# Minijos Nafta Clean Energy Project

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**Baltic Carbon Forum**

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Tallin

# What I will Talk About Today

- The Minijos Nafta Clean Energy Project
- A brief description of EOR (enhanced oil recovery) by injecting CO2
- Quick Review of ROZ (Residual Oil Zone) concept and how it is being applied in Texas
- The ROZ in Minijos Nafta license area Lithuania
- Netpower Allam Cycle Technology
- Project Status
- Other potential projects

# How to Pay for CCS

- It is now fairly clear that we need to act to reduce Greehouse Gas Emissions
- It is now recognized that CCS is one of only a few plausible technologies that could make a difference
- But there is no plausible business case for paying for this, except:
- Injecting CO2 in oil fields for enhanced oil recovery which is common well developed technology in the US
- Producing oil as part of the process provides a means of paying for CCS

# Minijos Nafta Clean Energy Project

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# The Project

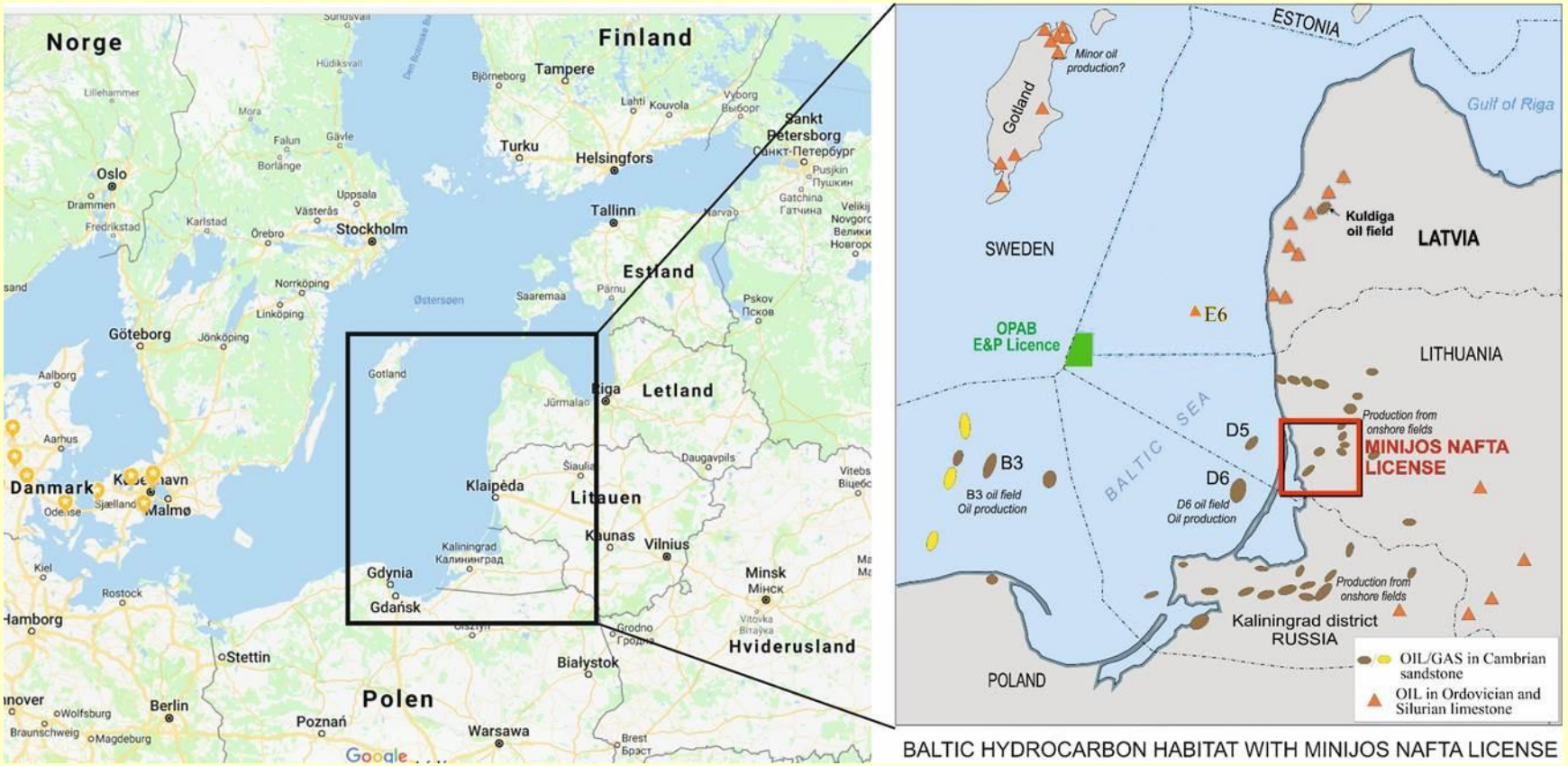
- ✓ Build an Allam cycle power plant in western Lithuania
- ✓ Capture the CO2
- ✓ Use the CO2 for EOR (Enhanced Oil Recovery)
- ✓ Recycle and permanently sequester CO2
- ✓ Provide a storage site for other major GHG emitters in Lithuania

# Project Benefits

- ✓ Employment >1,300 high tech./skilled jobs at peak construction
- ✓ Produce 1/3 of the electricity that Lithuania uses replacing 50% of imported electricity
- ✓ Produce 100 million barrels of oil
- ✓ Pay approximately 2 billion EUR in taxes and royalty over the 30 year life of the project
- ✓ Permanently sequester up to 200 million tons CO2
- ✓ Increase Lithuania's energy independence and ability to more fully integrate with the rest of the EU

# Minijos Nafta License Area

- Infrastructure is already in place.
- Access to major natural gas trunk (~5 km connection) line and high voltage transmission line.
- Oil field suitable for $CO_2$ EOR identified. Close to shipping port and refining facility.




BALTIC HYDROCARBON HABITAT WITH MINIJOS NAFTA LICENSE

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# Infrastructure

- Access to major natural gas trunk (~5 km connection needed) line and high voltage transmission line
- Oil field suitable for $CO_2$ EOR identified (30 – 40 km $CO_2$ pipeline required)
- Nearness to shipping port and refining facility

Major electrical lines (yellow) and gas pipelines (red)

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# Netpower Allam Cycle Power Plant

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# The Allam Cycle

## The supercritical $CO_2$ Allam Cycle is simple

Historically, $CO_2$ capture has been expensive, whether using air combustion or oxy-combustion

Air combustion:

