



11th Annual Stakeholders' Briefing

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Luncheon Keynote Address: The CO₂-EOR Potential from Residual Oil Zones and Why it so Important

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Today

- The “Trifecta” of very cheap fossil fuels
- Carbon
- CO₂ EOR the “ROZ” and why it is so important

The “Trifecta” Of Very Cheap Fossil Fuels

US Coal's Dramatic Change



Natgas (HH) Collapse

Historically, Natural gas reached an all time high of 15.39 in December of 2005 and a record low of 1.02 in January of 1992.



| Actual | Previous | Highest | Lowest | Dates | Unit | Frequency |
|--------|----------|---------|--------|-------------|-----------|-----------|
| 1.74 | 1.72 | 15.39 | 1.02 | 1990 - 2016 | USD/MMBtu | Daily |

www.tradingeconomics.com/commodity/natural-gas

Crude Oil's Dramatic Crash



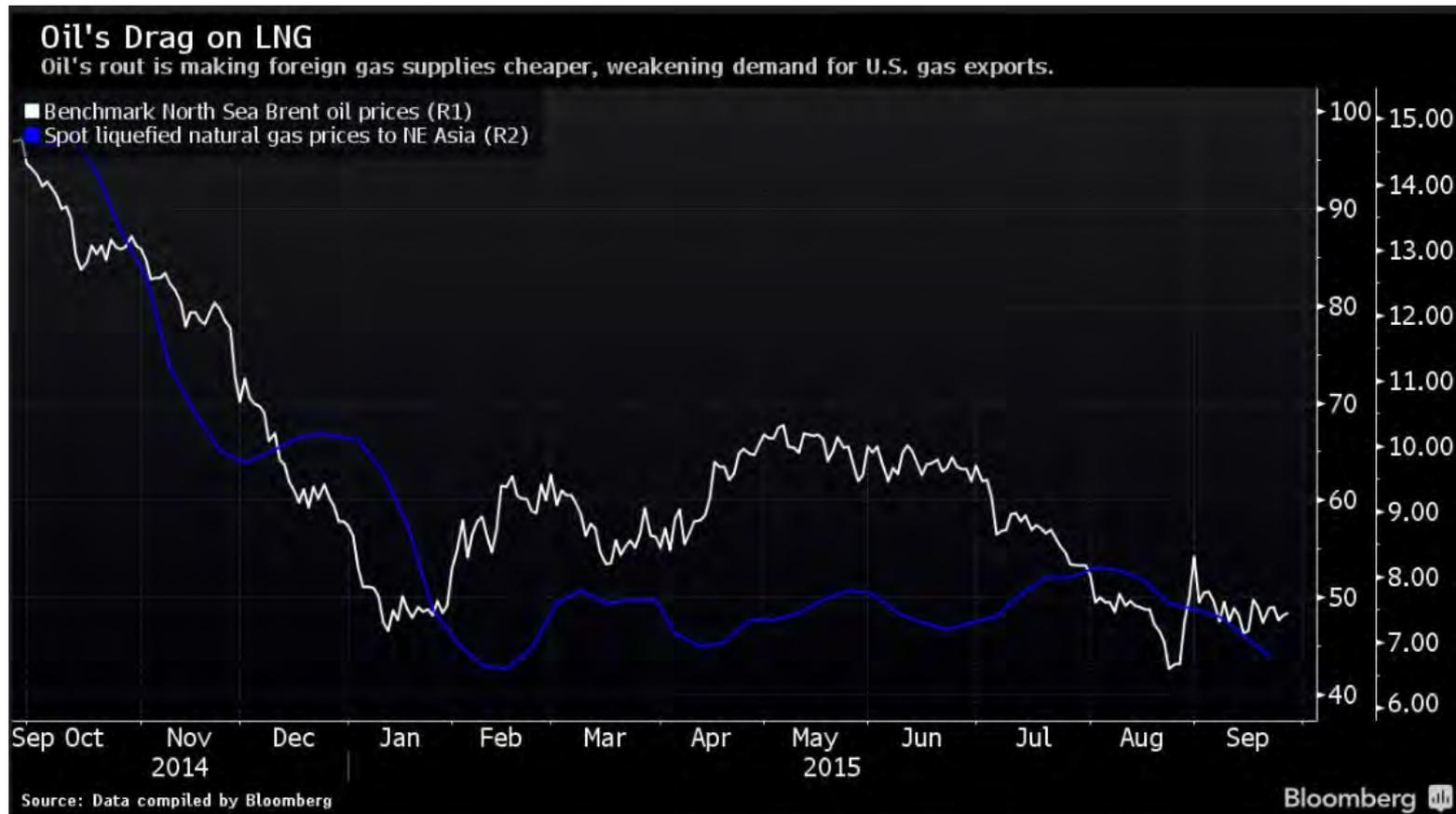
| Actual | Previous | Highest | Lowest | Dates | Unit | Frequency |
|--------|----------|---------|--------|-------------|---------|-----------|
| 36.97 | 36.45 | 145.31 | 1.17 | 1946 - 2016 | USD/BBL | Daily |

