"2nd Biennial CO$_2$ for EOR as CCUS Conference"

"Market Drivers and Issues for CCUS and CO$_2$-EOR"

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Houston   October 5, 2015
Areas of Interest

- Commodity Markets
- Oil prices
- Carbon markets
- Changing market dynamics
Commodity Markets
Overall Commodity Markets Uncertain


• What began that morning in London, with a sudden plunge in Glencore’s share price, cascaded across oceans and time zones and left the company’s billionaire chief executive, Ivan Glasenberg, scrambling to calm anxious shareholders, creditors and trading partners.

• Days later, even as Glencore regained most of the $6 billion of shareholder wealth erased in a few hours, many investors wondered if Glasenberg can hold the markets at bay.

• Commodity prices should continue to fall, as Glencore predicts that the supply of iron ore, oil, and other products will outpace demand in 2015.

• Top 10 global natural resources companies
Coal’s Dramatic Change

Value of Coal is Enormous

Above picture source: The CURC-EPRI Tech Roadmap pg. 24
Incremental Coal Demand to 2019

Underground Coal Gasification

Physical CO$_2$: A Valuable Commodity

Source: www.netl.doe.gov/research/coal/carbon-storage/research-and-development/co2-utilization
Saudi Arabia: Uthmaniyah CO$_2$ EOR Demonstration
Launching the Kingdom’s first carbon capture project
DHAHRAN, July 29, 2015
In the pilot project, 40 million standard cubic feet per day of CO2 will be captured at Hawiyah gas recovery plant and then piped 85 kilometers to the ‘Uthmaniyah field. At ‘Uthmaniyah, it will be injected — and sequestered, or stored — into flooded oil reservoirs under high pressure to enhance oil recovery, making it a win-win solution.

The project aims to enhance oil recovery beyond the more common method of water flooding, and is the largest of its kind in the Middle East.

"This breakthrough initiative demonstrates that we, as an industry leader, are part of the solution to proactively address global environmental challenges," said Amin H. Nasser, acting president and CEO. "Saudi Aramco is carrying out extensive research to enable us to lower our carbon footprint while continuing to supply the energy the world needs."

[Links to more information]
CO$_2$-Pricing for EOR at Field

• Each thousand cubic feet of CO$_2$ prices as a % of the value of a barrel of crude produced by the field delivered to that field.

• Variables such as:
  
  *Utilization efficiency of the CO$_2$ to crude*
  
  *Quality of the produced crude oil*
  
  *Distance to market of the produced crude oil*
  
  *Overhead and operations costs per barrel*

• Note: There is still “cost of sourcing” and “transportation” to be figured
Oil Markets

Graph of historical monthly WTI crude oil prices per barrel back to 1948. Data is adjusted for inflation using the headline CPI and is shown by default on a logarithmic scale.

http://www.macrotrends.net/1369/crude-oil-price-history-chart
Russia and Saudi Arabia to Continue Pumping Oil

- World’s two biggest oil producers indicate that they won’t crimp production despite price falls

- The output from those two countries adds to an already oversupplied global oil market, even with American output showing signs of weakness. Oil prices have fallen more than 50% in the past year as world supplies outpace demand by around 2 million barrels on any given day. On Friday, they turned higher as weekly data showed a sharp drop in U.S. drilling activity.

- It is also the latest indication that Russia isn’t prepared to join the Organization of the Petroleum Exporting Countries in trimming production to prop up prices. OPEC has indicated that it will only consider a cut if other big suppliers, such as Russia, join it and several OPEC members have tried to woo the country.

Oil Shipping Choke Points

All estimates in million barrels per day. Includes crude oil and petroleum products. Based on 2013 data.

http://www.eia.gov/countries/regions-topics.cfm?fips=wotc&trk=p3
Carbon Markets

http://uk.reuters.com/article/idUKN0830630220080708
International Carbon Markets


http://newclimateeconomy.report/economics-of-change
China Announces World’s Largest Cap and Trade Program


• 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.
US Clean Power Plan
http://www2.epa.gov/cleanpowerplan

• On August 3, 2015, President Obama and EPA announced the Clean Power Plan - a historic and important step in reducing carbon pollution from power plants that takes real action on climate change.

