CARBON REDUCTION STRATEGIES

for Trinidad and Tobago

by Krishna Persad (presented by Clyde Abder)

January 26th 2011

Trinidad and Tobago currently vents about 45 million tons of Carbon Dioxide per year

Not a lot perhaps when compared to the world total…but enough to make us the 7th largest per capita in the world

We have signed on to the Kyoto protocol and need to reduce carbon emissions…how can we do that?

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There are numerous ways in which carbon emissions can be reduced in Trinidad and Tobago

Most just simply cost money…and it adds up !!!

A few help save money

Only one is a net revenue earner…AND it is HUGE…in both carbon reduction and revenue earning
Let us show you some of the major options and then focus on the big revenue earner

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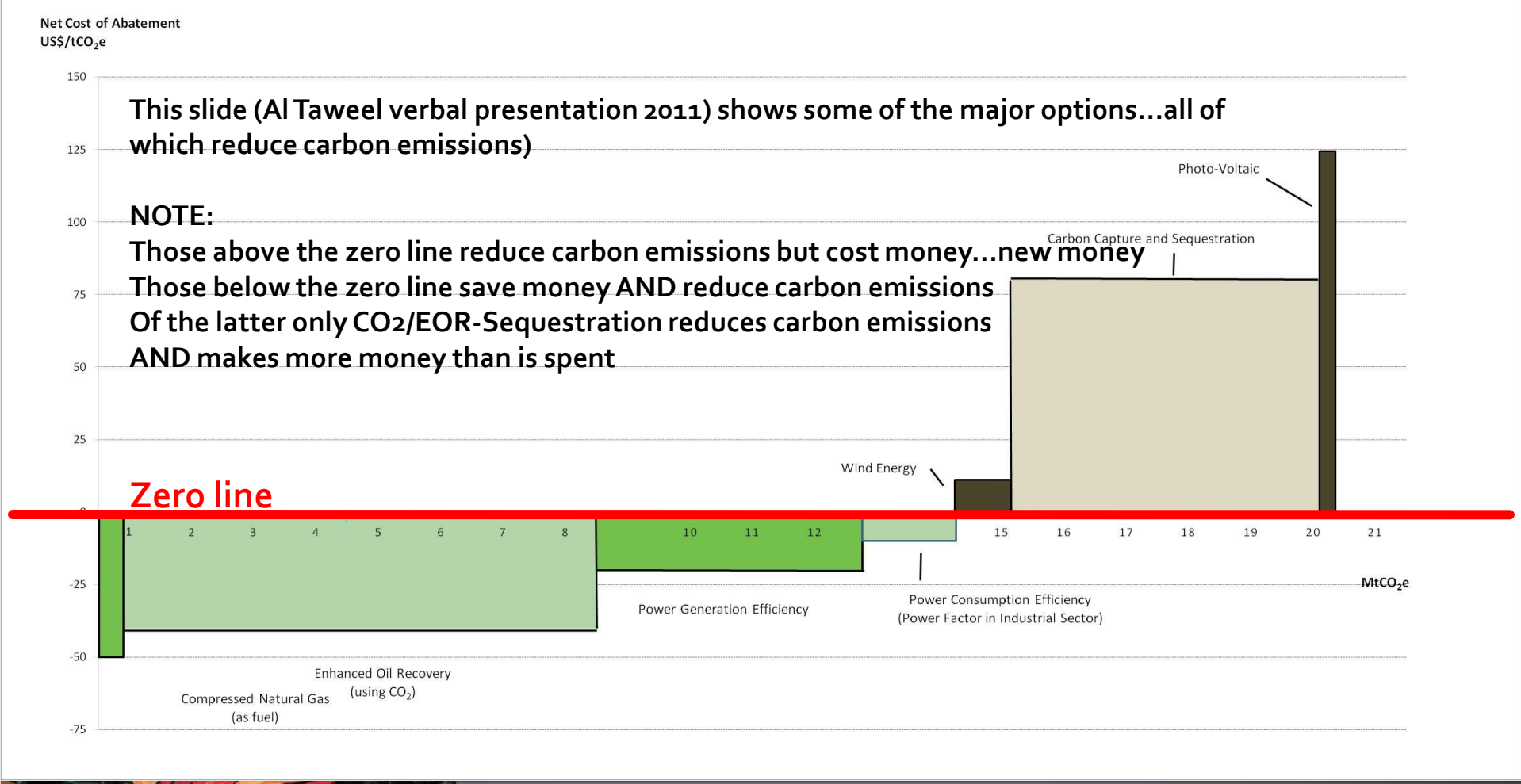

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CARBON REDUCTION STRATEGIES

We believe the potential for theCO2/EOR-Sequestration is higher than Prof. Al Taweel suggests

AND that there are other options for reduction of emissions

AND that wind and photovoltaic will be net revenue earners

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CARBON REDUCTION STRATEGIES

DIRECT

CO_2/EOR-Sequestration

Natural Gas Capture and re-injection or Flaring with flue Gas capture and CO_2 extraction (from flue gas) for use in CO_2/EOR-Sequestration

Energy Efficiency

- Electricity Generation
- Power Consumption

Alternative Energy Usage

- CNG as vehicular fuel
- Piped Natural Gas to homes and businesses

Renewable Energy

- Wind generated electricity
- Photovoltaic electricity
- Hydro-electricity incl. dams streams waves currents etc.

