007

Monthly EUA volumes transacted on exchanges. Last year’s figures in parentheses.

<table>
<thead>
<tr>
<th>Exchange</th>
<th>2007</th>
<th>2006</th>
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<tr>
<td>ECX</td>
<td>86.7%</td>
<td>(75.6%)</td>
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<tr>
<td>Powernext</td>
<td>5.5%</td>
<td>(13.3%)</td>
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<tr>
<td>Nord Pool</td>
<td>6.3%</td>
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<tr>
<td>EEX</td>
<td>1.4%</td>
<td>(3.1%)</td>
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<tr>
<td>EXAA</td>
<td>0.0%</td>
<td>(0.1%)</td>
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</table>

Source: Carbon 2008, “Post:2012 is now”: Figure 2.4, page 6, 11 March 2008
GHG Credits: EUA vs. US CCX 2008 values $33.20/tn vs. $3.90/tn

Intl CERs-$27.19/tn vs. US VERs $5-8/tn

Source: August 1, 2008 Point Carbon (www.pointcarbon.com) and August 2008 Chicago Climate Exchange
Note: August 1 Euro/Dollar rate 1.5567

http://www.chicagoclimatex.com/market/data/monthly.jsf
The Western Climate Initiative is a collaboration which was launched in February 2007 by the Governors of Arizona, California, New Mexico, Oregon and Washington to develop regional strategies to address climate change. WCI is identifying, evaluating and implementing collective and cooperative ways to reduce greenhouse gases in the region. In the spring of 2007, the Governor of Utah and the Premiers of British Columbia and Manitoba joined the Initiative. Montana joined in January, 2008 and Quebec moved from Observer to Partner status in April, 2008. Other US and Mexican states and Canadian provinces have joined as observers.

Cross Commodity Pricing

In Europe: Coal, fuel oil, gasoline, jet fuel, electricity and natural gas all have carbon figured into their valuations.

In the US only recently has the expected impact of carbon pricing begun to show up in energy pricing.

This impacts expected project economics and has had massive implications in the US.
CO₂-Enhanced Oil Recover (EOR)
CO$_2$ Overview

Well understood—but complex
Heavy capitalization
CO$_2$ shortage hampers increased utilization
Many undeveloped opportunities
Legal and Regulatory issues well covered in states where already implemented—less so in developing areas
Optimizes remaining oil in mature fields
Creates shareholder, local, state and federal wealth
Supports infrastructure costs/builds for sequestration
Carbon Dioxide Sequestration in Deep Brine Aquifers

Geologic sequestration in brine aquifers most likely route

Massive carrying capacity

Research underway globally – nominal commercial development

- Scope of subsurface impacted areas substantial
- Ownership issues of pore space diverse or undefined
- Ownership in turn defines short and long term costs, obligations and liabilities
- Public acceptance problematic
- Regulatory process nascent
CO₂ injectivity at Mountaineer

CO₂ injection should also be possible in shallower sandstone and carbonate layers in the region.

Rose Run Sandstone (~7800 feet) is a regional candidate zone in Appalachian Basin.

A high permeability zone called the “B zone” within Copper Ridge Dolomite has been identified as a new injection zone in the region.

Mount Simon Sandstone/Basal Sand - the most prominent reservoir in most of the Midwest but not desirable beneath Mountaineer site.
Additional Mediums