www.tradingeconomics.com/commodity/crude-oil

Oil and LNG

Bloomberg 9-23-15

<http://www.bloomberg.com/news/articles/2015-09-25/oil-s-killing-u-s-power-generators-and-they-don-t-even-burn-it>



India Poised To Replace China As The World's Center Of Oil-demand Growth

- **3-7-16 India seen setting oil-demand growth pace**
- India is poised to replace China as the world's center of oil-demand growth, according to authors of a study published by the [Oxford Institute for Energy Studies](#).
- As growth of Chinese oil demand slows, India's is increasing, note Amrita Sen, chief oil analyst of [Energy Aspects](#), and Anupama Sen, senior research fellow at the Oxford Institute.
- And India's development has characteristics similar to those of China 10-15 years ago, the analysts say.
- A demand surge comparable to China's of the early 2000s would strengthen an oil market now struggling with surplus.
- **Demand trends**
- Chinese oil-demand growth has retreated to below 300,000 b/d/year from an average exceeding 500,000 b/d/year in the 10 years prior to 2015. In response to governmental efforts to rebalance the economy, China's economic growth has slowed.
- Indian oil demand, meanwhile, grew by 300,000 b/d last year after rising by 100,000-150,000 b/d/year in the previous decade.
- "This jump in demand reflects a number of underlying dynamics at play, which indicate that India's oil demand may be on the verge of 'taking off,'" write the authors.
- They add, "Indian oil demand is demonstrating trends that were visible in China around a decade or a decade and a half ago during the country's industrialization 'boom.'"
- The pace of growth in Indian demand for oil products, especially gasoline, is rapidly approaching that of China just before that country's rapid expansion.
- And India's car ownership as a function of population has reached the Chinese level of a decade ago while its per-capita income on a purchasing power parity basis has "breached the threshold beyond which motorization rapidly ensues."

Japan Environment Ministry's Coal Plant Reversal Casts Doubt On CO₂ Pledge

- 2-22-16 The environment ministry issued rare objections to five new coal-fired stations last year but has been pushed by the powerful industry ministry to accept voluntary steps by power companies to curb emissions.
- ***As Japan gets ready to open up its power retail market in April, companies are rushing to build 43 coal-fired plants or 20.5 gigawatt of capacity in coming years, about a 50 percent increase.***
- "Global opinion is increasingly shifting away from coal but Japan's environmental ministry is switching sides to approve new coal power plants. This runs counter to the global action," said Kimiko Hirata international director of lobby group Kiko Network.
- As part of the agreement, the Ministry of Economy, Trade and Industry is set to tighten its rules over coal-fired power stations from April 1, including issuing new non-binding requirements on the heat efficiency of new and existing plants to curb emissions.
- ***Coal is attractive because it is the cheapest fossil fuel source and prices have slumped in recent years. Japan has turned to the energy source in record amounts since the Fukushima disaster in 2011 led to the shutdown of reactors.***
- A group of 36 power companies, which supply 99 percent of the country's electricity, have also formed a new body to take measures to trim emissions and meet the industry's voluntary goal to cut emissions by 35 percent in 2030, compared with 2013.

