August 2019
Carbon Capture, Utilization and Storage, and Oil and Gas Technologies Integrated Annual Review Meeting

Petra Nova Parish Holdings LLC
The Partners

- JXTG Holdings is a leading integrated energy, resources, and materials company
- NRG Energy, Inc. is a large independent power company in the US
- Hilcorp Energy is one of the largest privately-held oil and natural gas E&P companies in the US
- JIBC and NEXI are wholly-owned by the Japanese government.
- US DOE awarded $190 MM grant funded through the Clean Coal Power Initiative

Commercial Structure
Key Project Dates

December 2016
Plant Operations Commences

January 2017
First EOR Oil Production Well is turned on

2017 – 2019
3-Year DOE Demonstration Period

December 2016
CO2 Pipeline Commissioned

2017
1,000,000 tons of CO2 captured

July 2014
Carbon Capture Facility Construction Started

May 2013
Petra Nova Partnership Formed

July 2014
Financing Completed

October 2011
TCV Partnership Formed

May 2010
DOE Grant Awarded

2009
DOE Application

2010
Carbon Capture Facility Construction Started

Significant planning required from start to finish!
Project Systems

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 81 mile 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
Petra Nova Overview

- Petra Nova uses a 240 MW equivalent slipstream of flue gas from NRG’s 640 MW 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 5,200 tons of CO₂ per day

- To date, approx. 3.3 million tons of CO₂ have been captured
Carbon Capture System Site Layout

- Absorber
- CO₂ Pipeline
- Compressor
- Quencher
- Flue Gas Duct
- Regenerator
- Cogeneration (steam & power)
CO₂ Pipeline

- 81 Miles
- ~160 landowners; no condemnation authority
- 12” diameter
- .330 wall pipe (.406 on HDDs)
- 8 Mainline Valves (MLVs)
- 1,900 psi at inlet; ~1,650 psi at delivery
- No intermediate compression

Flat, rural, and co-located with existing utilities
West Ranch Oil Field

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

• Field is being flooded using a “5-spot” pattern (each injector surrounded by 4 producers)

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

• University of Texas Bureau of Economic Geology (BEG) developed the plan to sync with oilfield operations and manages the plan during the DOE 3-year demonstration period
Key Components of the Petra Nova MVA Program

1. **Modeling** – development of a fluid flow simulation model using actual logging and production data

2. **Mass Balance Accounting** – accounting for injected CO$_2$

3. **Pressure Monitoring** – monitoring pressure in 10 dedicated AZMI (above zone monitoring intervals) wells (5 each in two zones)

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** – characterization of soil gases at several sites

7. **Additional Monitoring** – in addition to the BEG program, the oilfield operator is also monitoring surface level and down hole pressures
West Ranch Central Facility #1

- 2 central processing facilities to separate oil-CO₂-water
- Currently 5 manifold sites to move process fluids
- All produced CO₂ and water is reinjected into the formation
Lessons Learned

Requirements for a successful CCUS 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
Current Focus for NRG

- Optimization of the technology that we have in place with the Petra Nova project
  - “First-of-a-kind” project creates challenges not seen with conventional projects.

- Optimization of project economics
  - Project economics impacted by commodity prices of oil, gas, coal, and power

- Continue to develop operational expertise
  - Limited industry-wide operations expertise

- Evaluating and optimizing on tax incentives for the current project, where possible
  - Regarding 45Q, NRG supports/applauds Congress action to continue advancing the development of CCS/CCUS projects across the nation
Thank You!