

Petra Nova CCUS Project in USA

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JX Nippon Oil & Gas Exploration Corporation

JX Nippon environment compliance technology

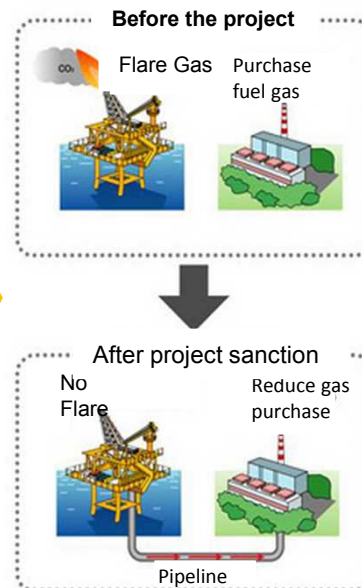
As an approach to global warming, devised and implemented measures to drastically reduce greenhouse gas emissions from oil and gas fields operated by the Company.

Zero-flare
2000 (Abu Dhabi)



The first sour gas injection in the Middle East and reduce emissions of CO₂ and H₂S. In 2006, sour gas injection was realized in another oil fields

CDM Project
2007 (Vietnam)

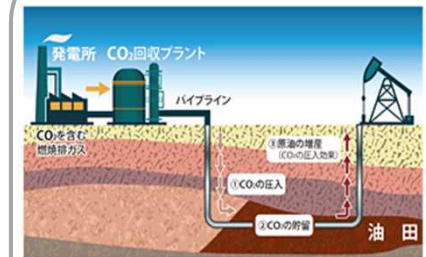


CO₂-EOR Pilot Test
2011 (Vietnam)



Carry out the first offshore CO₂-EOR in Southeast Asia.

CO₂-EOR
2017 (USA)



Capture CO₂ emitted from coal-fired power plants and inject into aged oil fields to increase oil production

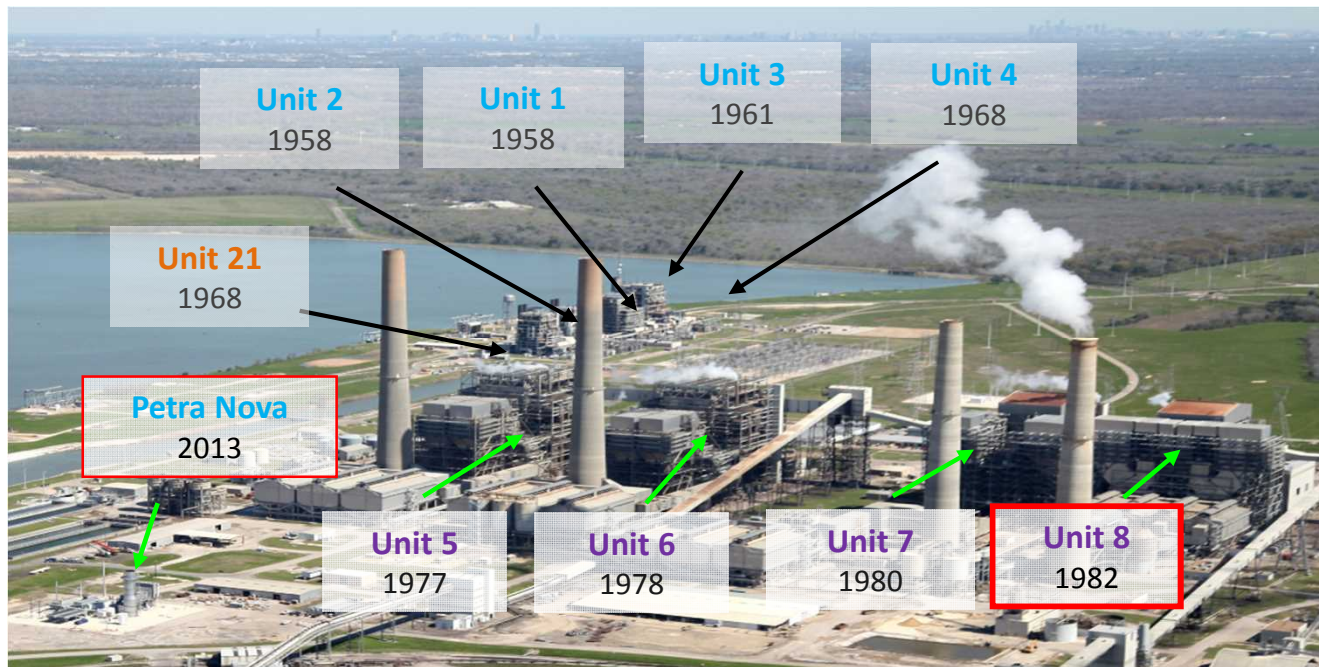
Aim for both stable supply of energy and environmental harmony