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CARBON REDUCTION STRATEGIES

INDIRECT

Use/Reuse/Recycling of Waste Products/Discarded Materials

Reduction of Water Usage

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CARBON REDUCTION STRATEGIES DIRECT

CO_2/EOR combined with simultaneous (Dynamic) Sequestration

CO_2 sources

- relatively pure CO_2 from ammonia plants… 200MMCFD
- flue Gas capture and CO_2 extraction…from industrial and electricity generating plants…2.3 BCFD

INITIALLY FOCUS ON AMMONIA PLANTS then
MOST of the rest can be later on used for CO_2/EOR and Sequestered

POTENTIAL REDUCTION around 30 MM tonnes per annum
i.e. the bulk of our CO_2 emissions

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CARBON REDUCTION STRATEGIES DIRECT

Natural Gas Capture or Flaring

The bulk of the associated gas in onshore oil production is vented to atmosphere
We produce about 20,000 bopd onshore…GOR is around 500 scf per bbl…that is 10 MMCFD…worse than emissions from all ammonia plants combined because
Natural Gas is 20 times worse than CO_2 as a greenhouse gas
Options: Capture compress and re-inject
Flare and vent flue gas
Flare, extract CO_2 from flue gas and use CO_2 for EOR then sequester

POTENTIAL REDUCTION around 200,000 tonnes per annum

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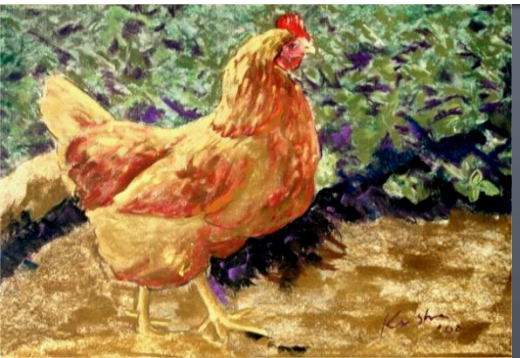
ENERGY EFFICIENCY

Electricity Generation Efficiency

e.g. moving to combined cycle

POTENTIAL REDUCTION around 4 MM tonnes per annum (Al Taweel 2011)



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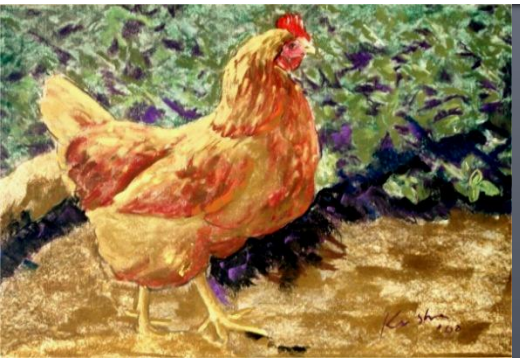
ENERGY EFFICIENCY

Power Consumption Efficiency

- **Power consumption efficiency in industrial plants**

POTENTIAL REDUCTION around 2 MM tonnes per annum (after Al Taweel 2011)



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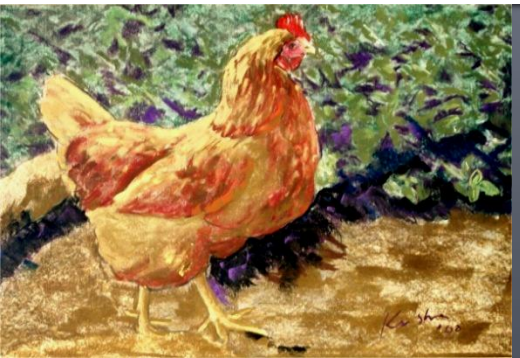
ENERGY EFFICIENCY

Power Consumption Efficiency

- **Power consumption efficiency in industrial plants**
- **Conversion of Street Lights to DC Fluorescents/LEDs run on PV panels**
- **Phase out of ALL Incandescent lights to Fluorescents/LEDs**
- **Improving energy efficiency of appliances**

POTENTIAL REDUCTION around 2 MM tonnes per annum (after Al Taweel 2011)



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CARBON REDUCTION STRATEGIES DIRECT

RENEWABLE ENERGY

WIND

- Commercial Wind Farms
- Wind Generators for homes

SOLAR

- Solar Water Heaters
- Photovoltaic Lighting in homes and businesses

HYDRO-ELECTRICITY GENERATION

- Dams
- Rivers and streams
- Waves and currents

POTENTIAL REDUCTION around 200,000 tonnes per annum

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CARBON REDUCTION STRATEGIES INDIRECT

Use/Reuse Recycling of Waste Products/Discarded Materials

Organic Fertilizer manufacture from CEPEP grass cuttings
Recycling of plastic bottles into furniture and roofing tiles etc
Recycling of glass bottles
Home composting from cuttings, kitchen garbage and old newspapers

POTENTIAL REDUCTION around 50,000 tonnes per annum

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CARBON REDUCTION STRATEGIES INDIRECT

Reduction of Water Usage

Capture of rain water for use to flush toilets and/or irrigation
Capture of grey water for use in irrigation
Capture and treatment of waste water from septic tanks for irrigation

POTENTIAL REDUCTION around 10,000 tonnes per annum

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CARBON REDUCTION STRATEGIES

We believe the largest carbon reduction strategy is CO_2/EOR-Sequestration
It is also the best because it makes money

