



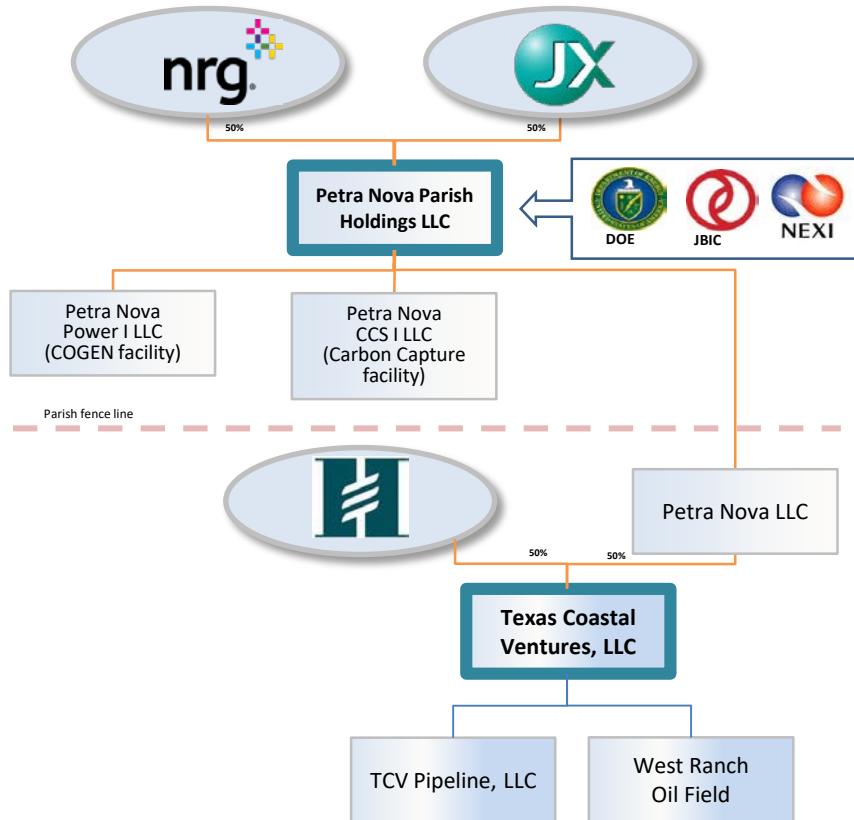
PETRA NOVA Carbon Capture

August 2019


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

Petra Nova Parish Holdings LLC


Commercial Structure




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

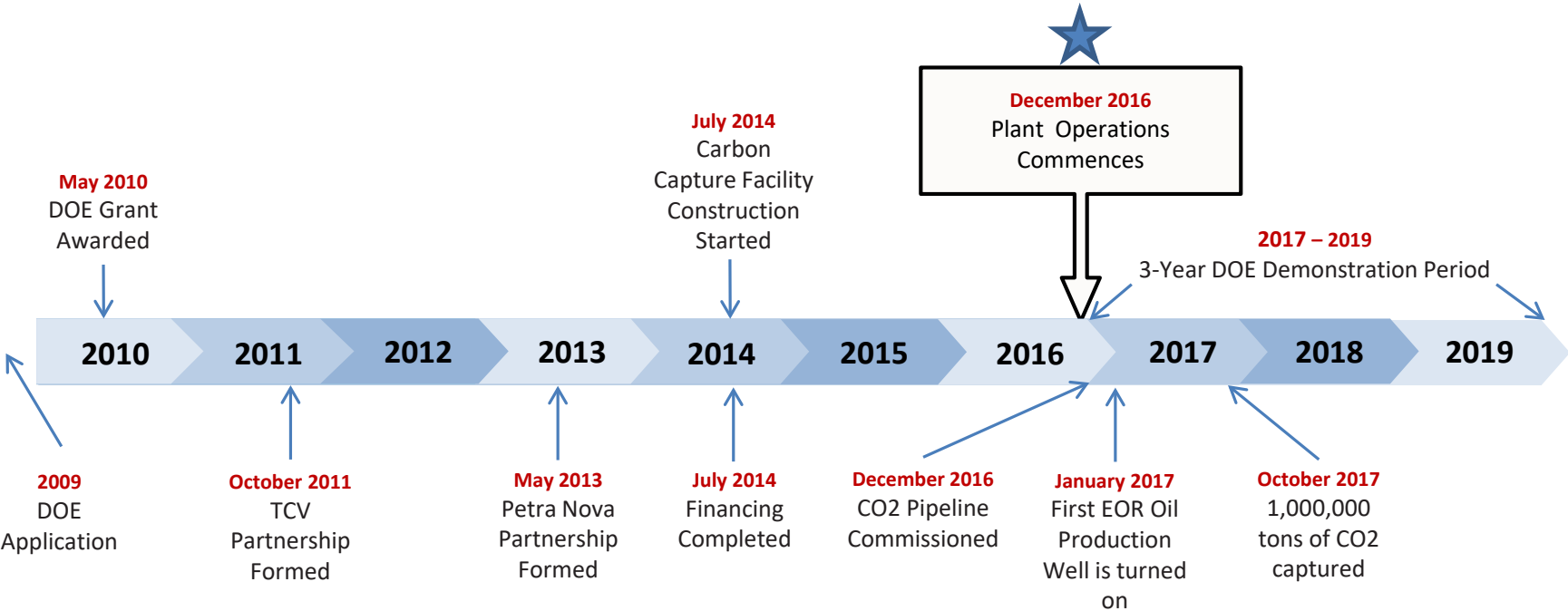