IMF: The Price of Oil And The Price Of Carbon

<http://blog-imfdirect.imf.org/2015/12/02/the-price-of-oil-and-the-price-of-carbon/>

- “The human influence on the climate system is clear and is evident from the increasing greenhouse gas concentrations in the atmosphere, positive radiative forcing, observed warming, and understanding of the climate system.” —Intergovernmental Panel on Climate Change, Fifth Assessment Report
- Fossil fuel prices are likely to stay “low for long.” Notwithstanding important recent progress in developing renewable fuel sources, low fossil fuel prices could discourage further innovation in and adoption of cleaner energy technologies. The result would be higher emissions of carbon dioxide and other greenhouse gases.
- ***Policymakers should not allow low energy prices to derail the clean energy transition. Action to restore appropriate price incentives, notably through corrective carbon pricing, is urgently needed to lower the risk of irreversible and potentially devastating effects of climate change.***

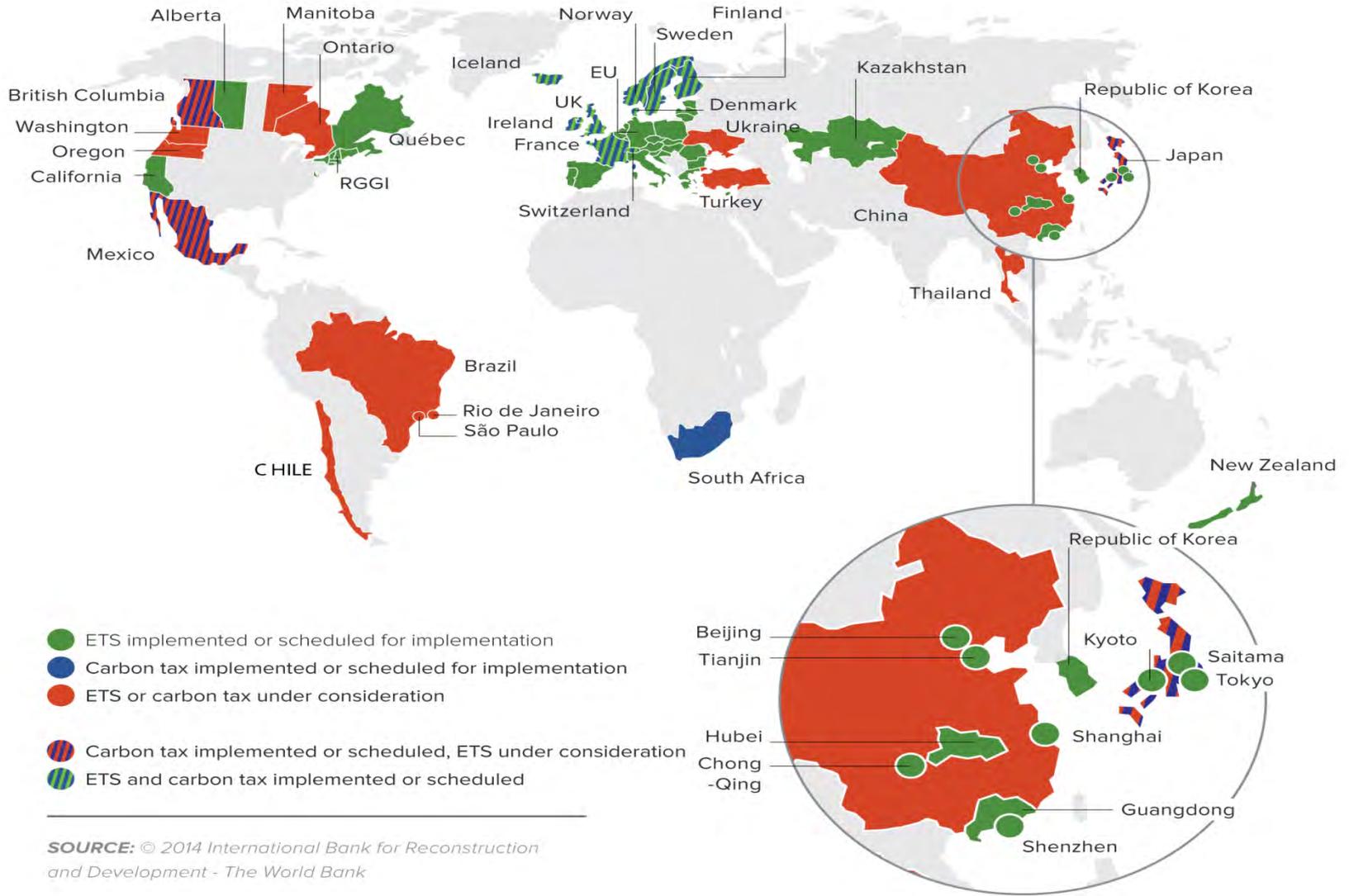
What Fossil Fuels May See

Innovative ways to make fossil fuels low carbon and competitive to renewables

- Pricing/policy parity
- New realistic tax incentives
- New financing vehicles
- Feed in tariffs for clean fossil fuel energy
- Contracts for differences for clean fossil fuel energy