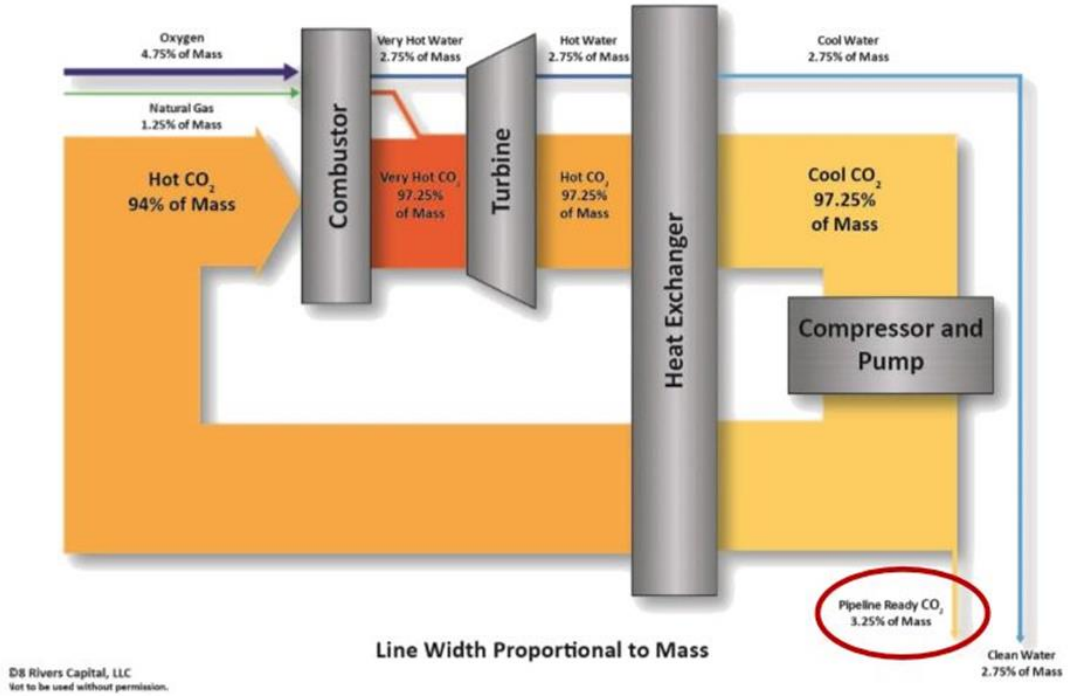
$$\underbrace{8N_2 + 2O_2}_{air} + CH_4 \rightarrow \underbrace{8N_2 + CO_2 + 2H_2O}_{expensive\ to\ separate}$$

Oxy-combustion:

$$\underbrace{2O_2}_{expensive\ to\ produce} + CH_4 \rightarrow CO_2 + 2H_2O$$

The Allam Cycle makes oxy-combustion economic by:

1. Relying on a more efficient core power cycle
2. Recycling heat within the system to reduce $O_2$ and $CH_4$ consumption, and associated costs of the air separation unit (ASU)

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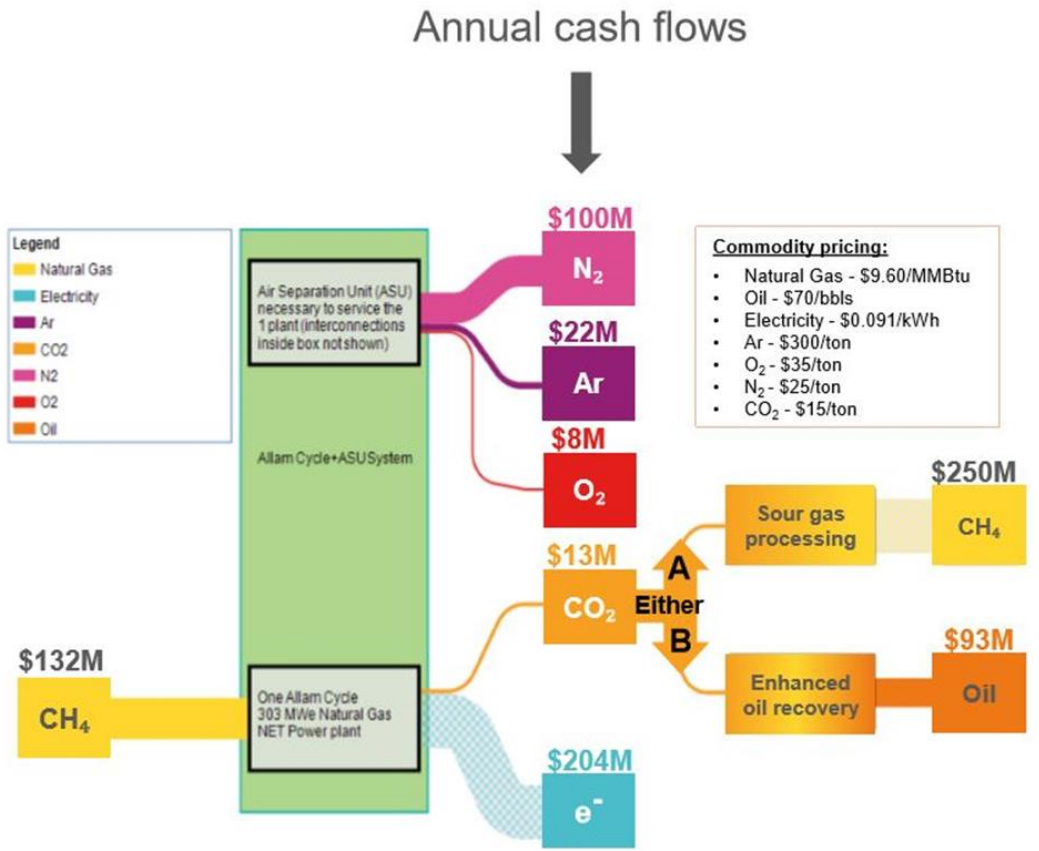
# The Value Chain

## Allam Cycle is about more than electricity

Value of industrial gas stream approaches value of electricity

45Q now being passed increases the value of NET Power's $CO_2$ significantly



# Netpower Demonstration Plant

## 50MWth Demo Plant

**Testing underway**

Entire cycle operational

During combustor test phase, flue gas bypassing turbine to allow for edge-of-envelope testing