- ✦ JBIC and NEXI are wholly-owned by the Japanese government.

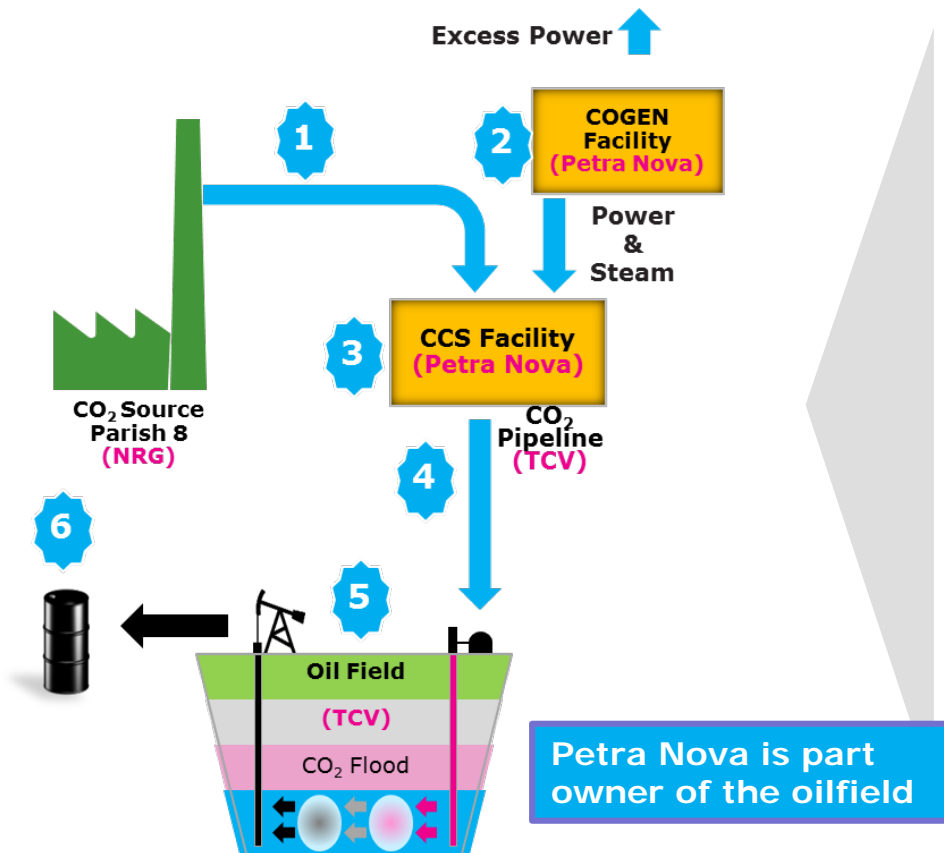
- ✦ US DOE awarded \$190 MM grant funded through the Clean Coal Power Initiative

Key Project Dates



Significant planning required from start to finish!