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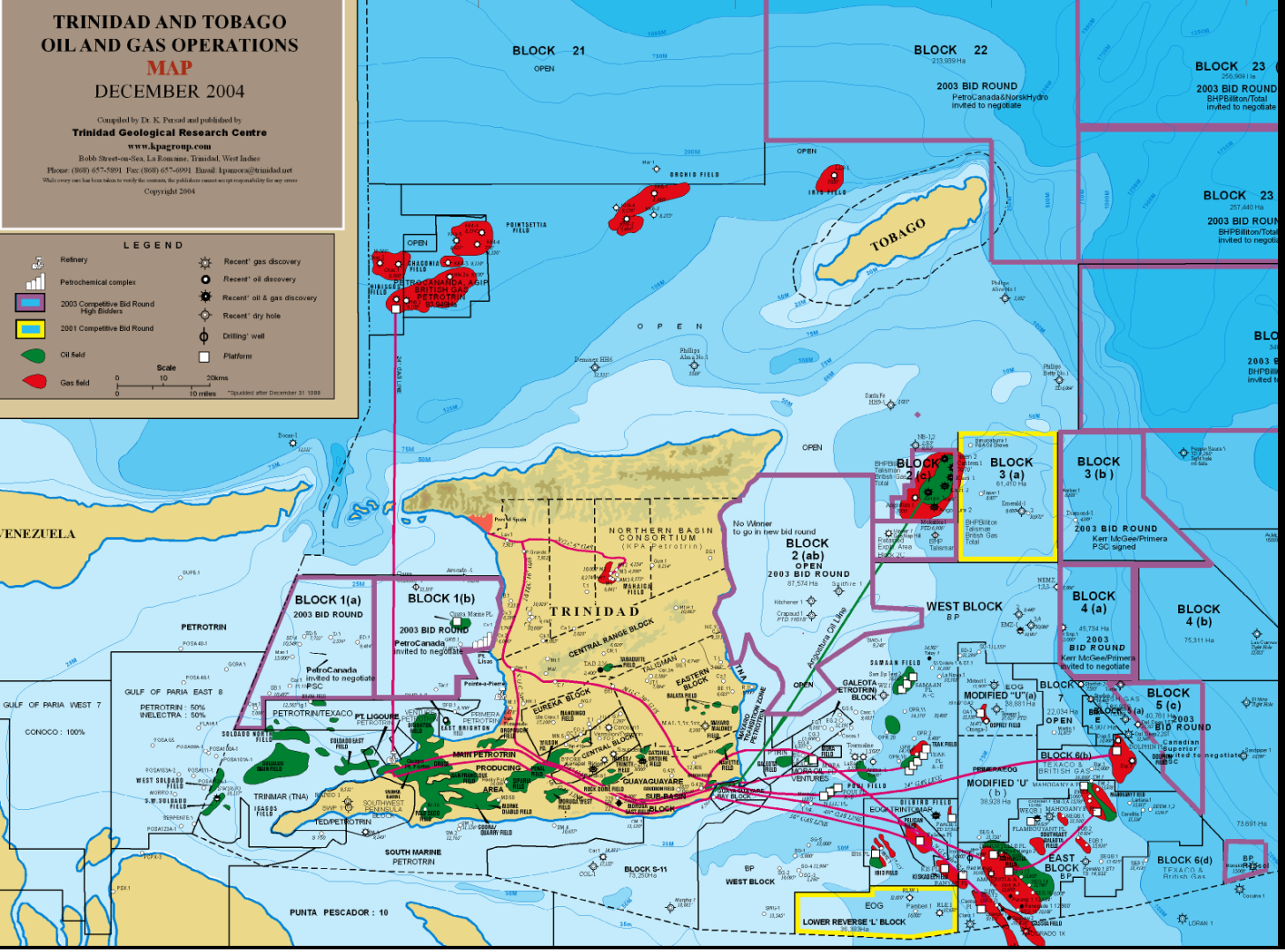

CO_2/EOR Sequestration

Potential …HUGE
100,000 bopd for 100 years
Over 3.5 billion barrels cumulative

AND

15 TCF of CO_2 (@ 5MCF per bbl) can be sequestered
30 MM tonnes per annum

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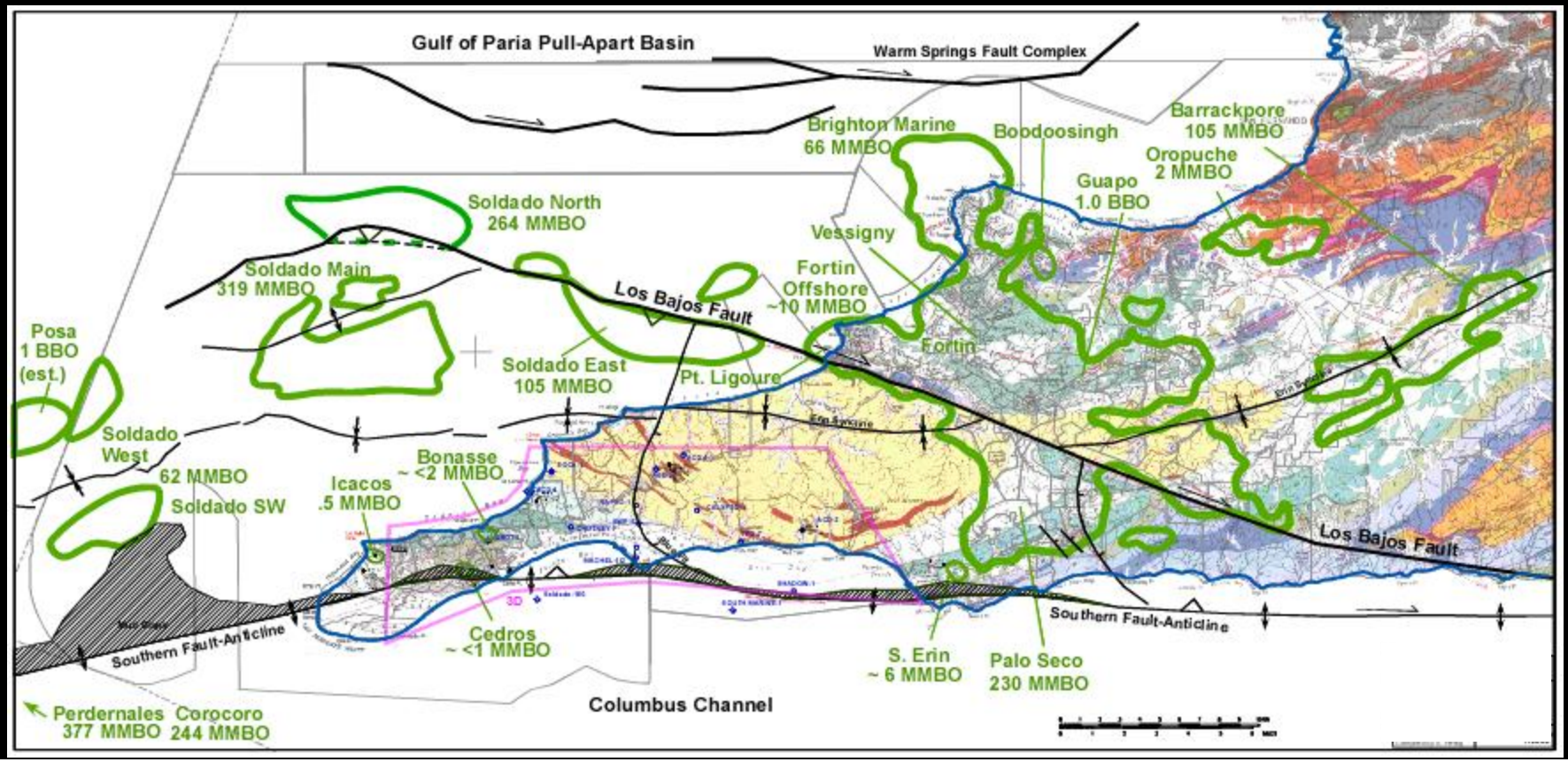
CO_2/EOR Sequestration Potential
Low Hanging Fruit…land and Gulf of Paria Fields especially those with heavy oil