Carbon

International Carbon Markets



SOURCE: © 2014 International Bank for Reconstruction and Development - The World Bank

China Announces World's Largest Cap and Trade Program

<http://news.discovery.com/earth/global-warming/china-announces-worlds-largest-cap-and-trade-program-150927.htm>

- Sept 24, 2015 Chinese President Xi Jinping announced that China will develop a carbon trading system as a way to reduce the country's greenhouse gas emissions.
- The announcement, made jointly with U.S. President Barack Obama, comes as both countries prepare to strike a global carbon emissions agreement at the Paris climate negotiations in December. The U.S. and China are the top greenhouse gas emitting nations in the world.
- China plans to launch the world's largest emissions trading program in 2017, creating a carbon market for electric power generation, steel, cement and other industries producing most of the country's greenhouse gas emissions. The program is meant to complement the Obama administration's Clean Power Plan, which was finalized in August and aims to slash carbon emissions from electric power plants by 32 percent below 2005 levels by 2030.

Historic Paris Agreement on Climate Change

195 Nations Set Path to Keep Temperature Rise Well Below 2 Degrees Celsius



What does “de-carbonization of energy (fossil fuels) by 2050.....” mean?

<http://newsroom.unfccc.int/paris/>

In 2013---Turning Point

November 7th 2013 'Unburnable' carbon fuels investment concerns-Investors group with €7.3 trillion of assets asks energy giants about their exposure and response to the risk of falling demand for oil and coal.

<http://www.theguardian.com/sustainable-business/unburnable-carbon-investment-agenda>

Norway Confirms \$900bn Sovereign Wealth Fund's Major Coal Divestment

May 27th, 2015

- The decision to divest Norway's \$945m fund from coal assets was made on 27 May, when an agreement between political parties was reached. It was formally passed by a parliamentary vote on Friday. Svein Flaatten, of the governing Conservative party, said coal investments were both a global warming risk and financial risk. A global deal to cut carbon emissions at a crunch UN summit in December could leave some fossil fuel reserves unburnable and worthless.
- Norway's parliament has formally endorsed the move to sell off coal investments from its \$900bn sovereign wealth fund, the world's biggest.
- It is the largest fossil fuel divestment yet, affecting 122 companies across the world, and marking a new success for the fast-growing and UN-backed climate change campaign.
- A new analysis said the fund would sell off over \$8bn (£5bn) of coal-related investments as a result.
- The biggest single sell-off from Norway's fund will be the UK utility SSE, in which the fund holds \$956m of shares. The fund is also set to sell its \$49m stake in Drax, which runs the UK's biggest coal-fired power station.
- Other major energy companies identified in the analysis by German and Norwegian NGOs are Germany's E.ON (\$685m) and RWE (\$320m) and the Danish company Dong (\$30m), which is often associated with wind energy but has a significant coal business.
- Sweden's Vattenfall and Italy's Enel are also set to be affected by the coal ban as are 35 groups in the US, including Duke Energy (\$434m). A dozen coal-related companies on China are set to lose their Norwegian investment, as are eight in Japan and five in Australia.
- <http://www.theguardian.com/environment/2015/jun/05/norways-pension-fund-to-divest-8bn-from-coal-a-new-analysis-shows>

\$2.2 Trillion Fossil Fuel Assets At Risk

Investors and markets are at risk from \$2.2 trillion of stranded fossil fuel assets



Follow us @carbonbubble #strandedassets



Coal is the most carbon intensive fossil fuel. No new coal mines will be needed and nearly **\$220bln** of projects are at risk.

Oil demand will peak around 2020 and more than **\$1.4 trillion** of projects are at risk.