**Design Freeze commercial plant summer 2018**

**Commercial Scale-Up to 303 MWe**

**Combustor:** no scale-up, full-scale testing complete

**Turbine shell:** 2.5x scale-up, testing in progress

**Balance of Plant:** components already commercially available at scale

**Q4 2021 Target COD for 1st full-scale plant**



La Porte, TX Demonstration Plant

# THE ROZ BACKGROUND
# (Residual Oil Zone)

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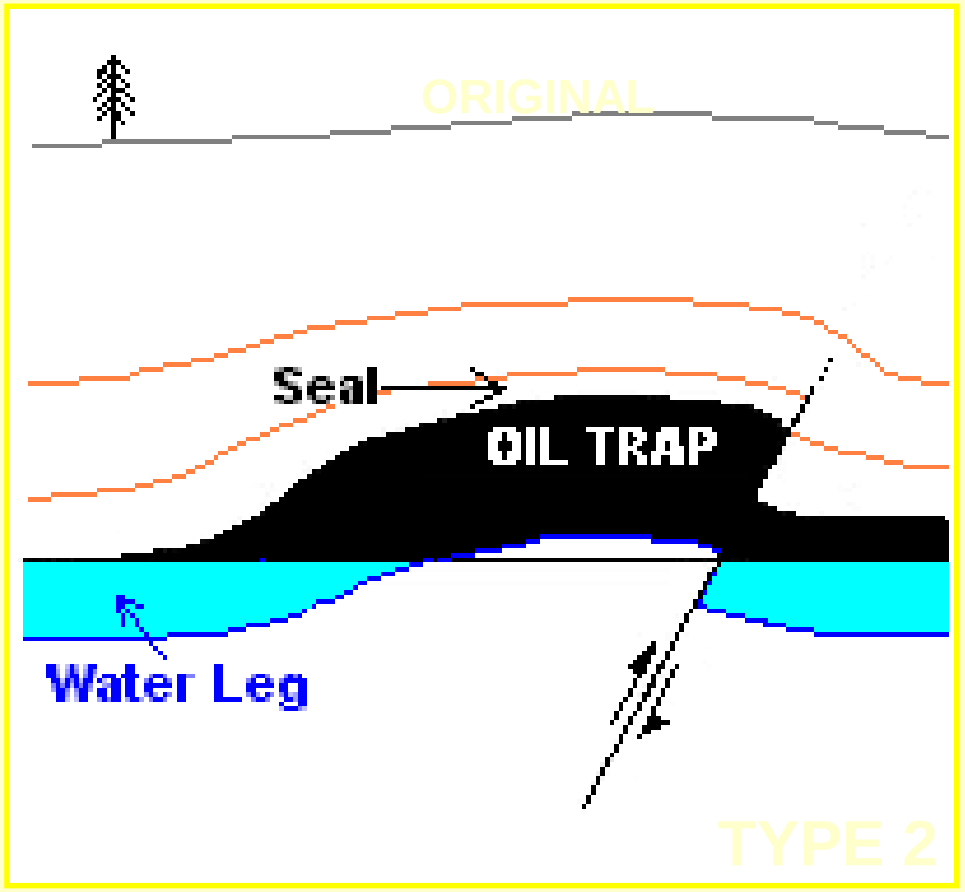
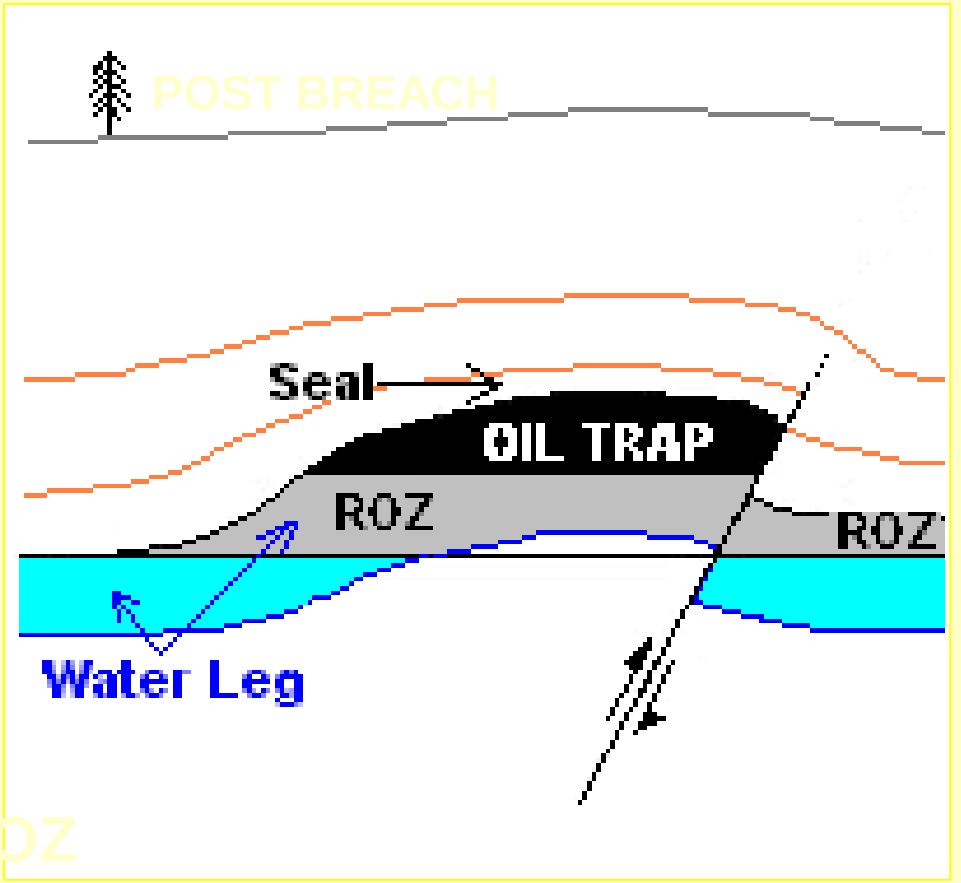
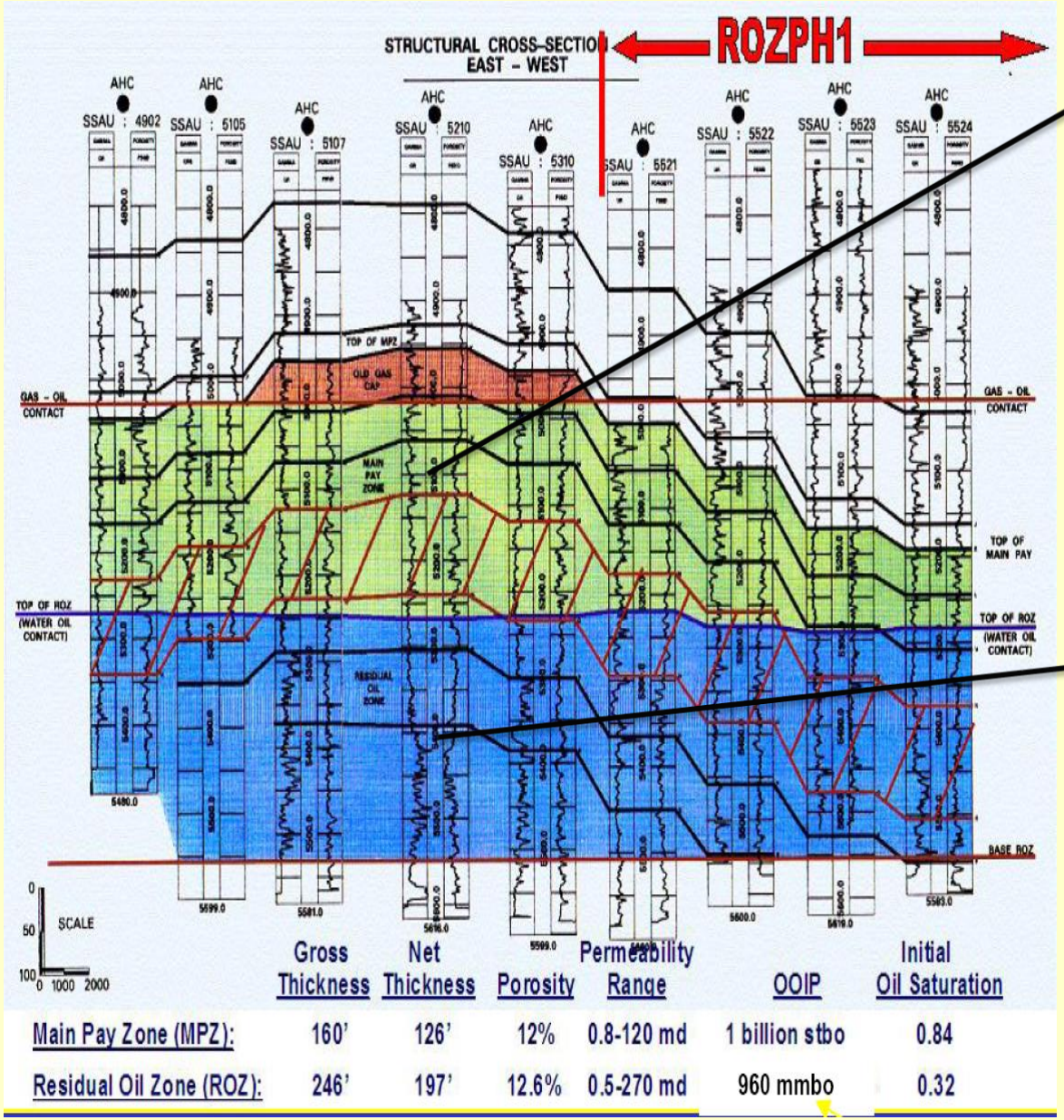
# Original Accumulation with a Breached then Repaired Seal & Forming a ROZ






| | Gross Thickness | Net Thickness | Porosity | Permeability Range | OOIP | Initial Oil Saturation |
|---|---|---|---|---|---|---|
| Main Pay Zone (MPZ): | 160' | 126' | 12% | 0.8-120 md | 1 billion stbo | 0.84 |
| Residual Oil Zone (ROZ): | 246' | 197' | 12.6% | 0.5-270 md | 960 mmbo | 0.32 |