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 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 Overview

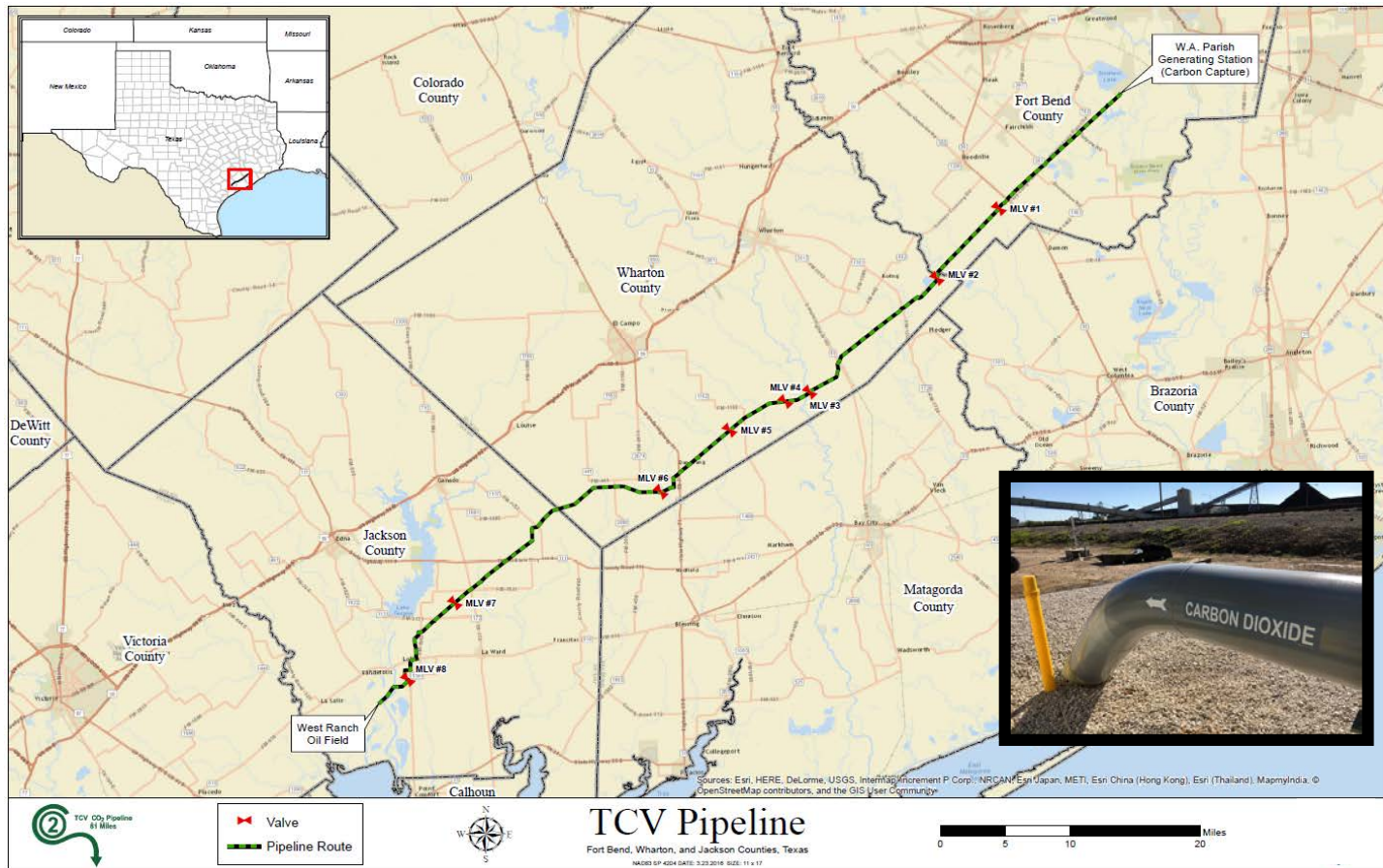


- Petra Nova uses a 240 MW equivalent slipstream of flue gas from NRG's 640 MW coal-fired power plant - W. A. Parish unit 8
- CO₂ accounts for ~13% of the flue gas
- Petra Nova captures >90% of the CO₂ from the processed flue gas
- When operating at 100%, Petra Nova captures 5,200 tons of CO₂ per day
- To date, approx. 3.3 million tons of CO₂ have been captured