Unminable Coal Seams and ECBM

Depleted Natural Gas Reservoirs and EGR

Mineralization and Carbonization

Deep Sea Sediments

Feedstock for Added Value Products
<table>
<thead>
<tr>
<th>Partnership</th>
<th>Website/Contact Information</th>
</tr>
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<tr>
<td><strong>Big Sky Carbon Sequestration</strong></td>
<td>Montana State University <a href="http://www.bigskyCO2.org">http://www.bigskyCO2.org</a></td>
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<tr>
<td><strong>MRCSP</strong></td>
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<td><strong>The Plains CO2 Reduction Partnership</strong></td>
<td>University of North Dakota, Energy &amp; Environmental Research Center <a href="http://www.undeerc.org/pcor">http://www.undeerc.org/pcor</a></td>
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<td><strong>Southwest Partnership CO2 Sequestration</strong></td>
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<td><strong>West Coast Regional Carbon Sequestration Partnership</strong></td>
<td>New Mexico Institute of Mining and Technology <a href="http://www.southwestcarbonpartnership.org">http://www.southwestcarbonpartnership.org</a></td>
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<tr>
<td><strong>Westcarb.org</strong></td>
<td>California Energy Commission <a href="http://www.westcarb.org">http://www.westcarb.org</a></td>
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</table>
DOE National Sequestration “Atlas”
Released 2007
Global CCS-Geologic Sequestration Efforts Extensive

Special Report on Carbon Dioxide Capture and Storage pge 198 fig. 5.1
Environmental Protection Agency

40 CFR Parts 144 and 146
Federal Requirements Under the Underground Injection Control (UIC) Program for Carbon Dioxide (CO₂) Geologic Sequestration (GS) Wells: Proposed Rule
NRDC “Win – Win” CO₂ EOR and Geologic Sequestration

Tapping into Stranded Domestic Oil: Enhanced Oil Recovery with Carbon Dioxide Is a Win-Win

Americans are demanding measures that will relieve the pain they are feeling at the pump today. The country has a significant, untapped win-win opportunity to stimulate our economy and reduce our dependence on imported oil while actually helping to protect wild places and reduce global warming pollution: a process known as carbon dioxide enhanced oil recovery (CO₂-EOR). According to industry research CO₂-EOR would give America access to large, domestic oil reserves—potentially more than four times the proven U.S. reserves, or up to 10 full years of our total national consumption. But without the stimulus of climate protection legislation, CO₂ for oil recovery is likely to remain in short supply and most of this domestic oil resource will stay in the ground.

CO₂-EOR Can Produce More

Oil Right Now

Enhanced oil recovery using carbon dioxide offers an immediate, credible, and effective way to produce more oil right here at home, from unused fields that have already been drilled and have much of the needed infrastructure already in place. CO₂ injection can increase oil production as much as a few hundred to two years—within weeks of the time needed to discover, bring online, and develop a viable new oil field. And in the EOR process, large quantities of CO₂ from industrial sources can be captured underground rather than emitted to the atmosphere, reducing global warming pollution.

“Stranded oil” is oil that is left in the reservoir after conventional recovery techniques have been completed. Injecting CO₂ multiflashens stranded oil, driving it to the wellbore and making it recoverable. The CO₂ “flooding” used for enhanced oil recovery can result in a recovery of up to 20 percent more of the original oil in place. Nationally, a minute 300 billion barrels of oil remains stranded, of which 95 billion barrels could be technically recoverable according to oil and gas industry research and engineering firm Advanced Resources International. As much as 45 billion barrels of “stranded oil” from just over 1,000 existing fields would be economical to produce at a price equal to $60 per barrel.
Locations
US CO₂ Systems

U.S. CO₂ Oil Production
Approximately 250,000 Bbls/d

Eastern Gulf Coast
7 Fields
+/- 20,000 Gross Bbls/d
Operator: Denbury
CO₂ Source: Natural
Permian Expansion
PERMIAN BASIN CO₂ INFRASTRUCTURE

Key Considerations:
- Significant EOR projects left to implement
- Current CO₂ deliverability ~1.5 Bcfepd

* Kinder Morgan CO₂ website
New CO₂ Source: Denbury’s Perspective
CO₂ EOR-Sequestration: Denbury’s Perspective

CO₂ Projects - Total Potential Tertiary Oil Reserves (1)

Phase 1
82 MMBbls

Phase 2
77 MMBbls

Phase 3
41 MMBbls

Phase 4
31 MMBbls

Phase 5
36 MMBbls

Phase 6
26 MMBbls

Phase 7
Hastings Field
50 - 90 MMBbls (1)

Phase 8
Seabreeze Complex
30 - 40 MMBbls (1)

(1) Probable tertiary oil reserves as of 12/31/06 based on 10% to 17% recovery factors. Hastings Field is under contract but not owned.
Texas