## CONVENTIONAL PAY

## RESIDUAL OIL ZONE ("ROZ") PAY

CHARACTERISTICS:

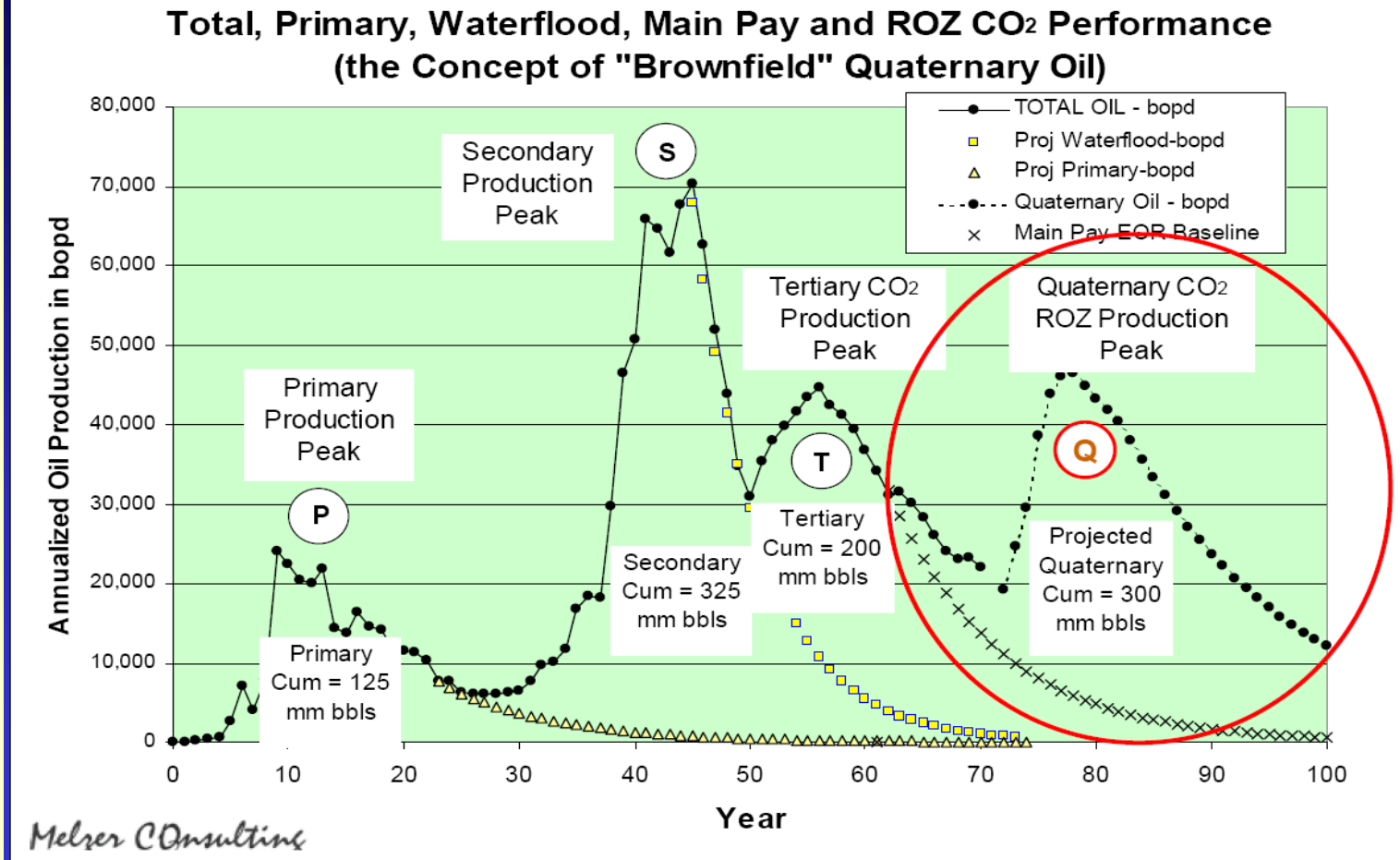
- Oil shows while drilling
- Oil saturation < 50%
- Tests water + some oil

BREACHED FIELD
"NATURAL WATERFLOOD"

10-30% of OIIP CAN BE PRODUCED WITH CO2

# THE CONCEPT OF RESIDUAL OIL PRODUCTION WITH CO2
# (Midland Basin, Texas example)

## 'Quaternary' Example Production History & Projection (San Andres – W. Tx)

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# ROZ
# LITHUANIA

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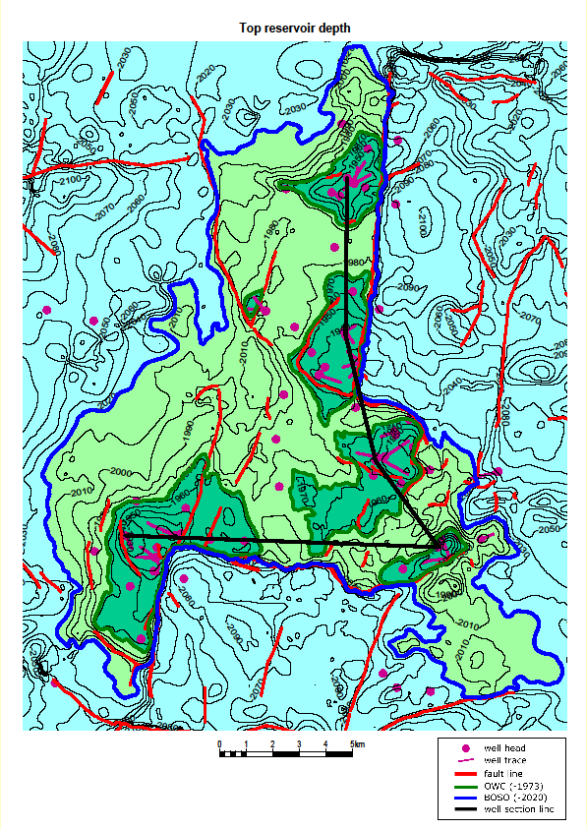
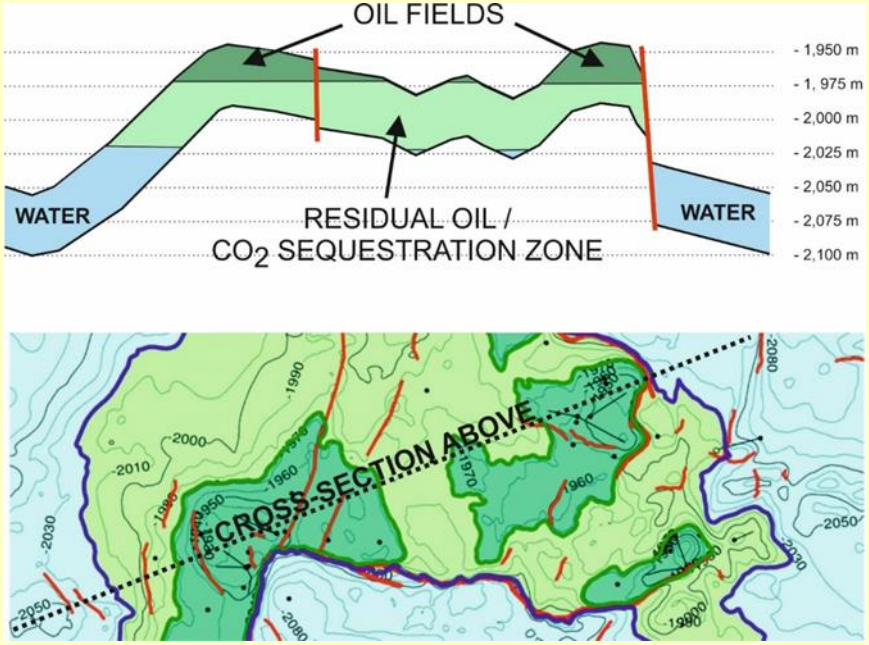
# The Oil Fields and ROZ