Carbon capture at commercial scale



- Petra Nova uses a **240MW** equivalent slipstream of flue gas from the 640MW coal-fired power plant (WA Parish - **Unit 8**).
- When operating at 100%, Petra Nova captures **5,200 short tons of CO₂ per day** (equivalent of taking 350,000+ cars off the road).
- CO₂ is used to **enhance oil production at the West Ranch oil field** in Texas, the US.

NRG Energy, Inc. W.A. Parish Power Plant

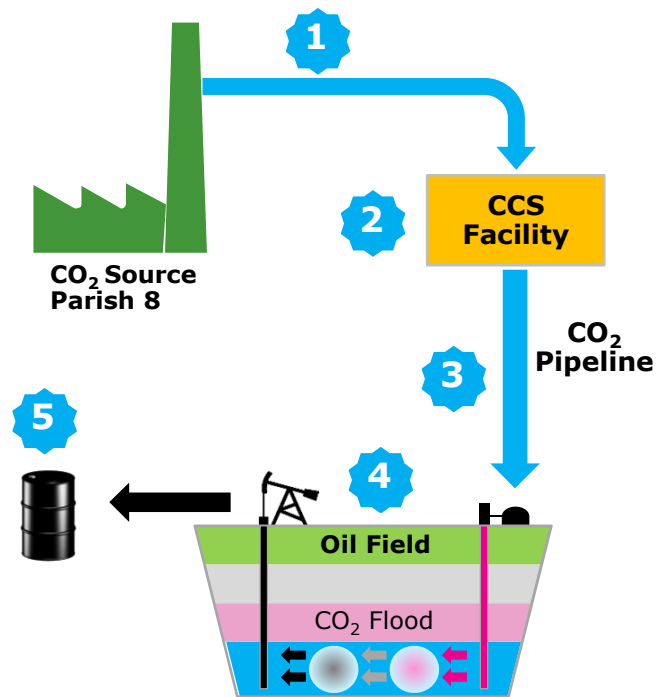


Coal Generation Unit : c.a. 2,500 MW (Unit 5-8)

Gas generation Unit : c.a. 1,200 MW (Unit 1-4, Unit 21(diesel) *, Petra Nova) *Starter unit

