



**3rd CSLF Workshop on Capacity Building  
for Carbon Capture and Storage (CCS)  
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# ***“The Economics of CCS for EOR: Market Issues”***



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# “CO<sub>2</sub> will Swamp EOR”

- But in Texas we have ~ 25 billion barrels of recoverable oil primarily in the Permian Basin, East Texas and the Gulf Coast...that only CO<sub>2</sub>-EOR will effectively reach...  
*Of course this all under ideal conditions!*
- What if you priced that oil at \$50/bbl? \$1.25 trillion dollars of gross value...
- What is that worth to recover?
- And we are now functionally at full capacity and utilization of CO<sub>2</sub> supply....moving ~30 millions tons yearly to EOR...
- How much sequestration would 25 billion bbls of production create? With rule of thumb EOR economics about 10 giga tons.... 2.5 bbls with 1 ton CO<sub>2</sub>

# Texas's Interest In CO<sub>2</sub>-EOR

[www.rrc.state.tx.us/divisions/og/statistics/production/ogisopwc.html](http://www.rrc.state.tx.us/divisions/og/statistics/production/ogisopwc.html)

[www.unconventionalfuels.org/images/CO2EOR\\_Fact\\_Sheet.pdf](http://www.unconventionalfuels.org/images/CO2EOR_Fact_Sheet.pdf)

[www.fossil.energy.gov/programs/oilgas/eor/index.html](http://www.fossil.energy.gov/programs/oilgas/eor/index.html)

[www.tpuc.tx.us](http://www.tpuc.tx.us) Report to 80<sup>th</sup> Texas Legislature 2006: The Need for Transmission and Generation...

- 1973 Texas Produced 3,444,000 bbl/d
- 2006 Texas Produced 934,000 bbl/day
- 2007 Texas by CO<sub>2</sub>-EOR ~200,000 bbl/day
- National CO<sub>2</sub>-EOR recoverables 88.4 billion bbls-Texas ~25 billion
- 2007 71 gw installed power generation 62 gw under firm load --- increases to 68 gw of firm load by 2011 adds 14 gw of new generation

# All States but Texas

- If CO<sub>2</sub>-EOR-Sequestration is viable a utility has three issues---very large issues:
- Shareholder expectations of more profits—or unacceptable risks
- Regulators expectations of more income to offset ratepayers costs—or unacceptable risks
- Ratepayers expectations of lowering CO<sub>2</sub> and sharing in the returns for CO<sub>2</sub>-EOR at a lower cost---or getting stuck with unacceptable costs
- ***Texas is deregulated—each power generator is incentivized to find the most efficient way to run a profitable business---he no longer has a ratebase to pass his costs along.....and we have a lot of CO<sub>2</sub>-EOR potential.***

# Economic Considerations

## Costs

- CO<sub>2</sub> commodity cost
- Transport and compression infrastructure-volumes and distances-EPC costs rising *regardless for brine aquifers or EOR*
- Energy budget for capture, compression and transport-energy costs rising-*regardless for brine or EOR*
- Purity at separation for EOR requirements-higher purity requirement means greater separation expense
- Surface infrastructure costs
- Subsurface infrastructure costs
- Monitoring, measuring and verification for sequestration
- Regulatory compliance for EOR and Sequestration
- Legal costs-perfecting surface and sub-surface lease and pore space ownership issues

## Value Returns

- Crude oil value-quality and transport to market
- Carbon credit generation if applicable
- Geologic asset value—increasing provable producible reserves and confirmed pore space valuation for sequestration

# Issue: CO<sub>2</sub> a Commodity, Pollutant or Hazardous Waste?

- **Commodity** – commercial value for use in EOR/EGR-already active
- **Pollutant** – *US Recent Supreme Court ruling that EPA must make this determination--Crude Oil, Coal and Natural Gas-are if mis-managed*
- **Hazardous Waste** - makes handling, injecting and sequestering far more expensive.  
Encumbers EOR/EGR commercial opportunities in the US coupled with sequestration.

*The “definition” of CO<sub>2</sub> in the US or any other region will have a profound impact on future costs associated with enhanced oil recovery and geologic sequestration. May negatively influence public acceptance of geologic sequestration and would change the complexion of future liabilities for emitters and pore space owners, let alone the current CO<sub>2</sub>-EOR operations.*

# Current Issues

- Growing need for more CO<sub>2</sub> for EOR in the US-CCS most likely route already use 30 million tpy in West Texas
- Global mechanisms to recognize geologic sequestration
- Monitoring and verification for sequestration protocols need to be firmly and universally established
- Present and future liabilities of geologic sequestration need to be defined
- Formal framework for GHG mitigation via geologic sequestration and valuation of tradable credits in the US
- Determination of GHG credits derived from CO<sub>2</sub> driven EOR and sequestration--CDM review 2009(?)
- Applications developing in most oil and gas production areas: North America, China, Russia, ME, Central Europe, Latin America, Africa