- Total area for $CO_2$ storage is over 245 square km (Blue Outline).
- The increased Oil recovery using $CO_2$ is in the order of 145 Million Barrels of Oil.
- Capacity to sequester more than 250 million tons CO2




**-1,973m Oil/Water Contact**

**-2,020m BASE OIL SATURATION**

The lower unproduced Residual Oil Zone has considerable oil saturation (40 to 60%) that can be recovered with $CO_2$.

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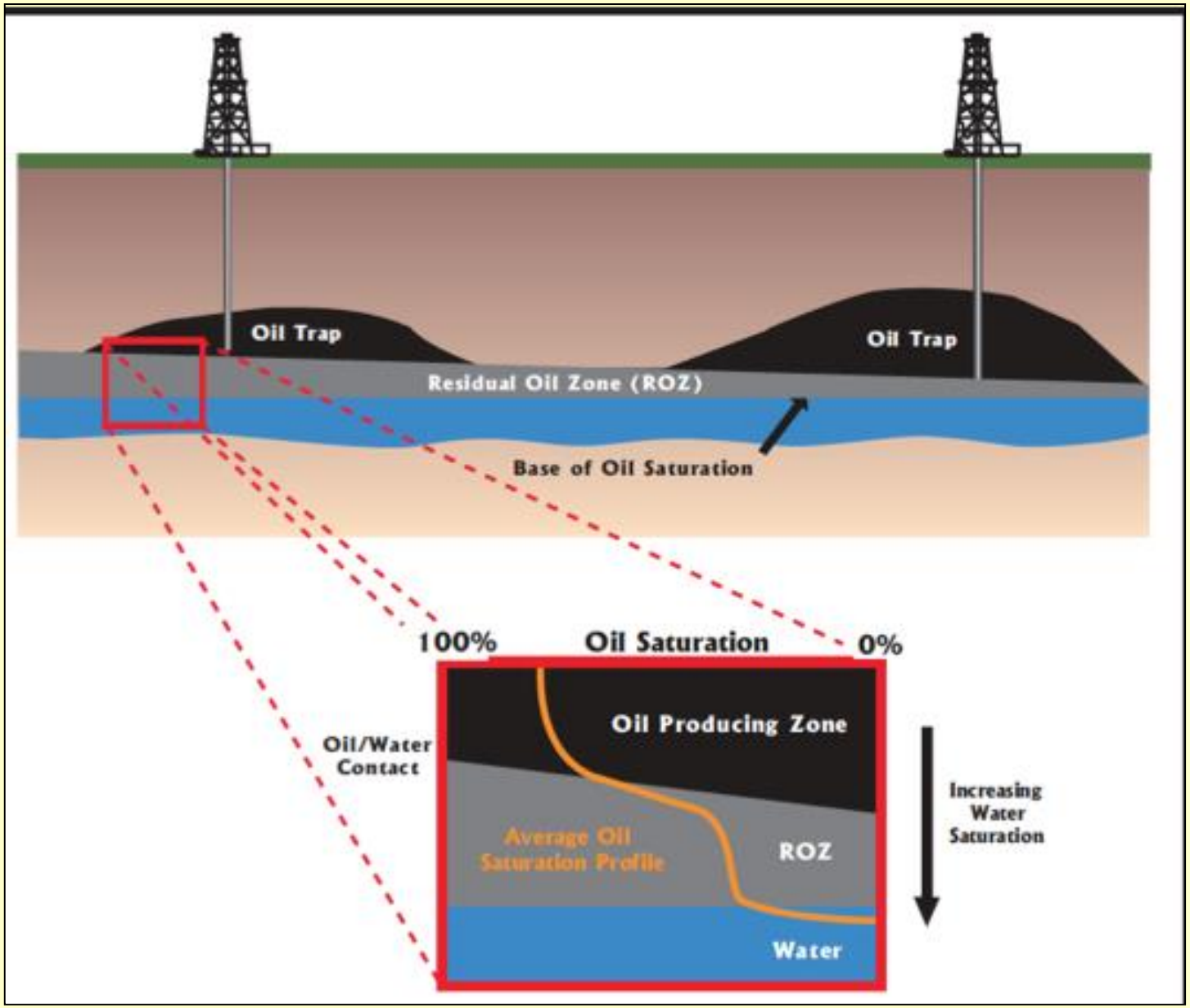
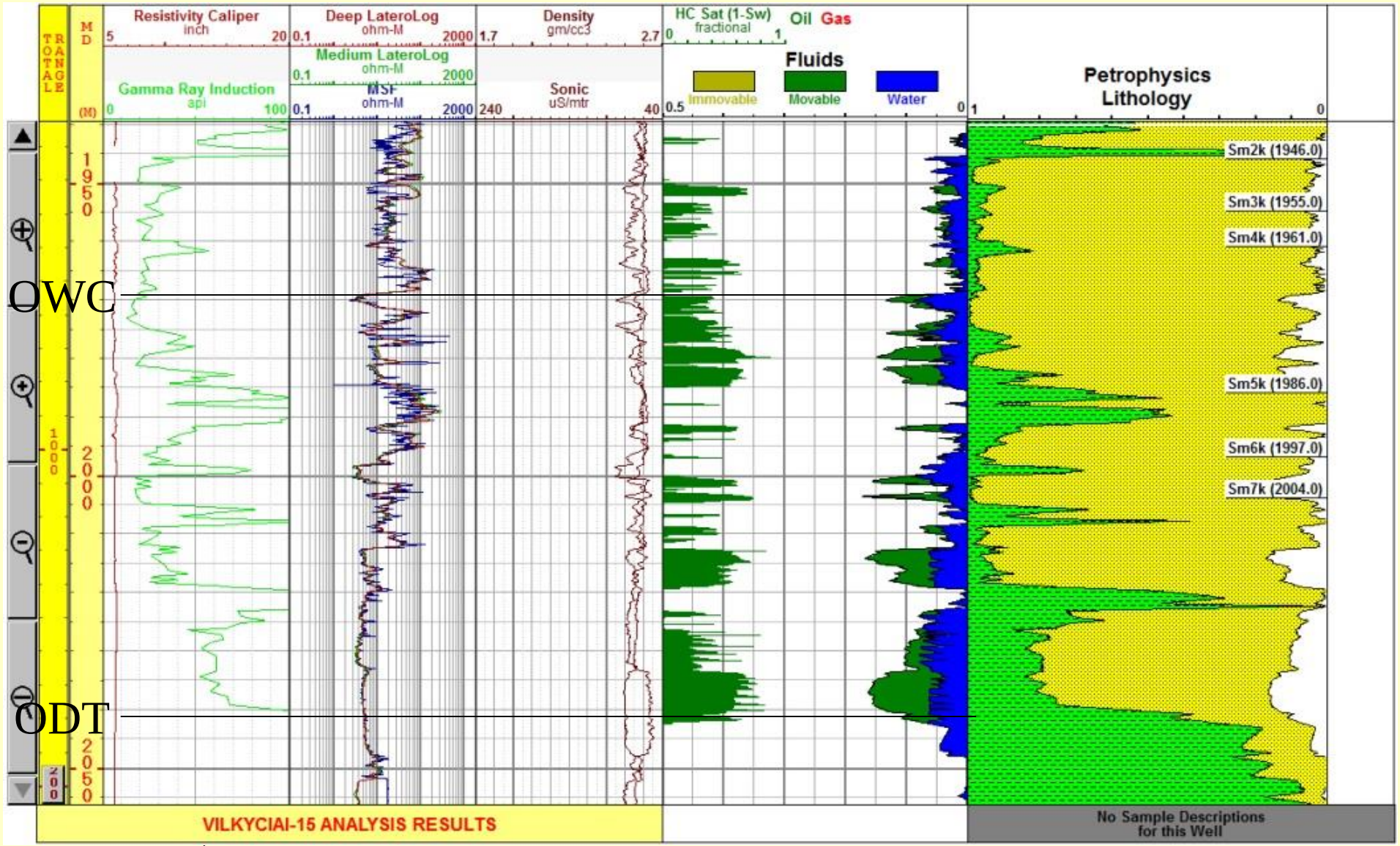
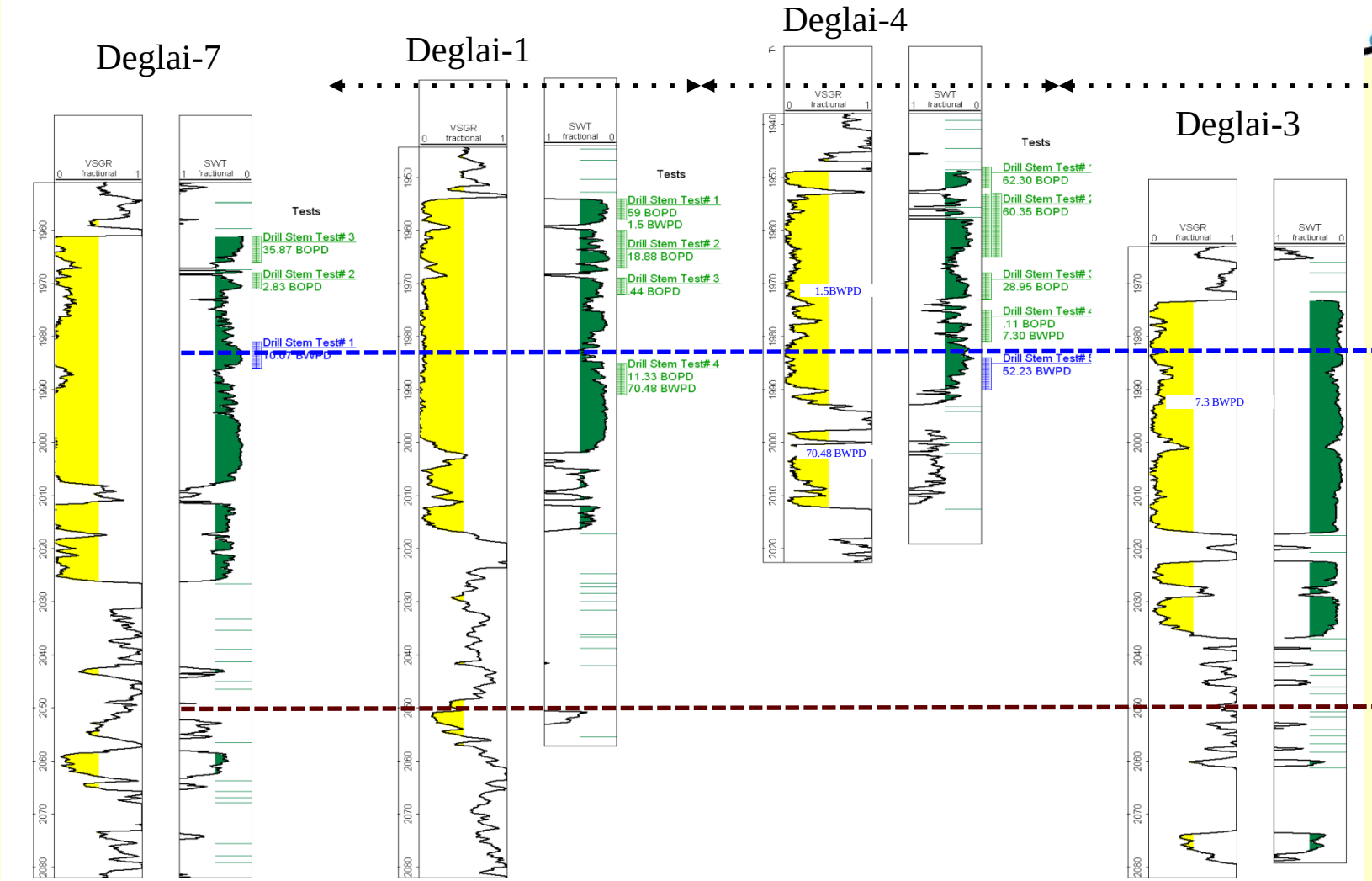