Total : c.a. **3,700MW**

Petra Nova Project Overview



Converting CO₂ to crude oil

Five Projects in One

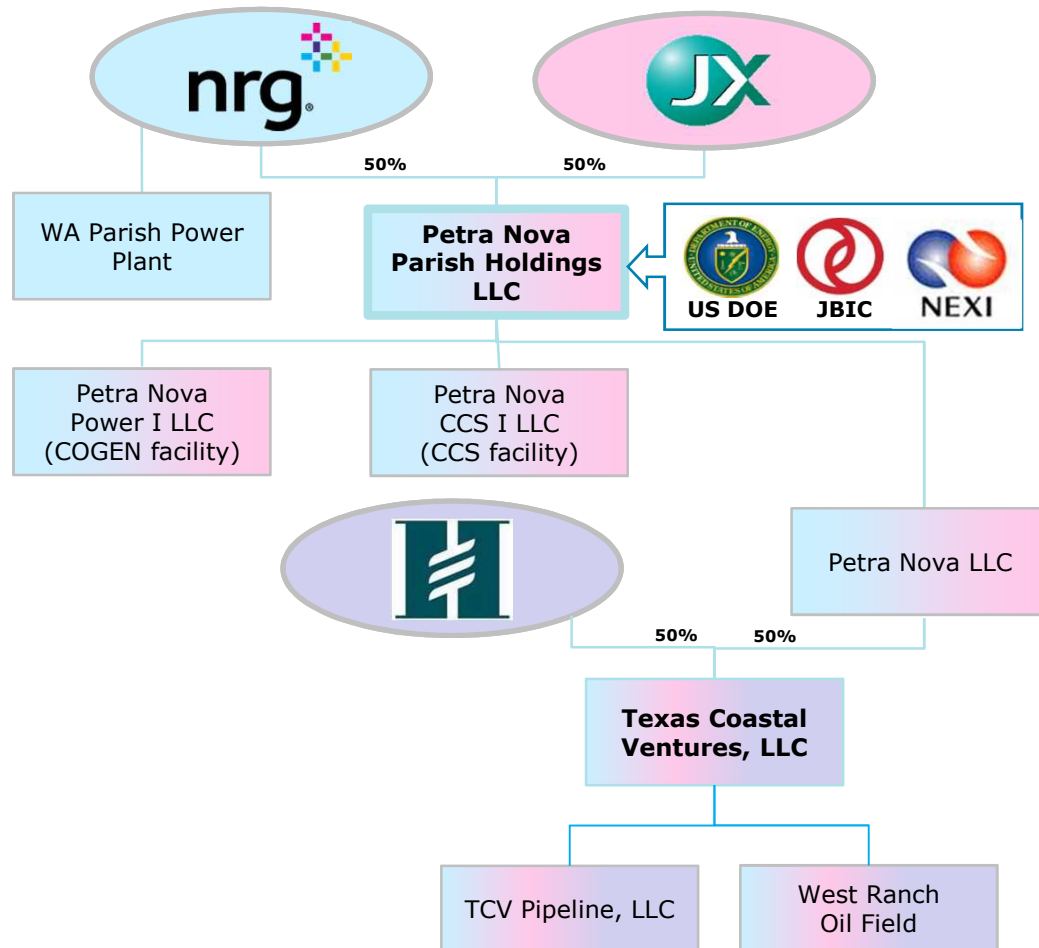
- 1. Diverting the flue gas** from an existing facility (Parish Unit 8)
- 2. Processing flue gas** in a carbon capture system to strip out the CO₂
- 3. Transport CO₂** to a nearby oil field.
- 4. CO₂-EOR operation** to produce otherwise unrecoverable oil
- 5. Transport and sell oil** – marketing, selling, and transporting the recovered oil

Benefits and Advantage of Unique Business Model

- ✓ Coal-fired power plants are **one of candidates for a large and stable CO2 source**
- ✓ On-shore oil industry is generally in shortage of CO2 – applicable to the CO2-EOR focus region - Permian Basin, Texas
- ✓ Carbon Capture project is typically a **cost center**
- ✓ CO2-EOR project might potentially unlock tremendous value if CCS owners and oilfield operators can share the uplift and both win in future.
- ✓ Recoverable reserves from the matured oil field would improve by sanctioning of the CCS & CO2-EOR project

- ✓ Turning CO2 into a productive asset in demand
- ✓ **Enhancing oil production to generate cash flow** while reducing footprint to the global environment by **reducing green house gas emission** at the same time.

Commercial Structure



- ✦ A core business company that engages in oil and natural gas exploration and production business in the JXTG Group, which is the leading integrated energy, resources and materials business group in Japan



- ✦ Leading U.S. integrated power company supported by approximately 23GW of generation.
- ✦ Serving nearly 3 million customers across the U.S.



- ✦ One of the largest privately-held oil and natural gas E&P companies in the U.S.
- ✦ Strong track record of implementing new production techniques into mature reservoirs
- ✦ Specialized team that has extensive experience implementing CO₂ floods



US Department of Energy

- ✦ Awarded US\$190 million grant
- ✦ Funded through Clean Coal Power Initiative
- ✦ Has been supporting the project since 2010



- ✦ JBIC & NEXI are wholly-owned by the Japanese government



Financing

Project Cost = approximately US\$1 billion

Sources of Capital:

US DOE CCPI grant

- ✓ **US\$190 million** from the United States Department of Energy (DOE) Clean Coal Power Initiative Program (CCPI).

Project finance loans

- ✓ **US\$175 million** from the Japan Bank for International Cooperation (JBIC).
- ✓ **US\$75 million** from Mizuho Bank, Ltd.
 - ✓ Mizuho's portion is insured by Nippon Export and Investment Insurance (NEXI).