Western - Permian Basin - well developed

Eastern - currently being “explored” for CO$_2$ -EOR options and opportunities ie: Exxon-Mobil and Eastman Chemicals

Gulf Coast - currently being “explored” for CO$_2$ -EOR options and opportunities ie: Denbury’s “GreenLine” to Hastings, DOW-Hunton at Freeport, Kinder Morgan, NRG and Eastman Chemicals
**CO₂ Market Analogs**

- Exxon CO₂ sales to Anadarko etc +250 mmcf/d – ongoing
- PetroSource CO₂ Sandridge + OXY participation
- Coffeyville CO₂ sales to Kansas and Oklahoma EOR operators + 2000 tpd – in negotiations
- Basin Electric/Dakota Gasification CO₂ sales to Encana +225 mmcf/d

- Illinois – Tenaska - in negotiations, Power Holdings - Kinder Morgan
- Kentucky – Cash Creek - ?
- Indiana – Duke’s Edwardsport – CO₂ in negotiations
- California – Hydrogen Energy CO₂ to be utilized by OXY at Elk Hills
- Oklahoma – AEP – SemGroup’s “SemGreen” contracted for CO₂

- Enhance Energy to build Alberta pipeline loop --in development
- Spectra Pipelines working on CO₂ pipeline feasibility in BC
- Atmos Energy and El Paso working on CO₂ pipeline-EOR options
Texas’s Interest In CO$_2$-EOR

1973  Texas Produced  3,444,000 bbl/d

2006  Texas Produced  934,000 bbl/day

2007  Texas By CO$_2$-EOR ~200,000 bbl/day
Texas HB 3732

CCS Incentives and Legislation: The State of Texas has since 1989 had in place an *EOR Severance Tax Incentive* scheme ensuring a reduced tax rate (2.3% on the market value of oil) for the first 10 years of CO₂ -EOR production. This is one-half of the standard rate. Recently the Legislature also adopted an *Advanced Clean Energy and EOR Tax Reduction* Bill (effective from September 1, 2007) which reduced the effective tax rate for use of anthropogenic CO₂ to 1.15% for the first 7 years of CO₂ -EOR production.

- The HB 3732 includes, i) recognition of CCS with EOR as a “qualifier” for Clean Energy, ii) provides severance tax reductions for anthropogenic CO₂-EOR projects, and iii) provides Ad Valorem Tax Abatement for CO₂ capture (see also HB 1967 – covering open access through CO₂ pipelines).
- Furthermore, to encourage the development of advanced clean energy projects in an environmentally protective manner the *State Energy Conservation Office (SECO)* is charged with making grant awards and loan guarantees totaling $20 and $10 million respectively on a bi-annual basis through to 2020. The SECO can finance up to 50% of the total amount invested by industry.
- Finally, the Texas FutureGen consortium led by the *Bureau of Economic Geology* and the *Texas Railroad Commission* has set a precedence that the State may take on longer-term ownership and liability of the CO₂, independent of future EPA rulings possibly defining CO₂ as pollutant.
The Texas Carbon Capture and Storage Association ("TxCCSA") is a non-profit industry association advocating for policies that support the development of a commercial CCS industry in Texas and promoting energy security through increasing environmentally responsible fuel production in Texas. We seek the growth and commercialization of the CCS industry through market-based policies and incentives that support private sector investment.

Goals

• Promote market-based policies that recognize the practical and economic benefits of CCS.

• Educate state and local stakeholders regarding the CCS industry, including CO₂ for enhanced oil recovery (EOR) and its national security and environmental benefits.

• Promote practices, programs and policies that position Texas in the forefront of clean energy and energy security efforts.

• Promote the development of CO₂ storage and injection methods that contribute to recovering oil in place from existing oil and gas reservoirs.

• Recognize geological storage of CO₂ as an acceptable emissions reductions methodology that has national security (as related to energy independence) as well as environmental benefits.

• Work to endorse CO₂ for EOR as a CCS activity under existing and future regulatory protocols.

