PETRA NOVA Carbon Capture

September 10, 2019

JX Nippon Oil and Gas Exploration Corporation
The JXTG Group was formed in April 2017 through a business integration of the JX Group and the TonenGeneral Group. The JXTG Group comprises three core operating companies under a holding company, JXTG Holdings.
Crude oil and natural gas production (a project company basis)

110 thousand barrels/day

Crude oil equivalent (FY2018 actual)

Zero-flare 2000 (Abu Dhabi)

The first sour gas injection in the Middle East reduced emissions of CO2 and H2S. In 2006, sour gas injection was applied to other oil fields.

CDM Project 2001-2011 (Vietnam)

Before the project
- Flare Gas
- Purchase fuel gas

After implementation
- No Flare
- Reduce gas purchase

Pipeline

Carried out the first offshore CO2-EOR pilot test in Southeast Asia.

CO2-EOR Pilot Test 2011 (Vietnam)

CO2-EOR 2017 (USA)

Capture CO2 from flue gas of coal-fired power plant and inject into an aged oil field to increase oil production.

Aim for sustainable energy supply, harmonizing with environment

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Rang Dong CDM Project (Vietnam)

Rang Dong Project in Vietnam Received CER* Issuance Approval Under the Kyoto Protocol
- World’s Largest ‘One-Time Issuance’ at the time
- The First CER Issuance in the World from the Recovery and Utilization of Associated Gas

Project Total CO2 CER: 9 Million Tons (2001 ~ 2011)

* CER : Certified Emission Reductions are carbon credits, based on CO2 equivalent, issued by the Clean Development Mechanism (CDM) Executive Board/United Nations Framework Convention of Climate Change for emission reductions achieved by CDM projects under the Kyoto Protocol.
United States: Petra Nova CCUS Project

- **CO2 Capture Rate:** 4,700 T/d
- Capture over 90% of CO2 from flue gas of WA Parish power plant
- 99.9% Pure CO2
- 130 km Oil Sales

**Diagram Details:**
- Flue Gas from Parish 8
- Absorber: KS-1 Solvent with CO2
- Regenerator: KS-1 Solvent without CO2
- Compressor
- 130 km pipeline
- Oil Sales
- 99.9% Pure CO2

**Location:**
- United States, Texas State
- W.A. Parish power plant
- West Ranch oil field
- Houston
- Gulf of Mexico

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The Partners

- **NRG Energy, Inc.** is a large independent power company in the US.
- **JXTG Group** is a leading integrated energy, resources, and materials company.
- **Hilcorp Energy** is an energetic independent energy company in America.
- **JBIC and Mizuho** (backed by NEXI) are providing loans totaling $250 million.
- **US DOE awarded $190 MM grant funded through the Clean Coal Power Initiative.**
Key Project Dates

May 2010
DOE Grant Awarded

October 2011
TCV Partnership Formed

May 2013
Petra Nova Partnership Formed

July 2014
Carbon Capture Facility Construction Started

December 2016
Plant Operations Commences
On Schedule/On Budget

2017 – 2019
3-Year DOE Demonstration Period

January 2017
First EOR Oil Production Well is turned on

August 2019
3,000,000 metric tons of CO2 has been captured


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Project Systems

How it Works

1. **Divert the flue gas** from NRG’s WA Parish Unit 8

2. **Provide power and steam** via dedicated COGEN facility, sell surplus power to grid

3. **Process flue gas** in a carbon capture system to strip out the CO2

4. **Transport CO2** to West Ranch Oil Field through 130km long CO2 pipeline

5. **CO2 Enhanced Oil Recovery** operation to produce otherwise unrecoverable oil

6. **Transport and sell crude oil** – marketing, selling, and transporting the recovered oil

Petra Nova is part owner of the oilfield

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NRG’s WA Parish Power Plant
Petra Nova Overview

- Petra Nova uses a 240MW equivalent slipstream of flue gas from 640MW coal-fired power plant - W.A. Parish unit 8
- CO₂ accounts for ~13% of the flue gas
- Petra Nova captures >90% of the CO₂ from the processed flue gas
- When operating at 100%, Petra Nova captures 4,700 metric tons of CO₂ per day
- To date, over 3 million metric tons of CO₂ has been captured
Kansai Mitsubishi Carbon Dioxide Recovery Process: KM CDR Process™

Commercially applied since 1999.