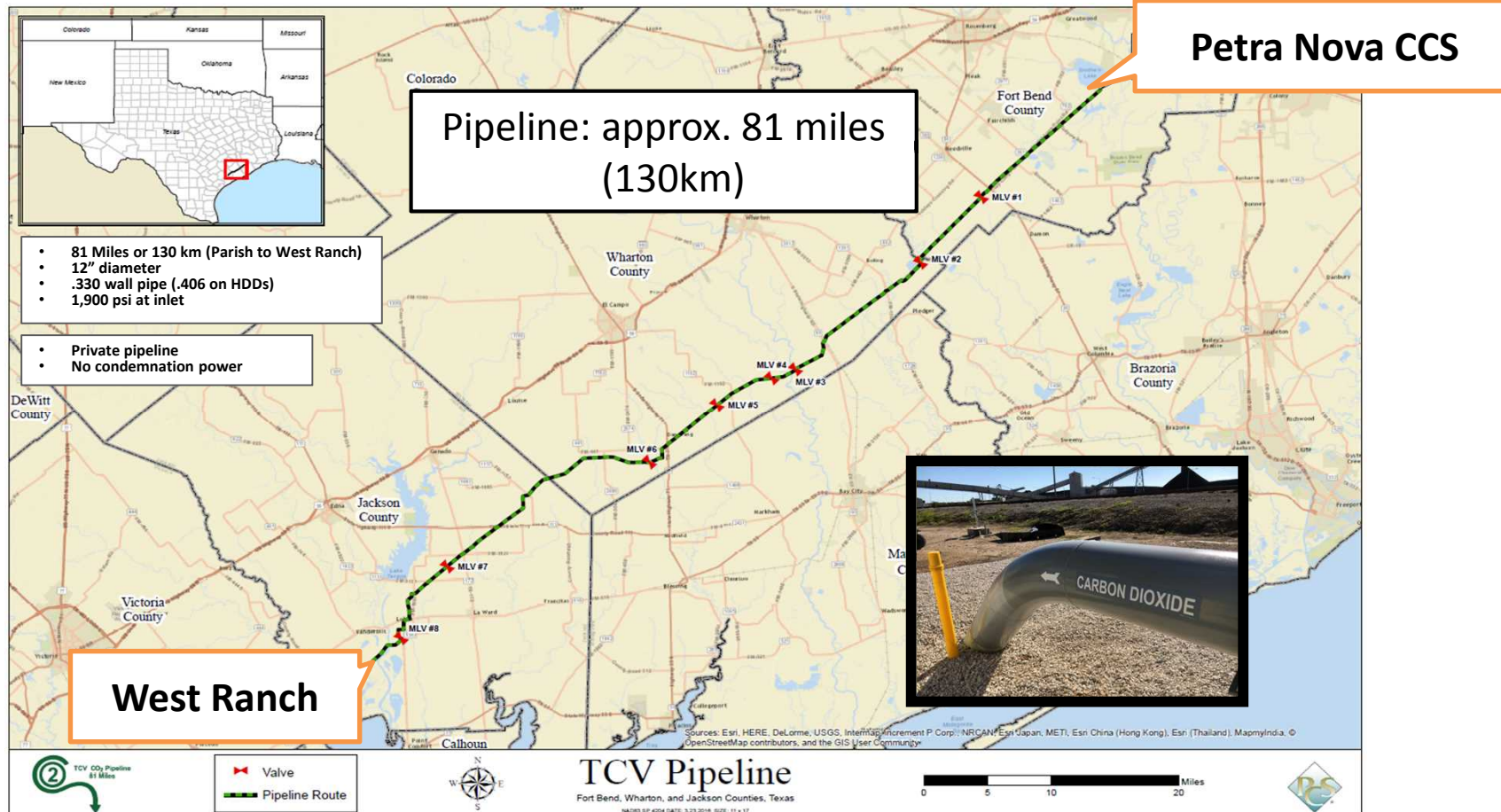
Equity contributions

- ✓ JX* and NRG each will contribute up to **US\$300 million** in equity.
 - * JBIC has a portion of equity interest in JX Nippon Oil Exploration (EOR), which is a 50% owner of Petra Nova Parish Holdings.