Carbon Capture System Site Layout



CO₂ Pipeline



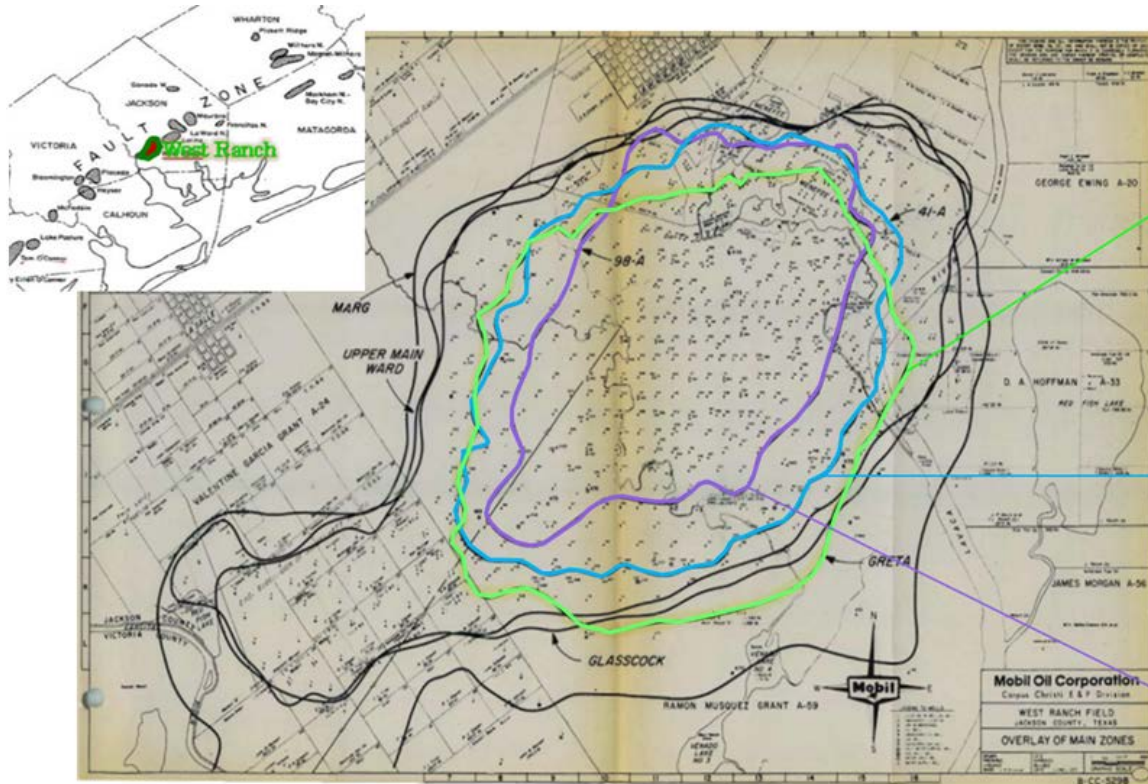
- 81 Miles
- ~160 landowners; no condemnation authority
- 12" diameter
- .330 wall pipe (.406 on HDDs)
- 8 Mainline Valves (MLVs)
- 1,900 psi at inlet; ~1,650 psi at delivery
- No intermediate compression