• CCUS and carbon trading are components of this program
Six Oil and Gas Majors Call for Carbon Pricing  June 1, 2015

• Major oil and gas companies BG Group plc, BP plc, Eni S.p.A., Royal Dutch Shell plc, Statoil ASA and Total SA, today announced their call to governments around the world and to the United Nations Framework Convention on Climate Change (UNFCCC) to introduce carbon pricing systems and create clear, stable, ambitious policy frameworks that could eventually connect national systems. These would reduce uncertainty and encourage the most cost effective ways of reducing carbon emissions widely.

• The six companies set out their position in a joint letter from their chief executives to the UNFCCC Executive Secretary and the President of the COP21. This comes ahead of the UNFCCC’s COP21 climate meetings in Paris this December.

• With this unprecedented joint initiative, the companies recognise both the importance of the climate challenge and the importance of energy to human life and well-being.

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
**Significant Carbon Events**

- **November 7th 2013** 'Unburnable' carbon fuels investment concerns- Investors group with €7.3tn 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](http://www.theguardian.com/sustainable-business/unburnable-carbon-investment-agenda)

- **June 12th 2013** Obama Quietly Raises 'Carbon Price' as Costs to Climate Increase. The increase of the so-called social cost of carbon, to $38 a metric ton in 2015 from $23.80, adjusts the calculation the government uses to weigh costs and benefits of proposed regulations. The figure is meant to approximate losses from global warming such as flood damage and diminished crops. [http://www.bloomberg.com/news/2013-06-12/tougher-regulations-seen-from-obama-change-in-carbon-cost.html](http://www.bloomberg.com/news/2013-06-12/tougher-regulations-seen-from-obama-change-in-carbon-cost.html)
ISO-CCS Standards for Geologic Storage under Development

- International Standards Organization - 31000, 17024, 14064, 14065
- International Performance Assessment Centre for Geologic Storage of CO₂ – Seed document
- Canadian Standards Association - ISO Secretariat, standards developer
- Bi-national agreement between USA & Canada

- International Organization for Standardization (ISO) Technical Committee TC-265
- Title: Carbon dioxide capture, transportation, and geological storage-includes CO₂-EOR
- Acceptance of Z-741 by Standards Council of Canada and American National Standards Institute (ANSI) is “seed document” for TC-265
- 26 countries participating and NGOs
US Carbon Markets and CCUS/CO$_2$-EOR Protocol Framework and Storage Protocols

- PEW/C2ES CCS Protocols - released 2012
- ACR CCS CO$_2$-EOR Offsets released April 2015


Man Shoots Down Drone, Lawyers Scratch Their Heads---Is it wrong to shoot a robot trespasser?

Impactors to CCUS Deployment

- Cheap natural gas easy route for power generation
- Is cheap money about to disappear?
- Contracting global economies
- Changing commodity players, sourcing and expectations
- Issues of conflicts in consuming/producing areas
- Traditional labor pools changing
- Commodity trade routes are changing
- Carbon management pricing and markets are taking a bigger role in commodity pricing, policy decisions and capital use
Oil and LNG


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**Oil’s Drag on LNG**

Oil’s rout is making foreign gas supplies cheaper, weakening demand for U.S. gas exports.

- Benchmark North Sea Brent oil prices (R1)
- Spot liquefied natural gas prices to NE Asia (R2)

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Source: Data compiled by Bloomberg
Navajo Free Trade Zone Rail Hub

President Shelly Honors Former Leaders and Meets about Navajo Mine

The Navajo Nation is working with BSNF to build a railroad spur in Thoreau, New Mex. Plans call for an inland port authority for imports and exports, ship coal on the transcontinental for export to foreign countries. The railroad spur is expected to be in project initiation by December. Coal from the Navajo mine can be used for the local power plants, and for foreign shipment.

Norwegian Visit to Navajo Nation

• Dr. Jostein added that Norway has a strong interest in working with the Navajo Nation and hopes to aid in the development of a more efficient avenue of clean coal burning,...

• One of those techniques is an Integrated Gasification Combine Cycle Power Generation Unit, which would utilize coal and preserve remaining resources acquired from the purchase of Navajo Mine from BHP Billiton near Farmington, NM.

• Note: Captured CO2 would move to the Permian Basin for EOR.
The U.S. Geological Survey (USGS) has completed an assessment of undiscovered conventional oil and gas resources in all areas north of the Arctic Circle. Using a geology based probabilistic methodology, the USGS estimated the occurrence of undiscovered oil and gas in 33 geologic provinces thought to be prospective for petroleum. The sum of the mean estimates for each province indicates that 90 billion barrels of oil, 1,669 trillion cubic feet of natural gas, and 44 billion barrels of natural gas liquids may remain to be found in the Arctic, of which approximately 84 percent is expected to occur in offshore areas.