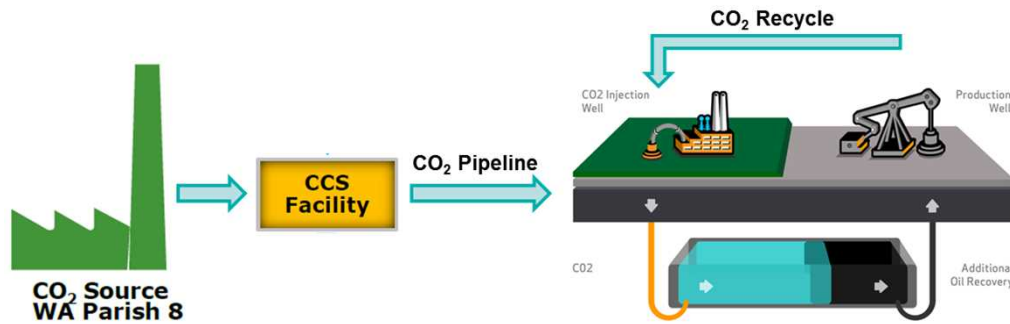
Carbon Capture System Site Layout



CO2 Pipeline Route



Enhanced Oil Recovery Project



Oil production has been boosted 2,000 percent up to date

West Ranch Field Operation

- 1.6 Mtpa of CO₂ emissions are captured from a coal-fired power plant.
- 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.

Key components of the MVA program

1. **Reservoir 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 has also installed numerous surface level pressure monitors and 2 down hole monitors

Lessons Learned from Petra Nova Project

CCS:

- ✓ Contributing factors to “On Time/On Budget” included extensive up-front planning, turn-key contracting structure, and strong partners.
- ✓ “First-of-a-kind” projects require more time for commissioning and start-up than conventional projects.
- ✓ To the extent it is economical, minimize single points of failure and include a robust spare part program for long-lead spares.

Oil Field Operation:

- ✓ Reservoir monitoring and management is important to implement development safely and efficiently.
- ✓ It is challenging to accurately estimate additional oil recovery. Evaluation program and phase development is the key.
- ✓ Need experiences to acquire skill-sets for EOR pattern development, well spacing and WAG scheme.

Clean Coal Power Initiative (CCPI)

- ✓ CCPI is closely linked with R&D activities that are focused on ultra-clean, fossil-fuel-based energy system.
- ✓ CCPI was initiated in 2002 to address 21st century energy issues through multiple solicitations (CCPI-1, CCPI-2 & CCPI-3).
- ✓ Petra Nova project was awarded as CCPI-3 project.

Cost-sharing principle between the participant and DOE:

- DOE may not finance **more than 50% of the total costs of a project.**
- Cost-sharing by the project participant is required throughout all phases of the project (design, construction, and demonstration period during initial operation)
- DOE **may share in project cost growth up to 25%** of the originally negotiated government share of the project

Production Tax Incentives

✓ Tax incentive in State of Texas

- ✓ Production tax of the state is at the rate of **4.6 percent** of the market value of oil produced.
- ✓ State of Texas provides several Tax incentives in order to support operator to challenge an enhanced oil recovery project.

✓ The Enhanced Oil Recovery (EOR) Incentive

- ✓ Oil produced from an approved new enhanced oil recovery project is eligible for special EOR tax rate of **2.3 percent** of production's market value (one-half of the standard rate)

✓ Advanced Clean Energy - EOR Tax Reduction

- ✓ Oil produced from enhanced recovery projects using anthropogenic carbon dioxide is eligible for additional tax rate reduction (one-half of the EOR tax rate). **1.15 percent** of productions market value

45Q Tax Credit

Background

- ✓ Enacted as part of the Energy Improvement and Extension Act of 2008
- ✓ The credit is equal to:
 - \$10/ton for qualified EOR project
 - \$20/ton for geological storage(*)the rates are adjusted for inflation in the subsequent years.
- ✓ Program is capped at 75 million tons



45Q Tax credit was reformed in February 2018 as follows:

- ✓ Removing requirement that the CO2 capture entity had to be the same entity that sequestered the CO2
- ✓ Remove the Cap and **Increase the tax credit value**
- ✓ Credit claiming period is 12 years

	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	\$/MT

Tertiary injectant/other use	\$12.83	\$15.29	\$17.76	\$20.22	\$22.68	\$25.15	\$27.61	\$30.07	\$32.54	\$35.00	---
Sequestration only	\$22.66	\$25.70	\$28.74	\$31.77	\$34.81	\$37.85	\$40.89	\$43.92	\$46.96	\$50.00	---

Note: In 2027 and subsequent years, the rates are adjusted for inflation after 2026.

New Tax scheme could lead to increasing in number of the CCS/CCUS project.

