

# CO<sub>2</sub> and Enhanced Oil Recovery:

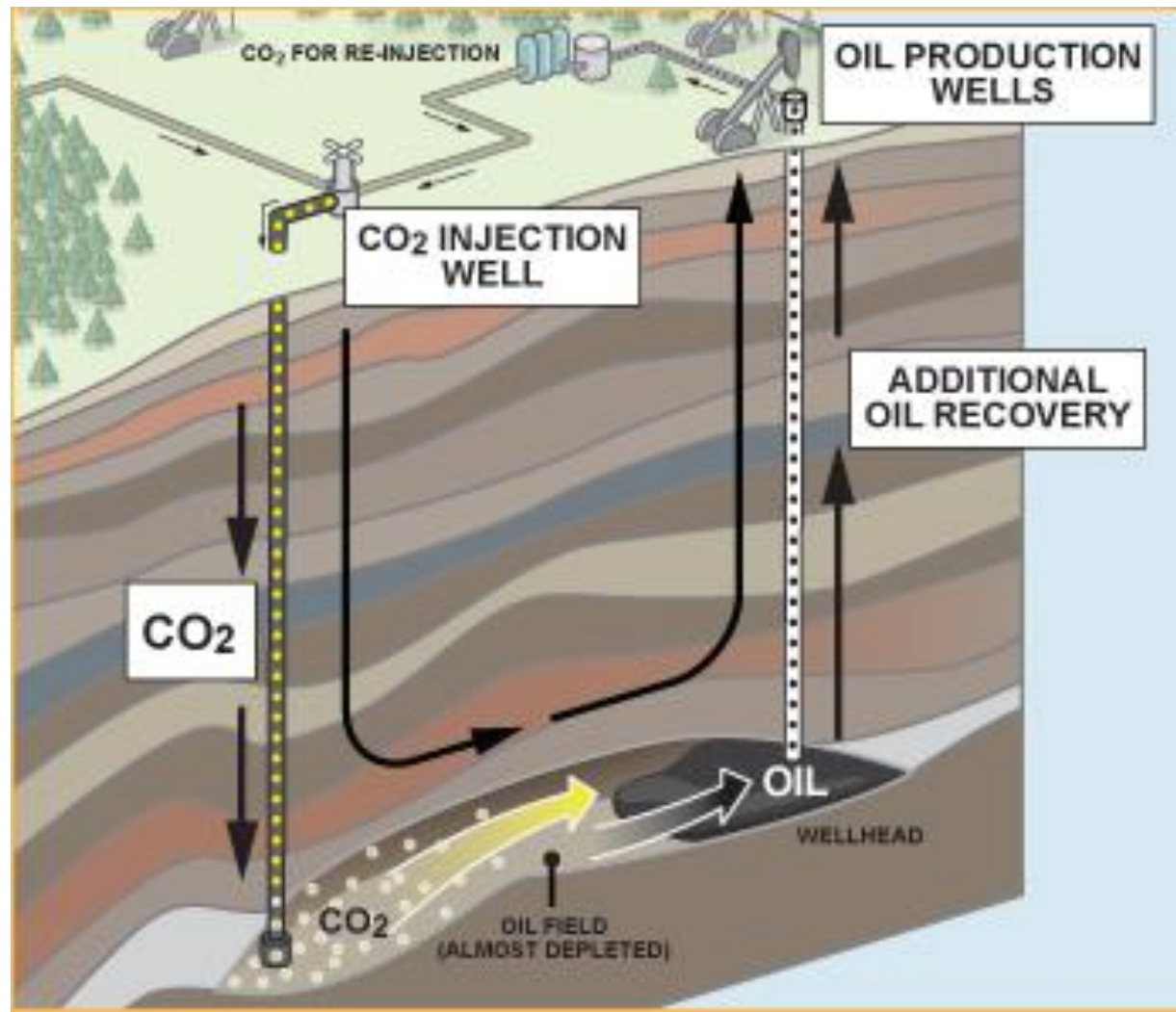
The commercial and industrial opportunities of CO<sub>2</sub> EOR

**Keith Whiriskey**





	State of EOR Globally
<b>CO<sub>2</sub> EOR Projects</b>	130 +
<b>Location</b>	USA Canadian Hungary Turkey
<b>CO<sub>2</sub> Source</b>	75% Natural CO <sub>2</sub>
	25% Anthropogenic CO <sub>2</sub>