- **Flue Duct** – Transports flue gas from Unit 8 to Petra Nova
- **Quencher** – SO₂ polishing scrubber and flue gas cooler
- **Absorber** – Amine solvent captures the CO₂ molecules - remaining flue gas goes out absorber stack
- **Regenerator** – Steam is introduced to separate the CO₂ from the amine solvent, CO₂ exits the top of the regenerator, solvent is recirculated to either the absorber or filtering process
- **Compressor** – compresses the CO₂ to up to 1,900 psi
- **CO₂ Pipeline** – transports the CO₂ to the TCV Pipeline
- **Cogeneration** – provides steam and power to the CCS facility
CCS Facility – Flue Gas Duct and Blower
CO₂ Pipeline

- 130 km
- ~160 landowners
- 12” diameter
- 8 Mainline Valves
- 1,900 psi at inlet;
- ~1,650 psi at delivery
- No intermediate compression

Flat, rural, and collocated with existing utilities
West Ranch Oil Field

Discovered in 1938, West Ranch is a “legacy oil field” in Gulf coast region.

Map: Location of Current CO2 EOR Projects and Pipeline Infrastructure
Source: Carbon Dioxide Enhanced Oil Recovery, Untapped Domestic Energy Supply and Long Term Carbon Storage Solution, NETL, DOE, 2010

BULLETIN OF THE AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS
VOL. 28, NO2 (Feb, 1944) WEST RANCH OIL FIELD, JACKSON COUNTY TEXAS
A. J. BAUERNSCHMIDT, JR
West Ranch Oil Field

1930
1940
1960
1980
2000
2014 Final Investment decision
2017 CO₂-EOR

Drilling Campaign
Around 500 wells drilled

1938 Discovery

Enhanced Oil Recovery

Lamar Univ. Spindletop-Gladys City Boomtown, Spindletop History
https://www.lamar.edu/spindletop-gladys-city/spindletop-history.html

NETL: March 2016 "Carbon Dioxide Enhanced Oil Recovery
Cross-section illustrating how carbon dioxide and water can be used to flush residual oil from a subsurface rock formation between wells.

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West Ranch Central Facility

- Over 200 new wells have been drilled
- Two central processing facilities to separate oil, CO₂, and water.
- Produced CO₂ and water are re-injected into the formation
Enhanced Oil Recovery Project

West Ranch Field Operation

- Captured CO₂ is injected into a reservoir and is produced through the production wells. Produced CO₂ is re-injected into the reservoir (CO₂ Recycling).

- A comprehensive monitoring, verification, and accounting plan (MVA) is in place to track the flow of CO₂ and to insure that it is sequestered in the reservoir.

- The University of Texas Bureau of Economic Geology developed the plan to sync with oilfield operations and manages the plan during the DOE 3-year demonstration period.

Oil production has been boosted tens of times up to date.
1. **Modeling** – development of a fluid flow simulation model using actual logging and production data

2. **Mass Balance Accounting** – accounting for injected CO₂

3. **Pressure Monitoring** – monitoring pressure in 10 dedicated above zone monitoring intervals (AZMI) wells.

4. **Fluid Sampling** – collection of pre-injection fluids (brine, gas, oil) in the injection and AZMI zones

5. **Groundwater Monitoring** – one year of baseline and periodic ongoing sampling of groundwater at several ground water wells

6. **Soil Gas Monitoring** – measurement of soil gases at several sites in the vadose zone.

7. **Additional Monitoring** – in addition to the University of Texas Bureau of Economic Geology (BEG) program, the oilfield operator is also monitors surface level and down hole pressures
Lessons Learned

Requirements for a successful CCS project:

- Technology evaluation and evolution
- Engineering and design management
- Location and pipeline development
- Commercial structuring and CO₂ sales
- Interface/relationship with the oil field
- Financing structure, including tax incentives, if available
- Government grant application and administration, if available
- Environmental study management
- Permitting and licensing
- EPC Selection, Contract Structure and Construction management
- Integrated Project Team—communications and messaging
- Aligned Partners
- Operational experience—engage early
Thank You!