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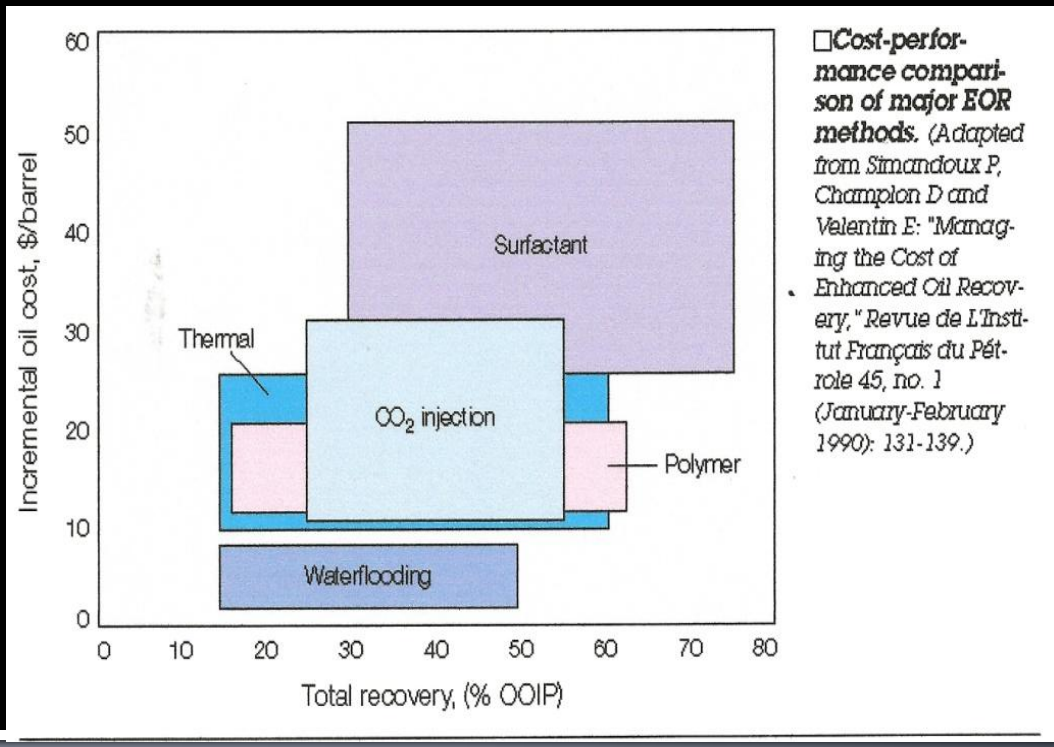
FUTURE PROSPECTS for PRODUCTION OF OIL BY CO_2/EOR

CO_2/EOR ideally can recover up 55% of OOIP together with other forms of recovery like primary and secondary.

Experience from the onshore Bati Raman Field in Turkey shows that this may be up to 35% in heavy oil

In the Weyburn /Midale fields in Canada incremental production is now over 25,000 bopd and up to 300 MMCFD is being sequestered



□*Cost-performance comparison of major EOR methods.* (*Adapted from Simandoux P, Champion D and Valentin F: "Managing the Cost of Enhanced Oil Recovery," Revue de L'Institut Français du Pétrole 45, no. 1 (January-February 1990): 131-139.*)

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EXAMPLE… BATI-RAMAN FIELD TURKEY…

the largest immiscible heavy oil CO2 EOR flood in the world

(AND T&T has significant resources of heavy oil)

Immiscible CO_2 flood since 1986. A plateau oil production rate of 12,000 STB/d was reached in December 1990 and maintained near this level for 10 years

Injecting 30 to 40 MMCFD of Co_2.