Flat, rural, and co-located with existing utilities



PETRA NOVA Carbon Capture

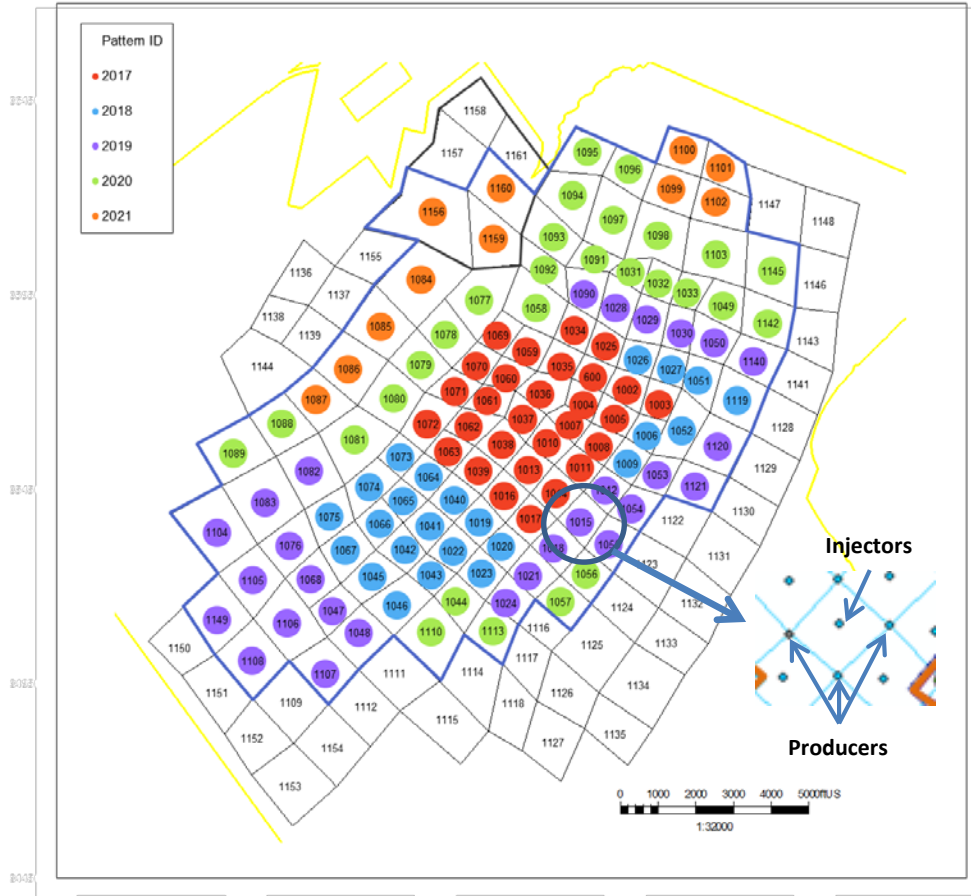
West Ranch Oil Field



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

Enhanced Oil Recovery Project

West Ranch Field Development

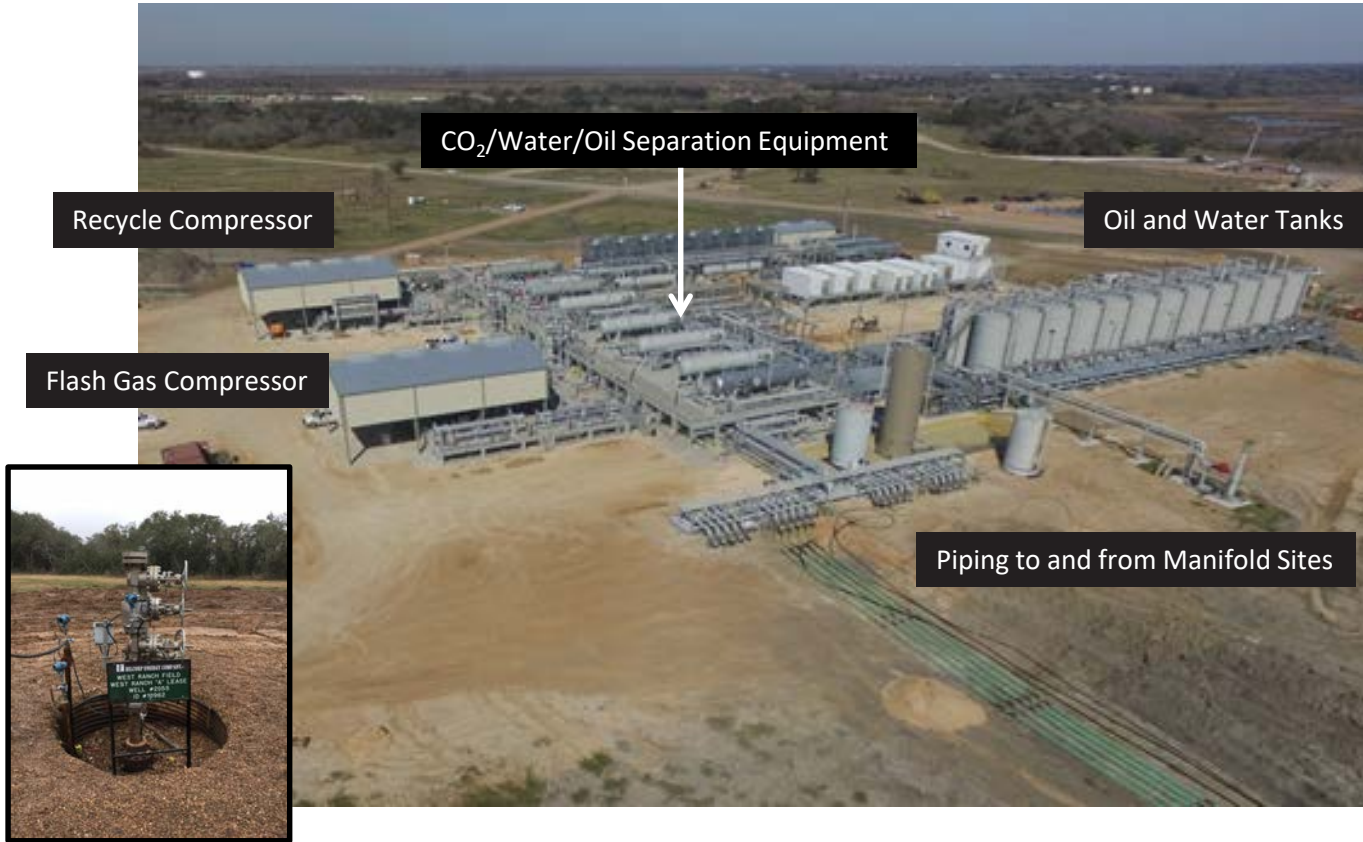


- Field is being flooded using a “5-spot” pattern (each injector surrounded by 4 producers)
- A comprehensive monitoring, verification, and accounting (MVA) plan is in place to track the flow of CO₂ and to insure that it is sequestered in the reservoir