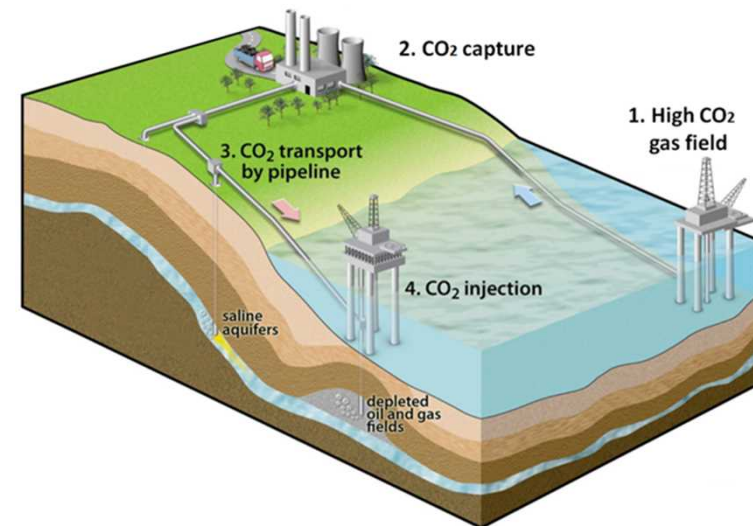
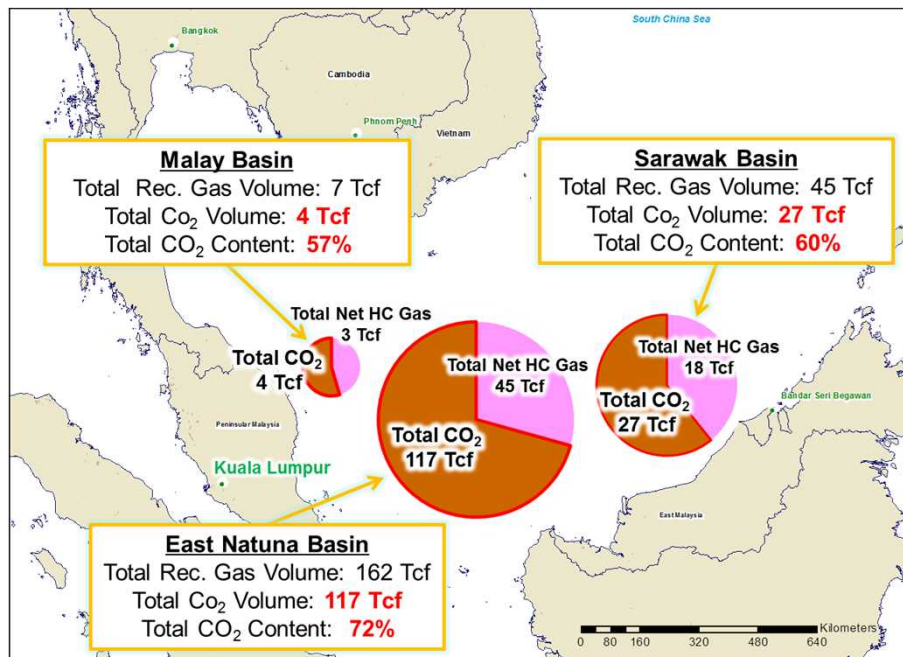
Lessons For Emerging Opportunities in Asia

1. In order to make CCUS prevail in business, **further development of improved carbon capture technologies with much cost reduction is essential.**
2. CCS/CCUS is currently beyond reach of private companies for normal commercial operations. **Governmental supports** are important to take off the scheme to implement in societies:
 - Financial Support by Government and/or government financial institution
 - Tax Incentives
 - Infrastructures (**regulatory frame works**, **Water supply**, CO2 pipeline, Processing Facility, etc.)
3. Sensitivity analysis of elements are important prior to the investment decision. (Crude Oil price, Capex, Opex & CO2 price etc.)

Future Opportunities of CCUS Project

High CO₂ Gas Field Development with CCS

CO₂ Volume from High CO₂ Gas Fields (CO₂ > 20%)
in Malay, Sarawak & East Natuna Basins



High CO₂ Gas Field Development

- ✓ with less CO₂ emission
- ✓ with commercial scale
- ✓ with potential Governmental supports

Interest in Petra Nova Remains High



2017



Numerous tours



Several speaking engagements



30+ articles written

Petra Nova has hosted visitors from many countries across the world.

<https://www.pbs.org/newshour/show/carbon-capturing-make-clean-coal-reality>

<http://www.click2houston.com/news/worlds-largest-carbon-capture-plant-opening-in-richmond>

***Thank you
for
Your Attention***