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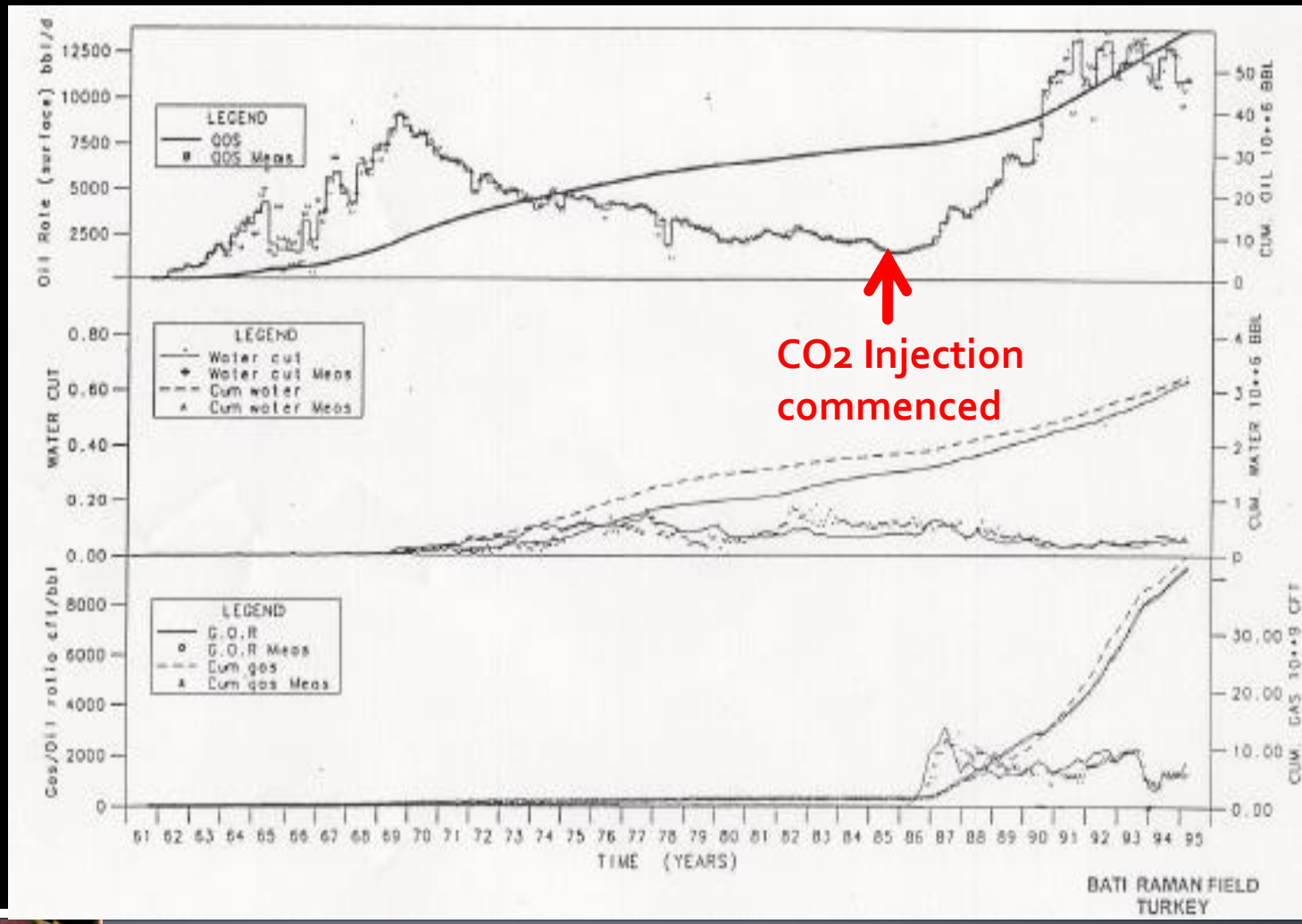
EXAMPLE
BATI-RAMAN FIELD TURKEY
35 MMBO (2%) primary to 1986

An additional 60 MMBO (5%) recovered in 20 years using CO_2 (to 2007)



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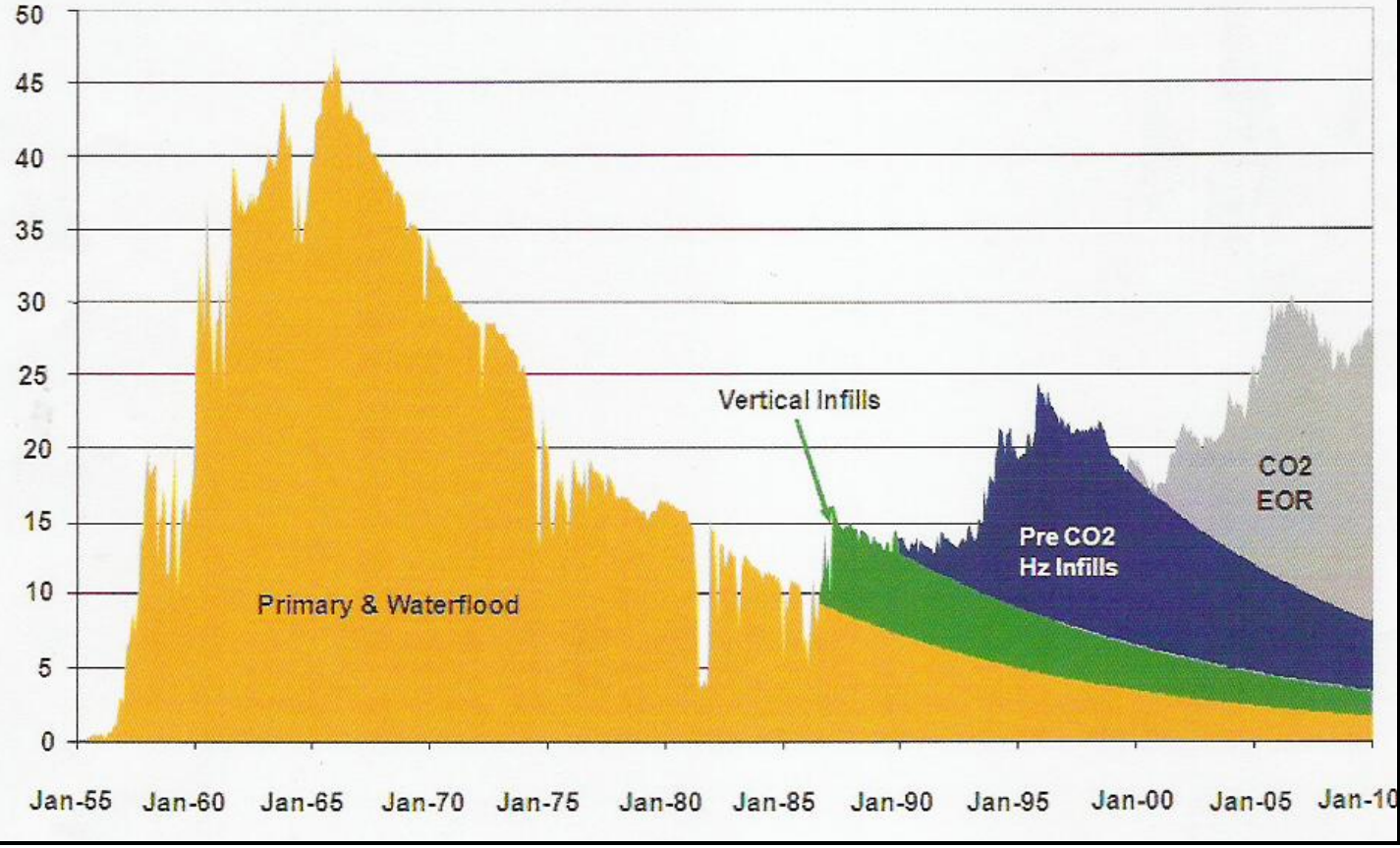
EXAMPLE