Panama Canal Expansion ~2016

http://micanaldepanama.com/expansion/
http://micanaldepanama.com/expansion/faq/#prettyPhoto
Chinese Backed “Nicaragua Interoceanic Grand Canal”
Dec 22, 2014 Groundbreaking

CO$_2$ Shipping

- The Costs of CO2 Transport ZEP
- Anthony Veder CO$_2$ shipping.
- AP Moeller/Maersk CO$_2$ shipping.
  [http://www.maersktankers.com/Activities/Pages/CO2%20Shipping.aspx](http://www.maersktankers.com/Activities/Pages/CO2%20Shipping.aspx)
- Yara CO$_2$ Business Unit.
- GCCSI CO$_2$ Liquid tanker study Vopak.
- GCCSI Chiyoda Preliminary Feasibility Study on CO$_2$ Carrier for Ship.
- Lloyds Feasibility of Danish CCS Scheme Comprised of Capture at Power Plants, Ship Transport and CO$_2$-EOR. Supports using modified chilled LPG carriers and modified ethane carriers for CO$_2$ in supercritical for long haul shipping.

Costs, plotted as transportation cost in US$/tCO$_2$ against distance, for onshore and offshore pipelines, and ship transport. The costs include intermediate storage facilities, harbour fees, fuel costs and loading/unloading activities. Costs also include additional costs for liquefaction compared to compression. There is a capital charge factor of 11% for all transport options.

Arctic Sea Routes

Questions & Thank You!

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North American Carbon Capture Storage Association

What is NACCSA

The North American Carbon Capture & Storage Association (NACCSA) is a nonprofit organization of companies in North America that support the development of a sustainable carbon dioxide (CO₂) capture use and storage (CCUS) industry in the United States and Canada. Policymakers and companies are interested in CCUS technology because it may be used for energy recovery and holds significant promise as a tool to manage man-made emissions of carbon dioxide, one of the principle greenhouse gases (GHG).
• The Astrup Fearnley group represents over a century of history, growth and excellence in the area of shipping services. This fascinating legacy is a success story created by generation after generation of the Astrup Fearnley family. We believe it is a story worth telling.

• Fearnley traces its history back to the year 1869 when its founder, Thomas Fearnley, established a shipbroking and agency business in Christiania, as the city of Oslo was known in those days. The little company soon prospered and engaged in, among others, the trade in lumber, wine, pitch and ice.

• In connection with its trading activities the company bought shares in vessels and chartered vessels. Although the company began by chartering sailing vessels, by 1880 the age of the steamship had clearly begun. By 1881 the partnership of Fearnley & Eger established the Christiania Steamship Company which contracted two newbuildings at the Kockums Shipyard in Malmø, the 1235 deadweight ‘Oslo’ and the 1215 deadweight ‘Bygdøy’.

• By the end of the 1880s the company had contracted a further six units. In the beginning of the 1900s Fearnley & Eger became, more or less, a shipowning company and invested in ever larger units. The company engaged in both liner and tramp activities and survived the two world wars. In addition to these shipowning activities, the firm continued to engage in developing its skills in the area of shipping services and was engaged primarily in the area of dry cargo shipbroking. As the tanker industry started to develop at the beginning of the 20th century, Fearnleys became enthusiastically involved in this new field of endeavour. Later on, when the transportation of gas by sea became an important area of commerce, Fearnleys developed a broking department which specialized in this new commodity. All in all, the history of the company has been closely focused on the concept of innovation; whenever new ideas and new industries developed which required seaborne transportation, Fearnleys was quickly on the scene.

• As the 20th century progressed, the need for brokerage services for the transportation industry became so great that Fearnleys began to develop these (along with related ancillary services) as its principal business area. Always on the cutting edge of new trends, the company became involved in car carrier transportation in the 1960s, offshore and rig broking in the 1970s, coinciding with the onset of the development of the Norwegian continental shelf offshore oil fields, and energy trading and financial services in the 1980s. Fearnleys was also a pioneer in the development of transportation industry research and consultancy services, and has been involved in monitoring and analysing shipping markets since the early 1960s when Fearnresearch was first established. Now at the dawn of the 21st century the little company which started in Christiania in 1869 is firmly established in every corner of the world and assumes a global perspective on transportation much to the benefit of its worldwide customer base.