• Identify business spin-offs and promote policies that attract foreign and new market-based CCS business opportunities to Texas.

• Inform members about policy, legal, regulatory and technical developments related to CCS through information sharing and analysis.

• Work closely with sources and users of coal, chemical companies, refineries, manufacturing, and producers, transporters and users of CO₂, to develop CCS technology and practices.

• Work closely with legislators, state agencies and state officials on policies that promote CCS and energy independence.

• Develop and promote adoption of a voluntary CCS certification and permitting program through the Texas Railroad Commission and Texas Commission on Environmental Quality.

• www.txccsa.org
Carbon Capture and Storage (CCS) is driven by growing interest in managing carbon dioxide emissions, and to date it is considered to be one of the most important options in a portfolio of technologies that could be used in CO₂ management. The NACCSA and its members will work to educate stakeholders in the United States and Canada about the technological readiness of CCS with the goal of helping to create a framework that supports the development of a CCS industry, including CO₂-EOR where those opportunities exist. The association will also work closely with its members to inform them about policy, legal, regulatory and technical developments related to CCS through information sharing and analysis.

- “The NACCSA will fill a critical need for cross-industry information and policy in the ongoing Carbon Capture and Storage discussion,” said Elizabeth “Libby” Cheney who serves as the NACCSA Chairperson from Shell Oil Company.

- "We have a strong commitment to the development of a commercial CCS industry from each of the current members and we welcome new companies to join us in our efforts,” said John Tombari, association Vice-Chairperson, from Schlumberger.

- About the North American Carbon Capture & Storage Association
  Founded in September 2007, the non-profit North American Carbon Capture & Storage Association (“NACCSA”) supports the development of a commercial CCS industry in the United States and Canada.

- On October 24, 2007, the North American Carbon Capture & Storage Association was launched. Alston & Bird has the privilege of serving as counsel to the Association.
Blue Source Overview
Blue Source Market Position

Overview

The company’s senior management developed, constructed and/or operated 5 of the last 6 anthropogenic CO₂ pipelines built in North America in the last 20 years.

Blue Source owns the largest portfolio of Greenhouse Gas (GHG) verified emission reduction credits, or “VERs” in North America.

Blue Source is owned 50/50 by its founders/senior management and First Reserve Corporation - the leading private equity firm specializing in energy.

Blue Source has $1+ billion (equity/debt) investment sources for project development in GHG ERs and CO₂ infrastructure projects.

The company has two primary business segments: a physical CO₂ asset development group and a GHG VER portfolio development group
Blue Source CO₂ Activities

Develop Infrastructure Linking Sources & Sinks
Sources: Gas treating plants, ethanol plants, gasification projects, including CTL and IGCC power plants, hydrogen plants, cement plants, fertilizer plants and power plants (incl. retrofits)
Sinks: EOR, deep saline aquifers, depleted oil & gas fields, depleted CO₂ reservoirs, and ECBM

Acquisitions – Pipelines and CO₂ producing or storage assets
In service Today – LaVeta gas processing

Focus Project: Coffeyville Resources
~38,000 Mcf (2,000 tonnes/day) of anthropogenic CO₂
Proven, reliable source (PetCoke advantage) since 2003
Project scope includes compression and pipeline(s) to EOR markets
Sequestration alternatives considered
Blue Source is marketing CO₂ and VERs
Carbon Credit Portfolio

Blue Source’s Verified Emission Reduction (VER) portfolio is the largest in North America, with project pipeline including:

- Carbon capture and storage
- Fuel switching
- Industrial gases (N2O, etc.)
- Renewable energy
- Energy efficiency
- Transportation
- Landfill gas
- Coal mine methane
- Wastewater treatment
- Biomass
- Agriculture/Forestry
CO₂ Pipeline Knowledge & Experience

Pipeline Design Experience
Land & Underwater
Critical Specifications (for gas contaminants)

Compression Selection & Specifications

Construction Management Experience
Worked with pipeline contractors having both land and underwater experience, i.e. Gulf Interstate Pipeline and Antares Offshore
Contact Information

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