- University of Texas Bureau of Economic Geology (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 CO₂
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



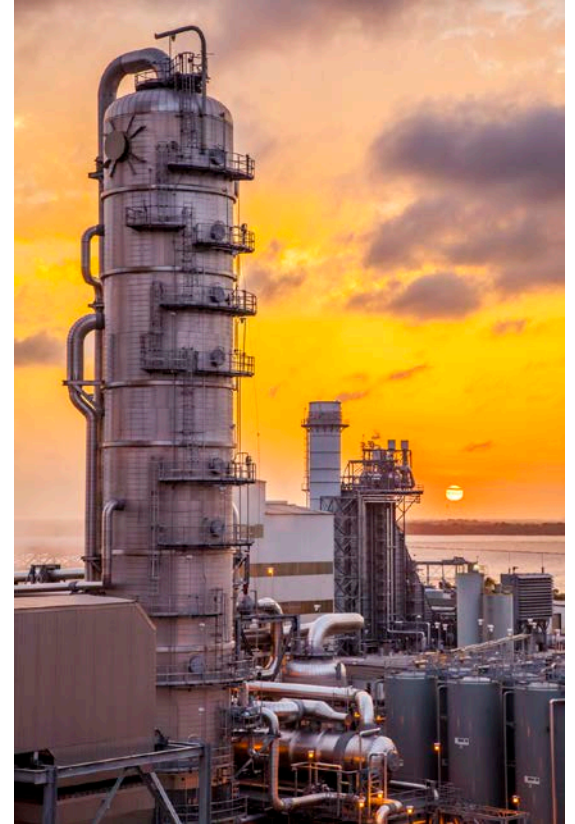
West Ranch Field Central Facilities

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

Lessons Learned

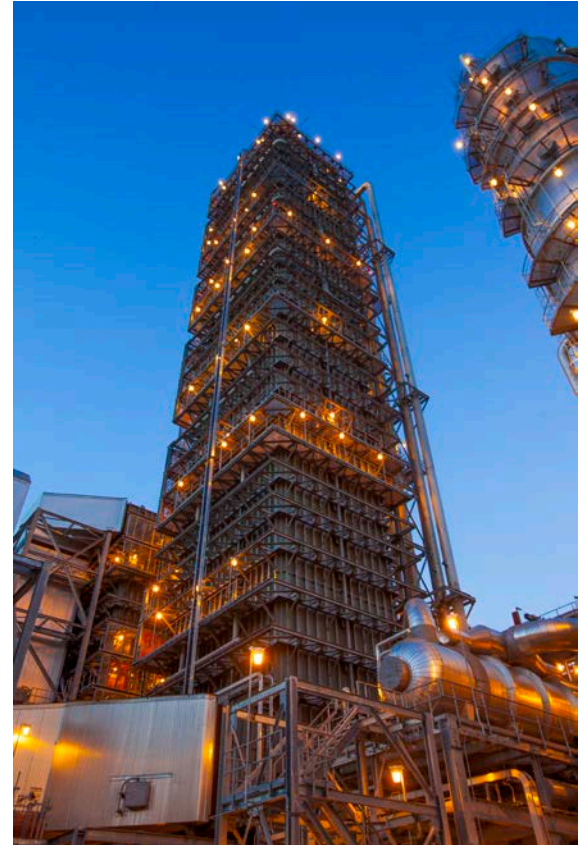
Requirements for a successful CCUS project:

- ✦ 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!