- MN oil trap 20m
- MN ROZ 70m

# Vilkyciai-15

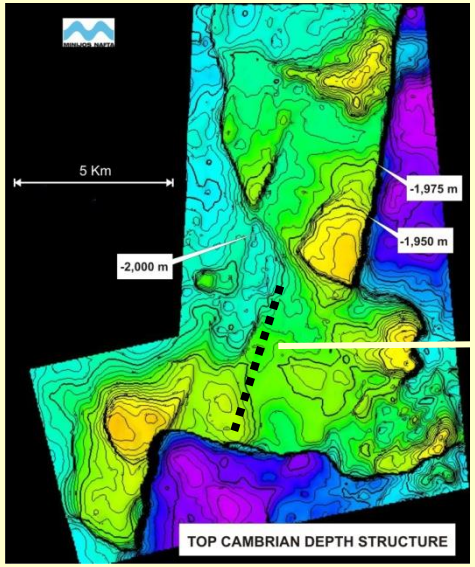


# Well Correlation in MN License

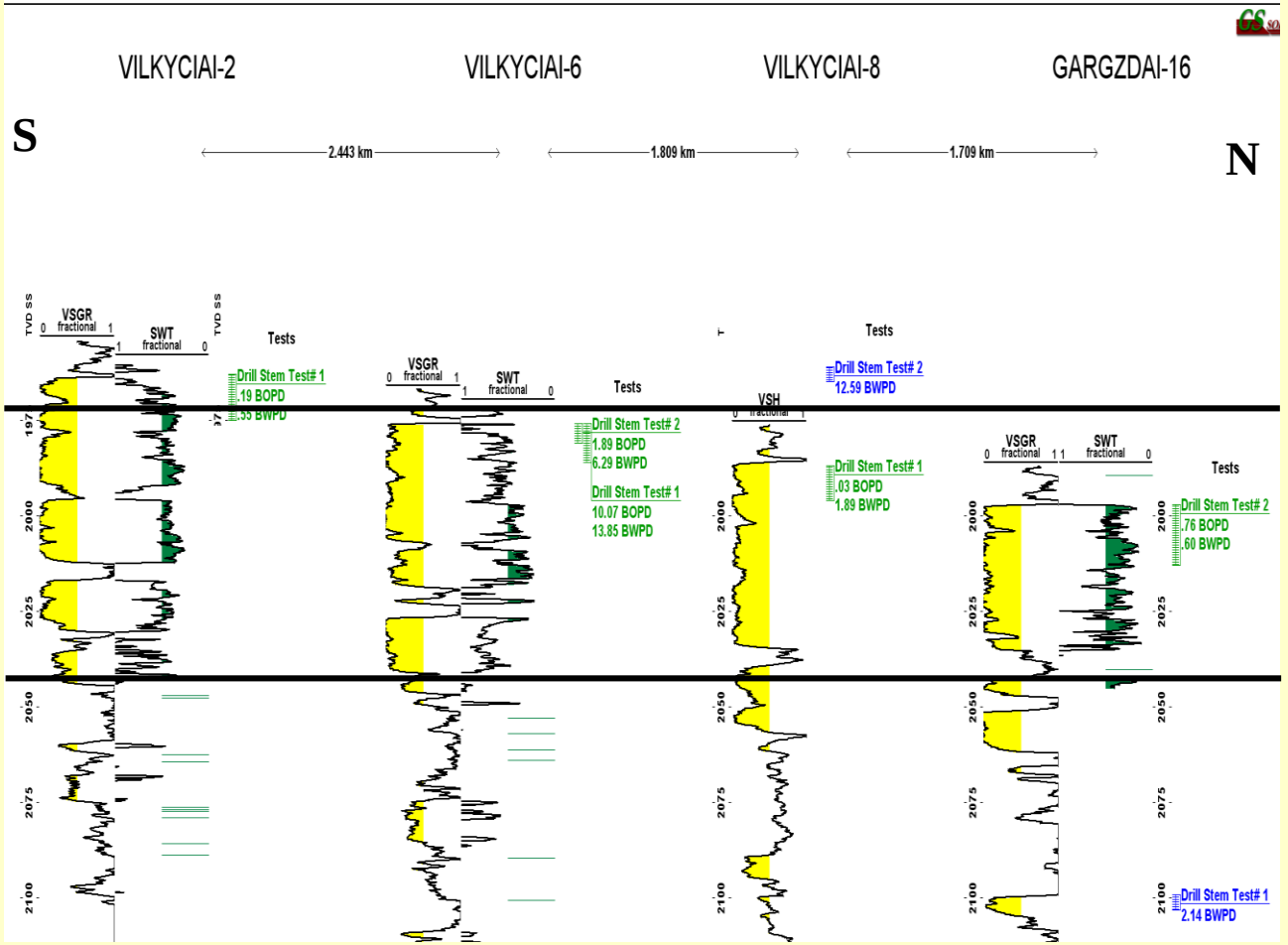



OWC selected at –1970m on basis well flow tests but oil is seen down to -2040m with oil saturations of 40-60%.

# Residual Oil Zone Minjos Nafta License Area




**CROSS-SECTION BELOW; ALL RESERVOIRS BELOW OWC**




**OIL-WATER-CONTACT –1,973**

**65 m RESIDUAL OIL ZONE (ROZ)**

**BASE of OIL SATURATION ("BOSO") –2,040**

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# Enhanced Oil Recovery (EOR)

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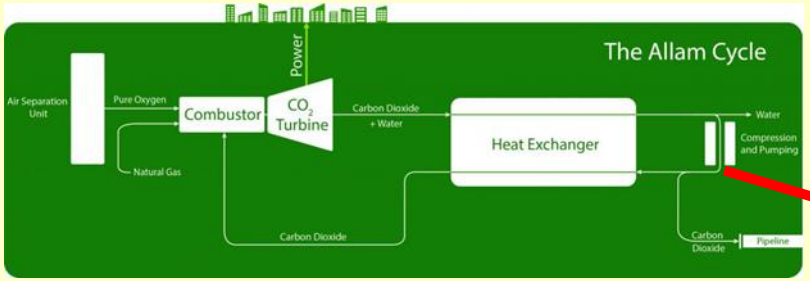
# EOR using CO2

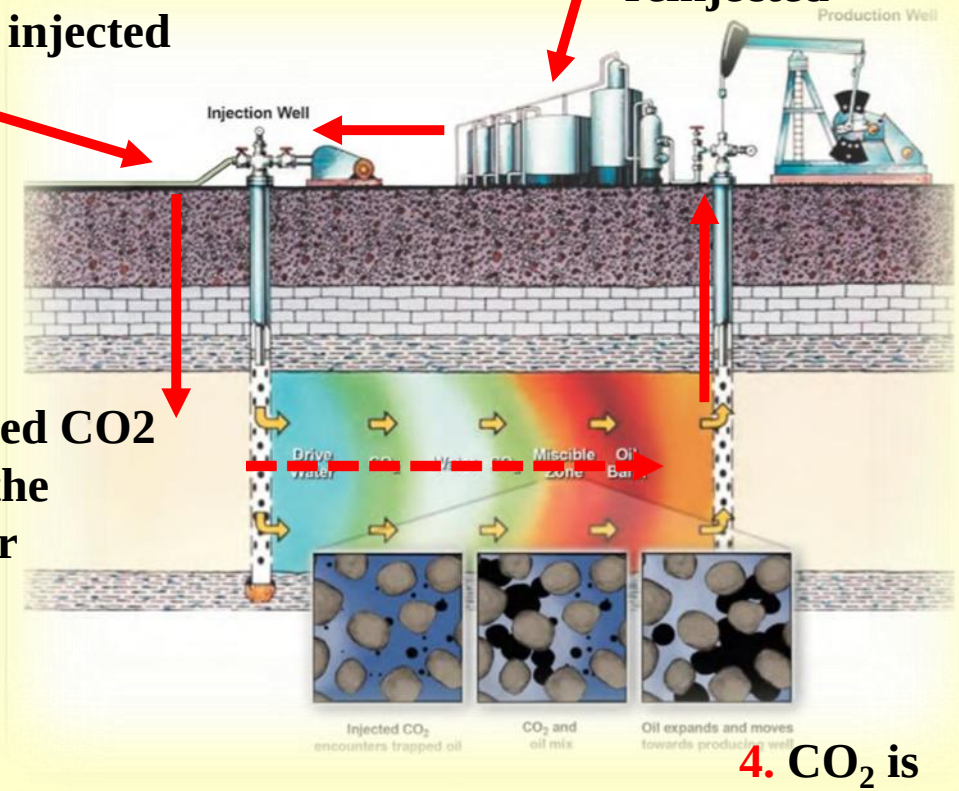
- A typical oil field produces around 25% of the oil in place with the rest remaining “stuck to the rock”
- Under the right temperature and pressure conditions liquid CO2 injected into oil bearing rocks chemically attaches itself to oil molecules making the oil more mobile
- An additional 10% to 20% of the oil in place can be recovered by injecting CO2
- This is common practice in the US. In Texas prior to the shale oil revolution around 30% of the oil produced came from CO2 injection
- The CO2 is captured as it is produced and re-injected such that the CO2 stays in the ground permanently