WEYBURN/ MIDALE

INJECTING 300MMCFD CO_2…
17 million tonnes sequestered to date Jan 2010

Weyburn alone is 28,000 bopd…35 year high
20,000 more than without CO_2

- EnCana's Weyburn Field: ~28,000 bbl/day, at a 35-year high
  (approximately 20,000 bbl/d more than would be produced without the CO_2 flood)



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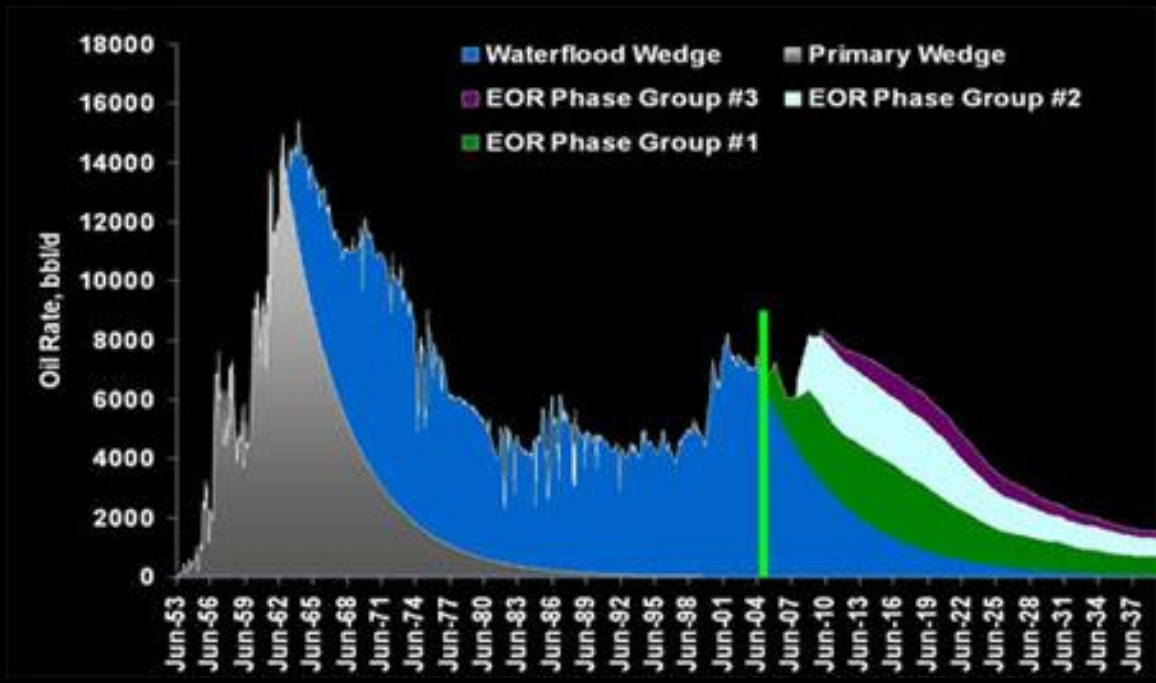
EXAMPLE

MIDALE FIELD IS OPERATED BY APACHE…CO_2 INJECTION STARTED IN 2006

PRODUCTION IS NOW 6,500 BOPD

25 million cubic feet (MMcf) of CO_2 will be injected daily for 20 years to assist in the recovery of an additional 45- to 60-million barrels of oil.

In 20 years, the level of CO_2 within the field will reach approximately 180 billion cubic feet, at which point the CO_2 will be recycled for an additional 20 years.



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MIDALE FIELD STATISTICS

Field Size:
40 square miles

Oil Type:
Medium sour crude

Original oil in place:
515 million barrels

Oil recovery (prior to using CO_2 for enhanced oil recovery):
154 million barrels

Projected CO_2 incremental oil recovery:
67 million barrels

Projected CO_2 stored:
10+ million tonnes* (gross)
8.5+ million tonnes (net)

**equivalent to removing over 2 million cars off the road for a year*

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HOW DOES CO_2 WORK ?