Growth in gas will disappoint industry expectations, especially in expensive LNG. Planned spending of more than **\$520bln** is at risk.



Which are the companies with most financial exposure?

We identified the **20 companies** with most capex in the danger zone.

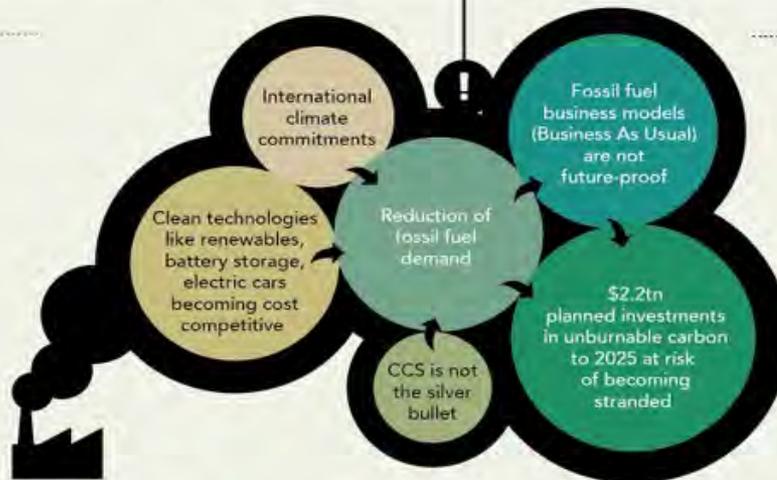
Top 3:

Shell → should each avoid potential investment of over **\$70bln**
Exxon →
Pemex →

Oil and gas majors' potential investment on projects that won't be needed in a 2°C scenario



Which are the countries with most financial exposure?



Do the 2°C stress-test



Institutional Investors
Derisk portfolio by identifying companies aligned with a 2°C demand scenario or engaging with those that are not



Companies
Provide information on the decisions taken to align corporate strategy with a 2°C demand scenario



Governments
Stress test national resources, infrastructure and energy plans against a 2°C demand scenario



Analysts & Advisors
Provide sensitivity analysis of which stocks are more resilient to a 2°C demand scenario

Saudi Aramco and Mobile Sources CO₂ Capture

On-Board CO₂ Capture & Utilization
Saudi Aramco is pioneering the On-Board CO₂ Capture & Utilization technology to address the CO₂ emission from road transportation vehicles.

CO₂ Reduction Technology for Heavy Duty Trucks
Saudi Aramco is developing auxiliary power unit (APU) to reduce CO₂ emissions from heavy duty trucks during idling.

Heavy duty vehicle contributes 2-4 GtCO₂ emissions in 2012 (IEA, 2014)

Fuel Cell-based APU Technology
Reduce CO₂ Emission by Fuel Saving during idling

Mid-size truck: Solid Materials 10% CO₂ Capture

Compact System: Liquid Materials 25% CO₂ Avoidance



Solid Materials
10% CO₂ Capture



Liquid Materials
25% CO₂ Avoidance

- Oil does not emit CO₂
- But our customer's customers do..
- So we have given them the option to capture their CO₂ if they want to...

LCA CCUS

*How Green is My Oil?
A Detailed Look at Carbon Accounting for
CO₂-EOR Sites*

Nicholas A. Azzolina and David V. Nakles (The CETER Group, Inc.)
Wesley D. Peck, John A. Hamling, and Charles D. Gorecki (EERC)
L. Stephen Melzer (Melzer Consulting)

Presented at the
21st Annual CO₂ Flooding Conference

December 8, 2015

Midland, Texas

**Given 12-8-15
Midland Texas
CO2 Conference
Week on the
“Life Cycle
Analysis of CO2-
EOR/CCUS**



The “ROZ”

Presentation on “ROZ” December 8th 2015 CO₂ Conference Week Midland, TX

The Residual Oil Zone (ROZ) Expands the Potential of CO₂ Utilization and Storage



The Residual Oil Zone (ROZ) Expands the Potential of CO₂ Utilization and Storage

Prepared for:
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2015 CO₂ Conference Week Midland, Texas

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Acknowledgements

This study, entitled **“Defining an Overlooked Domestic Oil Resource: A Four-County Appraisal of the San Andres Residual Oil Zone (ROZ) “Fairway” of the Permian Basin”**, draws on the extensive geological and log analyses performed by Advanced Resources International, in partnership with the University of Texas of the Permian Basin (Dr. Robert Trentham) and Melzer Consulting (Mr. Steve Melzer), sponsored by the Research Partnership to Secure Energy for America (RPSEA).