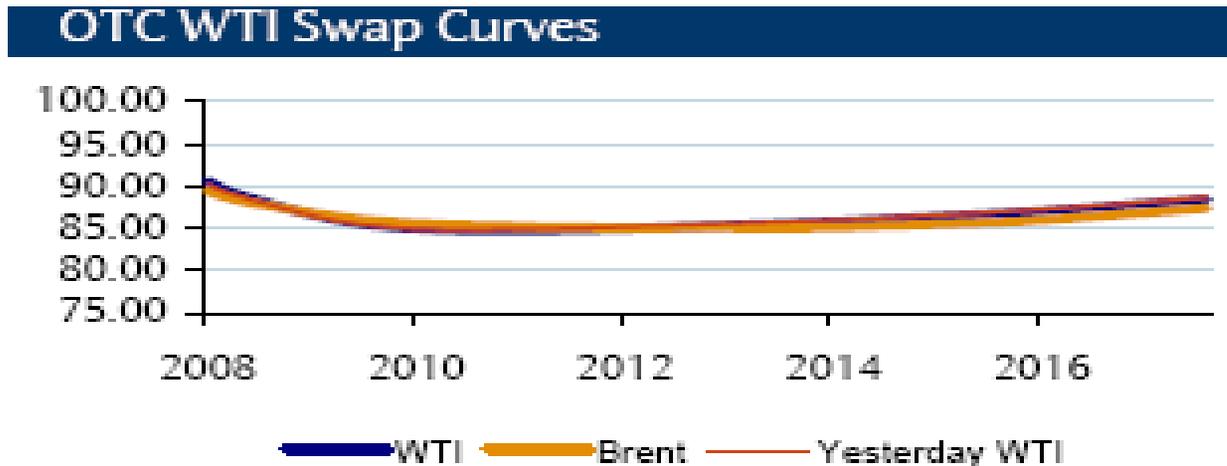
# **Commodity CO<sub>2</sub>, GHG Markets, Issues and Drivers**

# Two Markets for Same Molecule

- Commodity CO<sub>2</sub> for use in Enhanced Oil Recovery in the US and Globally
- Sequestered CO<sub>2</sub> or Greenhouse Gas and resulting tradable offsets
- Carbon Capture Storage (CCS) can readily optimize values from both markets

# Brent and WTI forward Swap/Price Curve

January 18, 2008 Barclays daily market report



10 year WTI/Brent Oil price ~\$88.00/bbl. Value of CO<sub>2</sub> created by oil price.  
In US rule of thumb: 1000 cubic ft of CO<sub>2</sub> is valued as 3.0% of bbl of oil value.  
(Note: Rising EPC costs are lowering % rule of thumb)