CARBON DIOXIDE DISSOLVES IN THE OIL THEREBY SWELLING IT

THIS RESULTS IN MUCH LOWER VISCOSITY AND HIGHER RELATIVE OIL SATURATION

BOTH EFFECTS COMBINE TO

INCREASE OIL PRODUCTIONS RATES BY 2-3 TIMES PRE-INJECTION RATE
And
INCREASE % OF OIL PRODUCED TO AS MUCH AS 55% OF TOTAL OOIP

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CO_2/EOR and SEQUESTRATION

IN T&T IT WILL BE NECESSARY TO BUILD A CO_2 PIPELINE SYSTEM FROM PT. LISAS TO THE FIELDS

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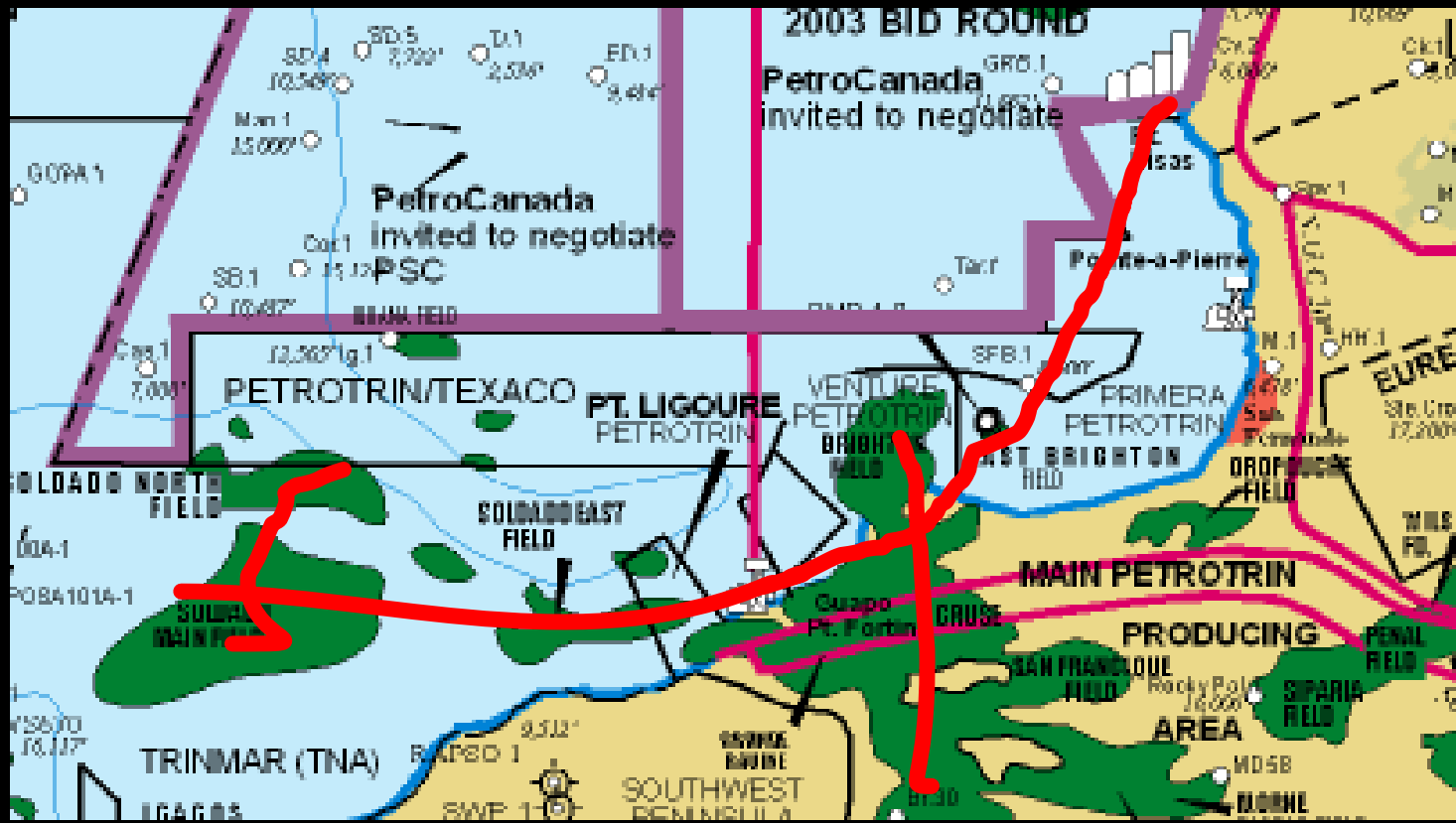
PIPELINE SYSTEM…a good first step could be to the Gulf of Paria fields and then to the onshore western Southern Basin onshore Fields