The geological work for the four-county ROZ “fairway” study area, sponsored by RPSEA, has been combined with the reservoir engineering and economics analyses work for the study area performed by Advanced Resources International, sponsored by the U.S. DOE National Energy Technology Laboratory.

The Size of the “Main Pay” CCUS “Prize”

- With “Current Technology,” the economically viable* oil recovery and demand for CO₂ from the main pay of domestic oil fields (lower-48) is:
 - 22 billion barrels of crude oil
 - 9 billion metric tons of CO₂
- Use of “Next Generation” technologies increases these values to:
 - 78 billion barrels of crude oil
 - 26 billion metric tons of CO₂
- This demand for CO₂ is equal to CO₂ capture from 45 to 130 GWs of coal-fired power.

Oil Recovery and CO₂ Demand: Current and “Next Generation” EOR Technology

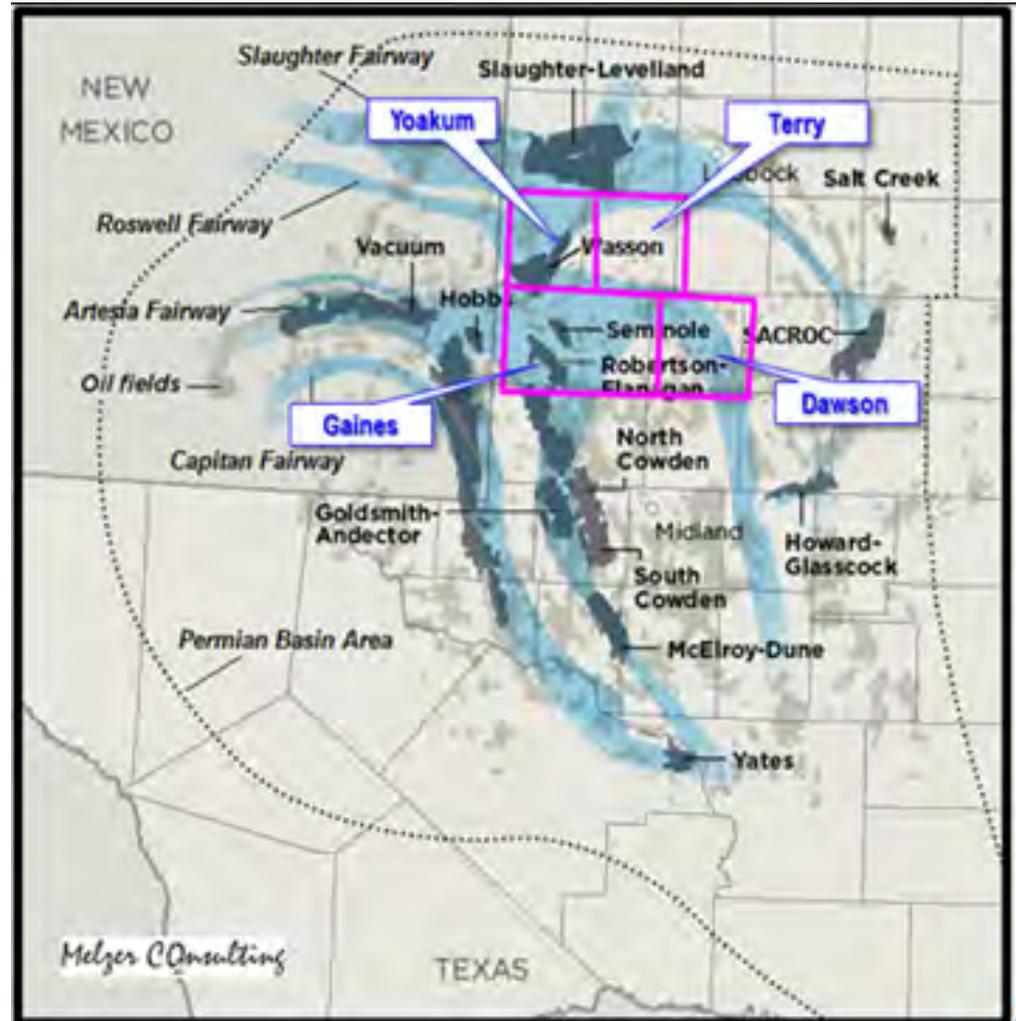
| Resource Area | Economic Oil Recovery (BBbls)* | | Demand for Purchased CO ₂ (Billion Metric Tons) | |
|--------------------|--------------------------------|-----------------|--|-----------------|
| | Current Tech. | Next Gen. Tech. | Current Tech. | Next Gen. Tech. |
| Lower-48, Onshore | 21 | 63 | 9 | 21 |
| Lower-48, Offshore | 1 | 15 | ** | 5 |
| Total | 22 | 78 | 9 | 26 |