# Carbon Capture & Storage - CO2 Injection Process




**1.** **$CO_2$ from the NET Power Plant is injected**

**3.** **Oil and CO2 are recovered and $CO_2$ is reinjected**




**2.** **Injected CO2 sweeps the reservoir**

**4.** **$CO_2$ is permanently sequestered**

**Eliminate 30 million tons of $CO_2$ emissions. Provide additional $CO_2$ storage capacity allowing the 5 biggest emitters in Lithuania to sequester their emissions (5M - 6M tons $CO_2$ / year)**

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# 1 Billion Barrels OIP

| | |
|---|---|
| area km2 | 137 |
| area m2 | 137,000,000 |
| thickness m | 70 |
| net to gross | 0.40 |
| net sand volume m3 | 3,836,000,000 |
| porosity | 0.10 |
| pore space m3 | 383,600,000 |
| oil saturation | 0.5 |
| Oil in place m3 | 191,800,000 |
| barrels/m3 | 6.3 |
| Oil in place barrels | 1,208,340,000 |
| recovery factor | 0.10 |
| potential oil | 120,834,000 |

# Minijos Nafta Oil Potential

MINIJOS NAFTA VOLUMETRICS:

Remaining conventional reserves (government) : 6 MMBO

Sand 5 potential above OWC :20 MMBO

Exploration potential : 6 MMBO

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CO2 additional recovery above OWC (Melzer) : 18.5 MMBO

CO2 recovery in residual zone (Melzer) : 100-300 MMBO

# CO2 Injection Tests

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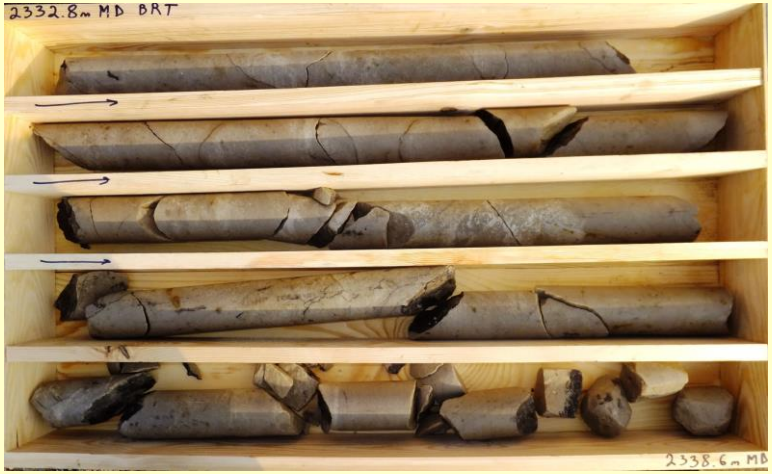
# CO2 Test injection

- 3 CO2 injection tests
- All produced oil after CO2 injection

# PS-2 Well Test




- Well was drilled and completed only within the ROZ
- Initial production produced only water
- After injection of CO2 in the ROZ produced oil
- IT DOES WORK

# Project Status

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# MOU Signed for Clean Power project in Lithuania

Build a NET Power emissions-free gas fired electric power plant in Lithuania which would:

- ✓ Sequester 30 million tons of $CO_2$ emissions. Provide additional storage capacity for $CO_2$ allowing the 5 biggest emitters in Lithuania to sequester their emissions (5M - 6M tons $CO_2$ / year)
- ✓ Activate the largest private investment ever in Lithuania
- ✓ Replace 50% of electricity imports, greatly enhancing Lithuania's energy independence (providing 33% of Lithuania's electricity needs)
- ✓ Lower the cost of electricity and natural gas
- ✓ Utilize the LNG import terminal to import an additional 484M $Nm^3$ gas annually
- ✓ Enable the production of 100-150 million barrels oil by using CO2 for EOR and permanent sequestration of 200 million tons CO2


From L to R: Damian Beauchamp (Chief of Staff, 8 Rivers), Žygimantas Vaičiūnas (Lithuanian Energy Minister), Dan R. Brouillette (U.S. Dep. Sec. of Energy), and Bill Brown (CEO, NET Power)

Memorandum of Understanding toward NET Power project in Lithuania signed between NET Power, 8 Rivers, and the Lithuania Ministry of Energy at CERA Week in Houston, TX on March 14, 2019. Signing observed by United States Deputy Secretary of Energy, Dan R. Brouillette.

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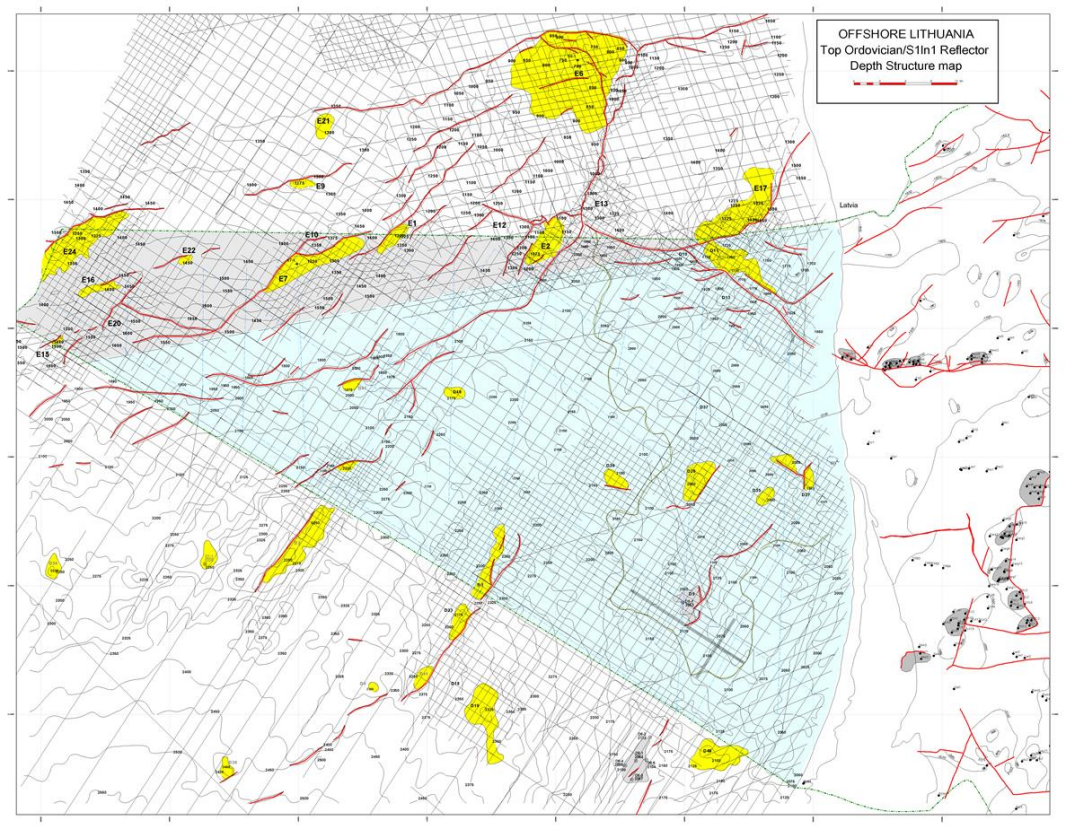
# Conclusions

- Produce 1/3 of Lithuania's electricity requirement
- All CO2 captured and stored
- 100 mbo recoverable using CO2 EOR
- Sequester 30 to 200 million tons of CO2
- The possibility to produce 100 million barrels of oil significantly alters the economics of CCS

# Other Baltic Area Projects




- Many known structures offshore Latvia and Lithuania
- Some of these are suitable for CCS
- Odin is interested in talking to other parties about developing CCS projects in the Baltic area