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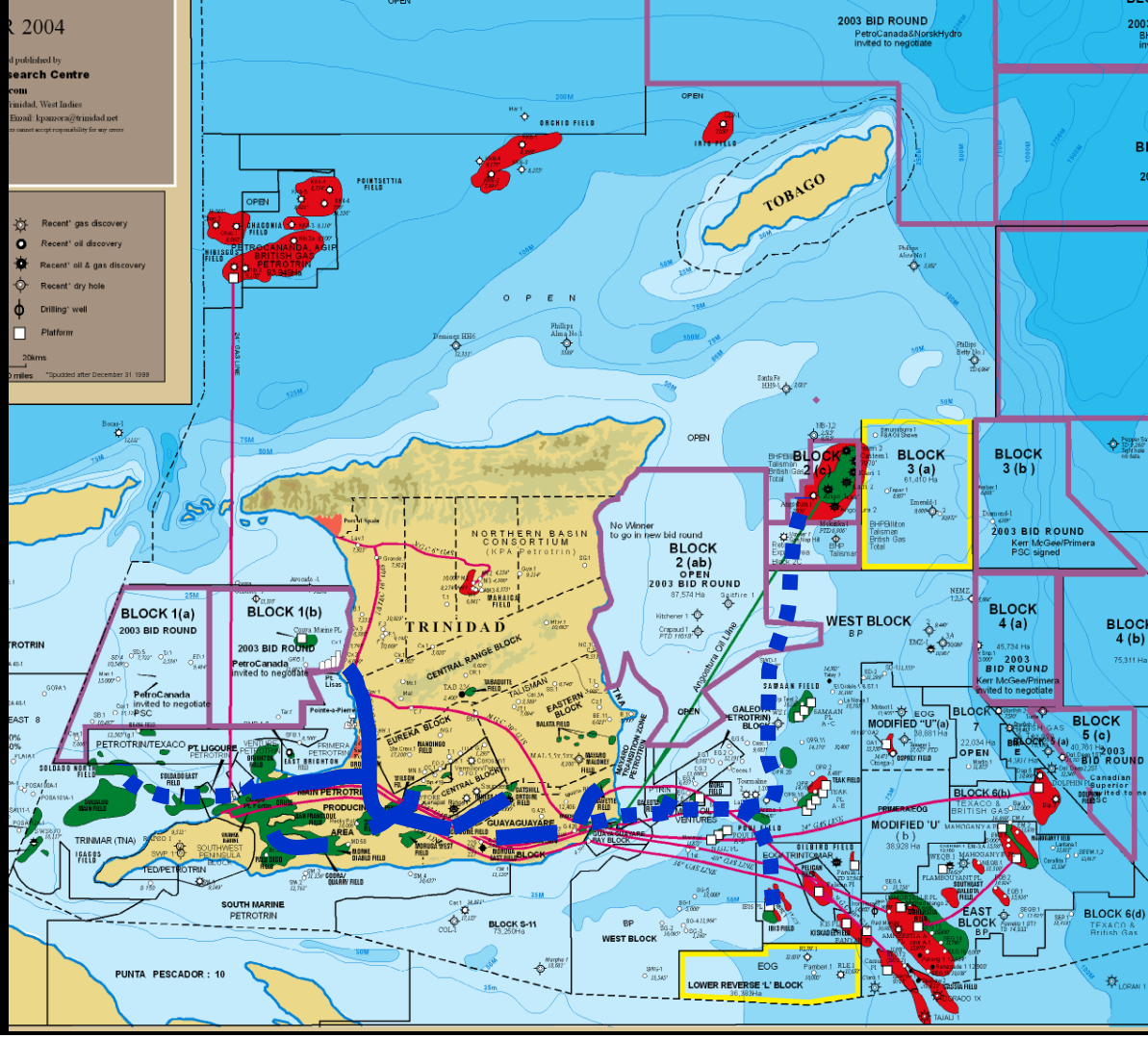
PIPELINE

ONE COULD THEN EXPAND ALONG NGC'S (AND/OR PETROTRIN'S) RIGHTS OF WAY INTO THE REST OF THE ONSHORE AND EVENTUALLY INTO THE EASTERN OFFSHORE



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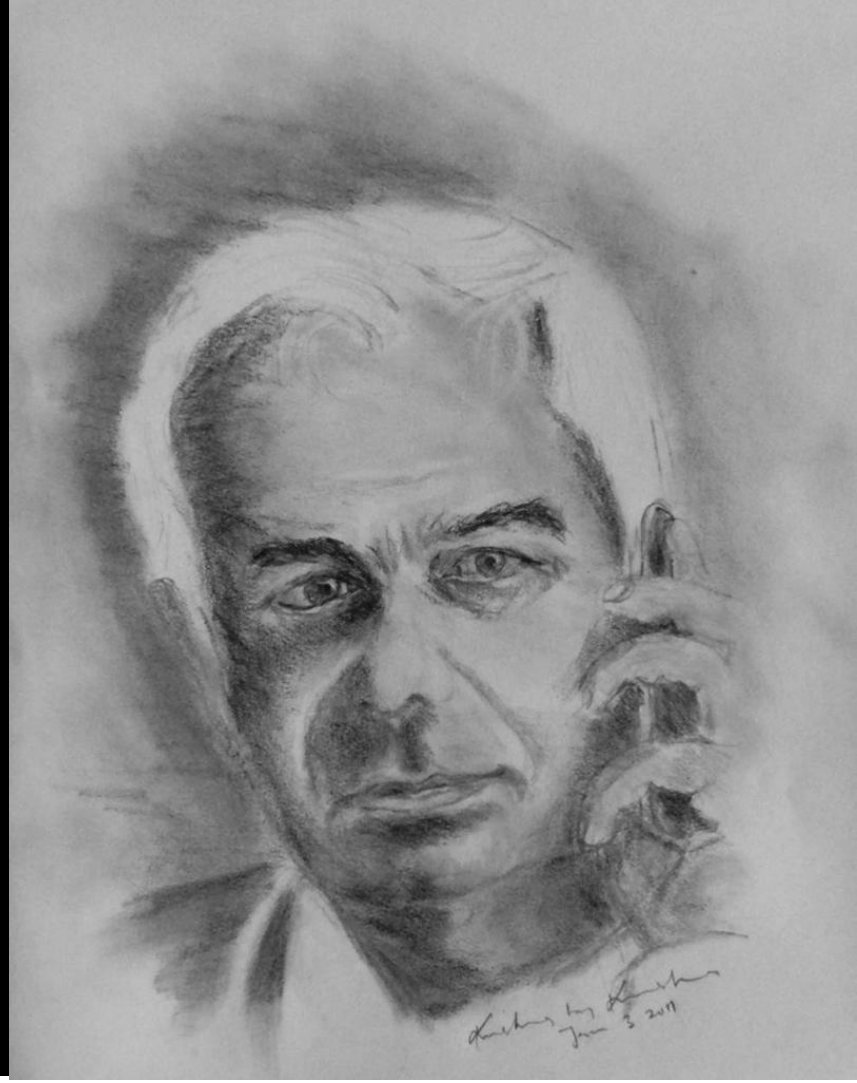
QUESTIONS ?

Clyde Abder has kindly consented to not only present this paper but answer ant questions



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