*At oil prices of \$80 to \$90/B, CO₂ costs of \$36 to \$40/mt and 20% ROR (before tax).

**Less than 0.5 Bmt.

Residual Oil Zone (“ROZ”) Four Counties >100 billion Bbls Oil in Place

- DOE sponsored four county assessment indicates that over 100 billion barrels of oil in-place in the ROZ “Fairway”.
- Work is required to establish its recoverability, economic feasibility and CO₂ requirements. (Four county study released in December 2014)
- Follow on study of additional 10 counties initiated.
- So far ROZ also present in: Australia, North Sea, Wyoming..
- The catch-CO₂ is needed to produce the oil.





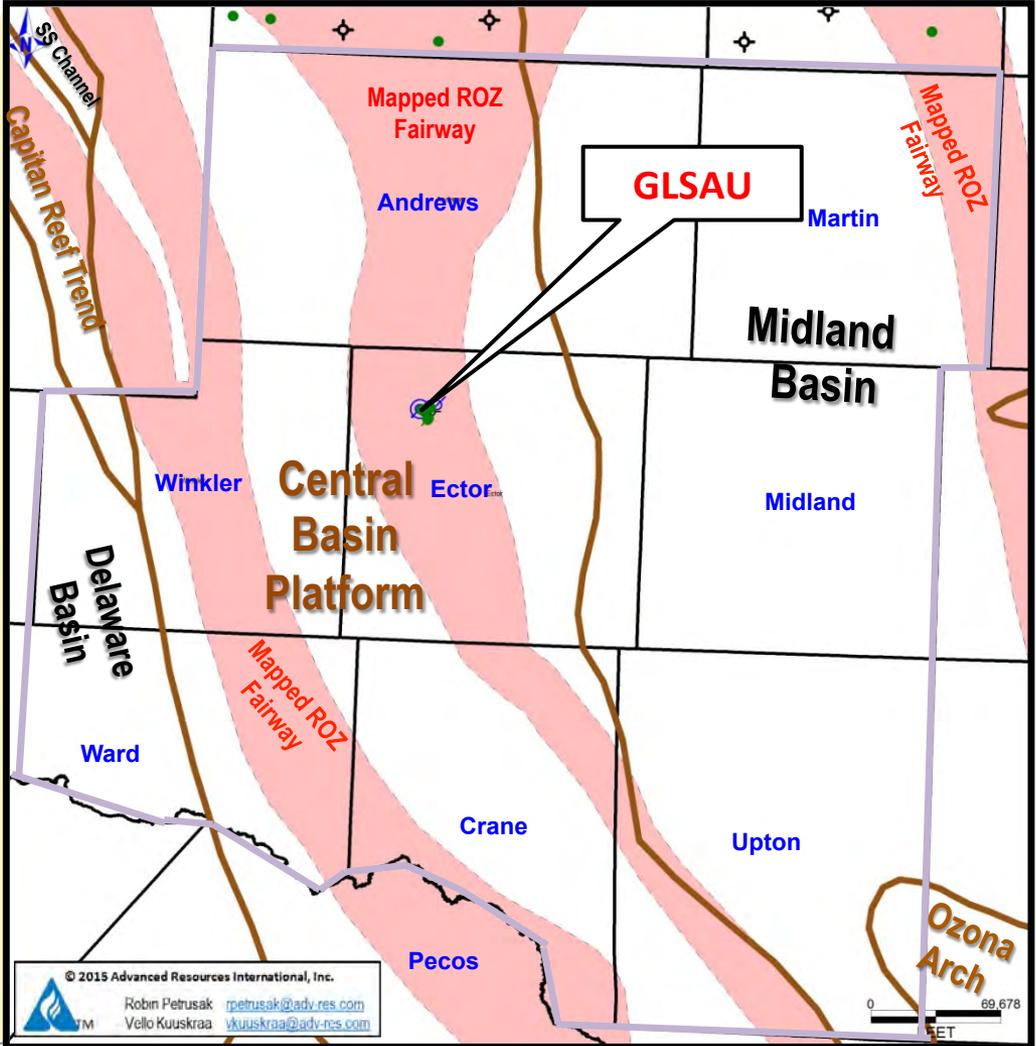
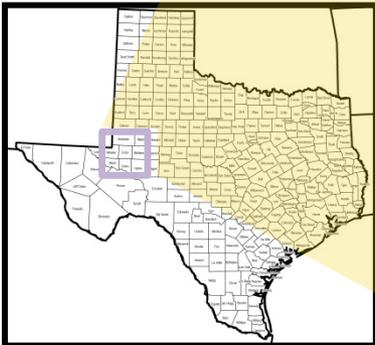
Overview of the Eight County ROZ Resource Assessment December 8th 2015