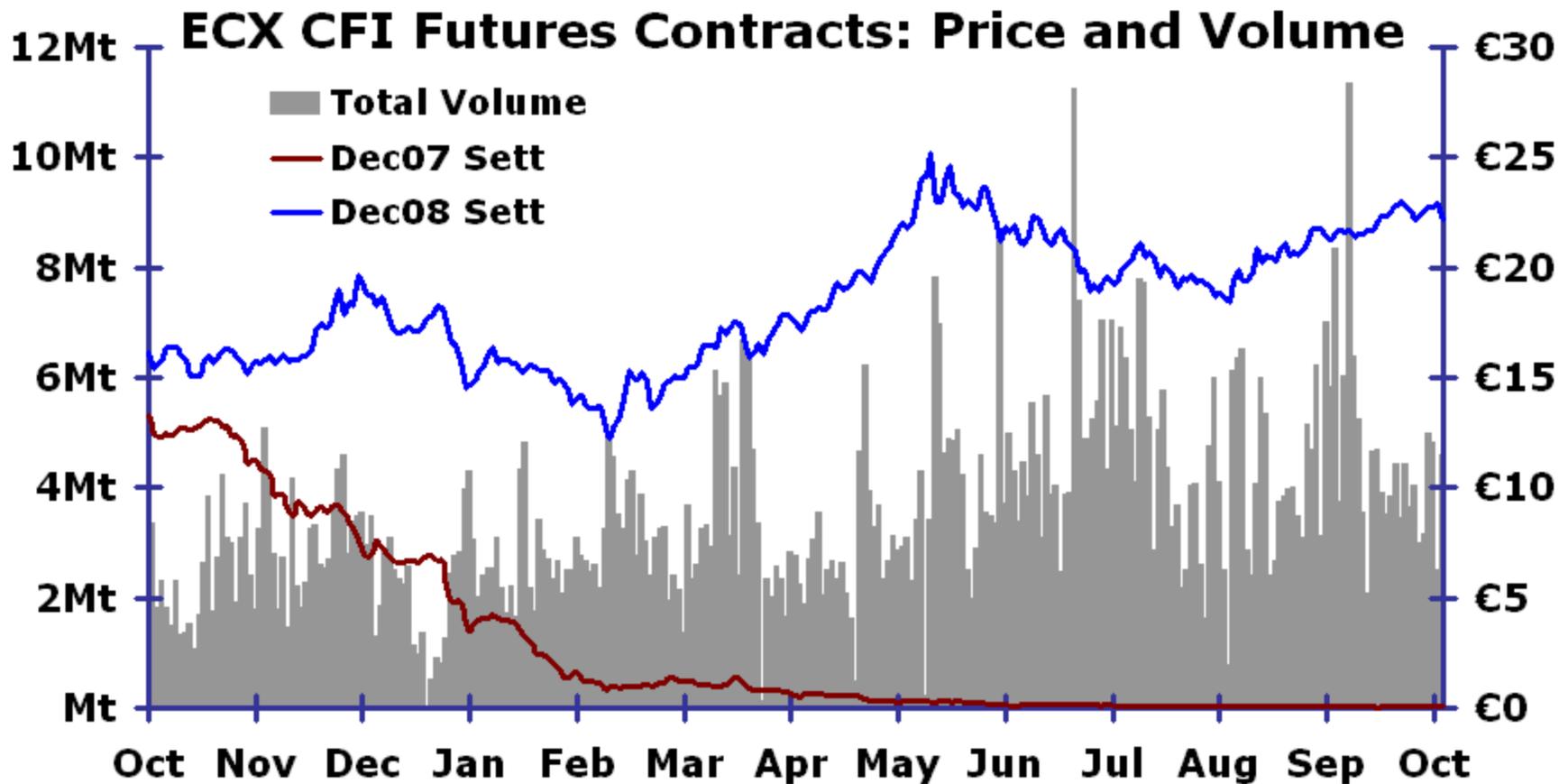
\$88. X 3.0% = 2.64/mcf, hence

*Implied value* delivered to wellhead: 17.4 X 2.64 = \$45.936/US ton.

One US ton (17,400 cubic feet) will produce ~2.5 bbls of oil

Crude oil quality, field characteristics, distance to/from markets will influence ultimate CO<sub>2</sub> value.

# Recent GHG Credit Markets



# GHG Credits: EUA vs. US CCX

## 2008 values = \$32.56/tn vs. \$2.30 tn

source: Jan 18, 2008 Point Carbon and Jan 2008 Chicago Climate Exchange

### CCX CFI Monthly Summary

Point Carbon  
EUA OTC closing price

18 January 2008  
EUA DEC 2008  
€22.28 ▲0.10



Jan 2008 Show for Selected Date

#### Carbon Financial Instruments - Jan 2008\*

Product	Vintage	High	Low	Close	Change	Volume
CFI	2003	\$2.30	\$1.85	\$2.30	0.20	104,400
CFI	2004	\$2.30	\$1.85	\$2.25	0.30	74,500
CFI	2005	\$2.25	\$1.85	\$2.25	0.30	71,500
CFI	2006	\$2.25	\$1.90	\$2.25	0.15	149,700
CFI	2007	\$2.25	\$1.90	\$2.25	0.35	212,900
CFI	2008	\$2.25	\$1.90	\$2.25	0.35	29,000
CFI	2009	\$2.25	\$1.90	\$2.25	0.35	18,000
CFI	2010	\$2.25	\$1.90	\$2.25	0.35	20,500
<b>Total Electronically Traded Volume</b>						<b>680,500</b>

Price Units: Per metric ton of CO<sub>2</sub>  
Volume: Electronically traded volume reported in metric tons CO<sub>2</sub>  
Change based on previous month's closing price

\* - This report is based on trading through 01/18/2008

<http://www.chicagoclimatex.com/market/data/monthly.jsf>

# GHG Markets

- Commodity type mechanisms evolving in rest of world
- Diverse participation
- Price transparency on five recognized exchanges-more developing
- Cross commodity interplay with power, gas, oil, coal and emissions markets taking place daily, now embedded in energy complex
- Knowledge base expanding

# Global GHG Market Growth

- 3.2 million tonnes trade across all exchanges in Europe on Friday August 3, 2007--considered a “slow” day
- By end of May 2007 \$11.8 billion had been raised in carbon trading funds
- Five primary trading exchanges (EEX, ECX, EXAA, NordPool, BlueNext) with Hong Kong, Dubai, NYMEX, Japan and others following
- CDM/JI markets
- OTC-bilateral markets
- Additionally CCX, AUS NSW and Canada
- National registries and trading systems expanding
  
- 2006-- **1.6 billion tonnes** of CO<sub>2</sub>e traded with a value of over **\$31 billion US** or € 22.5 billion outside the US
  
- 2007--**2.7 billion tonnes (64% higher than 2006)** of CO<sub>2</sub>e traded with a value of € 40.4 billion Euros or **~\$60 billion US** (Point Carbon Jan 18, 2008)
  
- Late Jan 2008 Belgium-Dutch Bank “Fortis” predicted € 48/tne credit value past 2012
  
- **“0” tonnes attributed to geologic sequestration!**

# Conclusion

- Geologic sequestration and CO<sub>2</sub> driven EOR moving to center stage—initial oil recovery funds primary development
- US Federal and State CO<sub>2</sub> legislation on front burner
- UNFCCC-CDM acceptance developing for GHG credits creation
- Commercial activity engaged
- NGO activity engaged
- US, Europe and other's energy needs supported
- China has substantial active interests and potential
- Arabian Gulf Countries engaged
- Northern and Central Europe engaged
  
- ***Massive market with long life cycle***

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