Eight County Study Area of Permian Basin ROZ “Fairway”

We recently extended the San Andres ROZ “fairway” resource assessment to eight additional Permian Basin counties - - Andrews, Martin, Winkler, Ector, Midland, Ward, Crane and Upton.

- The study used an extensive set of log- and core-based reservoir data to estimate the size of the ROZ oil in-place.
- Data were assembled for wells both inside and outside the currently mapped ROZ “fairway” boundaries.
- The Goldsmith-Landreth San Andres Unit (GLSAU) provided valuable core data for calibrating the log-based San Andres ROZ resource assessment.



Results of Eight County ROZ “Fairway” Resource Assessment

Our detailed analysis of 155 study area logs (with 121 log-based data points used in the quantitative portion of the resource assessment) identifies 79 billion barrels of San Andres ROZ oil in-place in this expanded eight county area:

- Nearly three-quarters of this San Andres ROZ resource, 58 billion barrels, is higher quality, with porosity greater than 8% and oil saturation greater than 25%.
- The remainder of the San Andres ROZ resource, 21 billion barrels, is lower quality, with porosity less than 8% and oil saturation less than 25%.
- Significant portions of the eight county area, including much of the Midland County, contain Grayburg Formation ROZ “fairway” resources.
- The technically recoverable and economically viable portion of this second ROZ resource has yet to be determined.

Is That All There Is?

The San Andres ROZ “fairways” of the Permian Basin are but one of a much larger set of ROZ resources.

Additional potential exists:

1. In the ROZ interval below existing oil fields, excluded from this ROZ “fairway” study.
2. In ROZ intervals in the Grayburg and Glorieta formations of the Permian Basin.
3. In other basins, such as the Big Horn and Williston, with confirmed ROZ presence.
4. In numerous international basins and oil fields - - Australia, the Middle East, South America and Lithuania.

Concluding Thoughts

Utilization of CO₂ for enhanced oil recovery, the “U” in CCUS, is a key component of essentially all major CO₂ capture and storage projects:

- Summit Power’s Texas Clean Energy IGCC project
- Petra Nova’s (NRG & JX Nippon) WA Parish Post-Combustion project
- Saskpower’s Boundary Dam Post Combustion project
- Southern Company’s Kemper County IGCC project

With the addition of ROZ resource, the CO₂-EOR market is sufficiently large to serve as the primary storage option for captured CO₂ emissions.

The revenues from the sale of CO₂ combined with potential incentives (tax credits) of \$30 to \$40/mt (“son of 45Q”) would enable a large number of additional coal-fired electric power plants to undertake CO₂ capture, helping keep coal- and natural gas-fired power generation part of the energy mix while revitalizing the CO₂-EOR industry.

Why the ROZ is so Important

- Shatters myth CO₂-EOR is only a “niche” market
- Pathway for supporting “clean fossil fuels” by providing added value in the clean energy chain
- Adds depth to the amount of fossil fuels resources available to the US and other countries

Questions & Thank You!

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