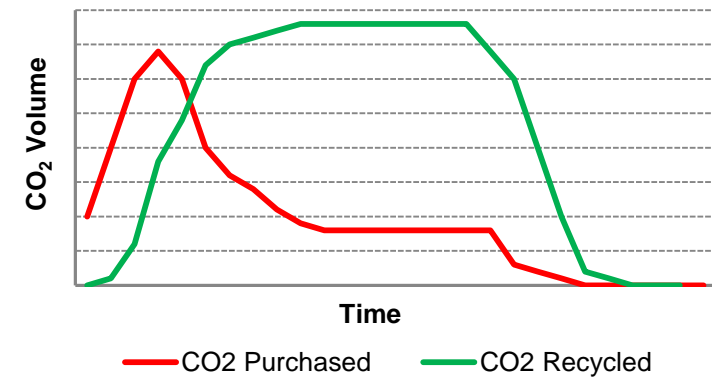


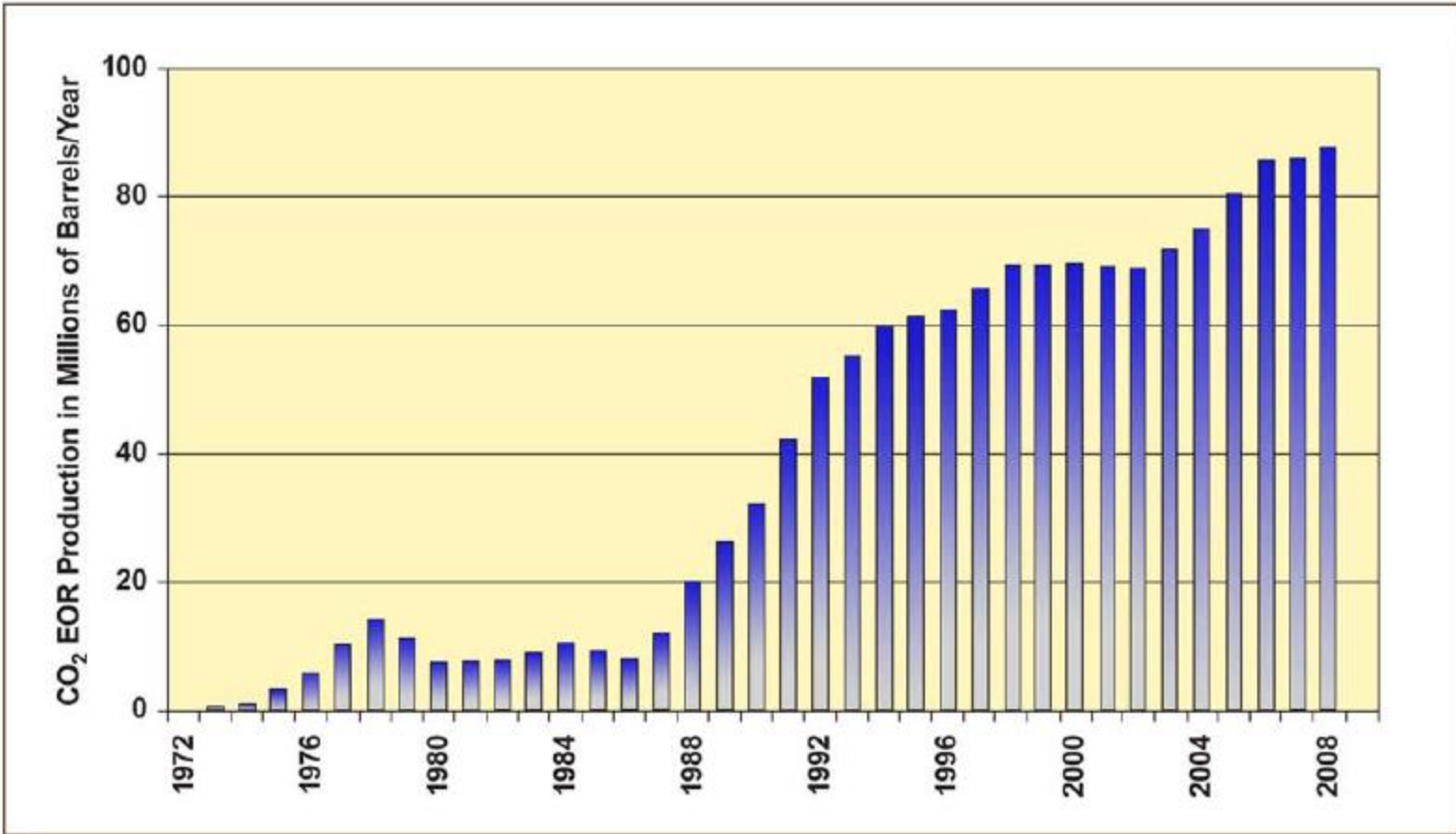
Additional oil potentially recoverable from the UK North Sea, using different alternative CO<sub>2</sub>-EOR methods (McCormack PILOT 2014). A similar volume exists beneath the Norwegian North Sea.

EOR Process	Estimated EOR Potential (mmstb)
Miscible Hydrocarbon flood	5400
Miscible CO <sub>2</sub> Injection	5700
Surfactant/Polymer (Chemical EOR)	4800
Polymer (on its own)	2100
Low Salinity Waterflood	2000



Requirement	Description
Adequate Pressure	The minimum miscibility pressure must be reached for effective CO <sub>2</sub> EOR operations
Oil Gravity	< 900 kg/m <sup>3</sup>
Oil Saturation	>25%
Porosity	>15%
Permeability	>1 md
Size	<28 STOIIP M <sup>3</sup> 10*6
Mature field	Water Injection Gas Injection WAG
No Significant Gas Cap	The presence of a large gas cap (if export route is available) may reduce the probability of a project due to souring of gas with CO <sub>2</sub>





*U.S. CO<sub>2</sub> EOR Production*



- The aggregate production from CO<sub>2</sub> EOR has grown to about 18% of the Permian Basin's total oil production
- This figure also equates to approximately 5% of the daily U.S. oil production. The oil industry rightfully brags about discovering a new billion barrel oil field.
- 65,000,000 tonnes of CO<sub>2</sub> per year.



*Insulated CO<sub>2</sub> source wellhead*



Great Plains Synfuels Plant



2 mT pre/a  
334 km

Weyburn EOR Project



Koch Nitrogen Enid Fertilizer plant



680,000 Tonnes per/a  
225 km

Golden Trend Field EOR







## Ammonia Production

- 4.2 million tonnes per year
- 8 producers
- World class producer
- Largest Ammonia pipeline

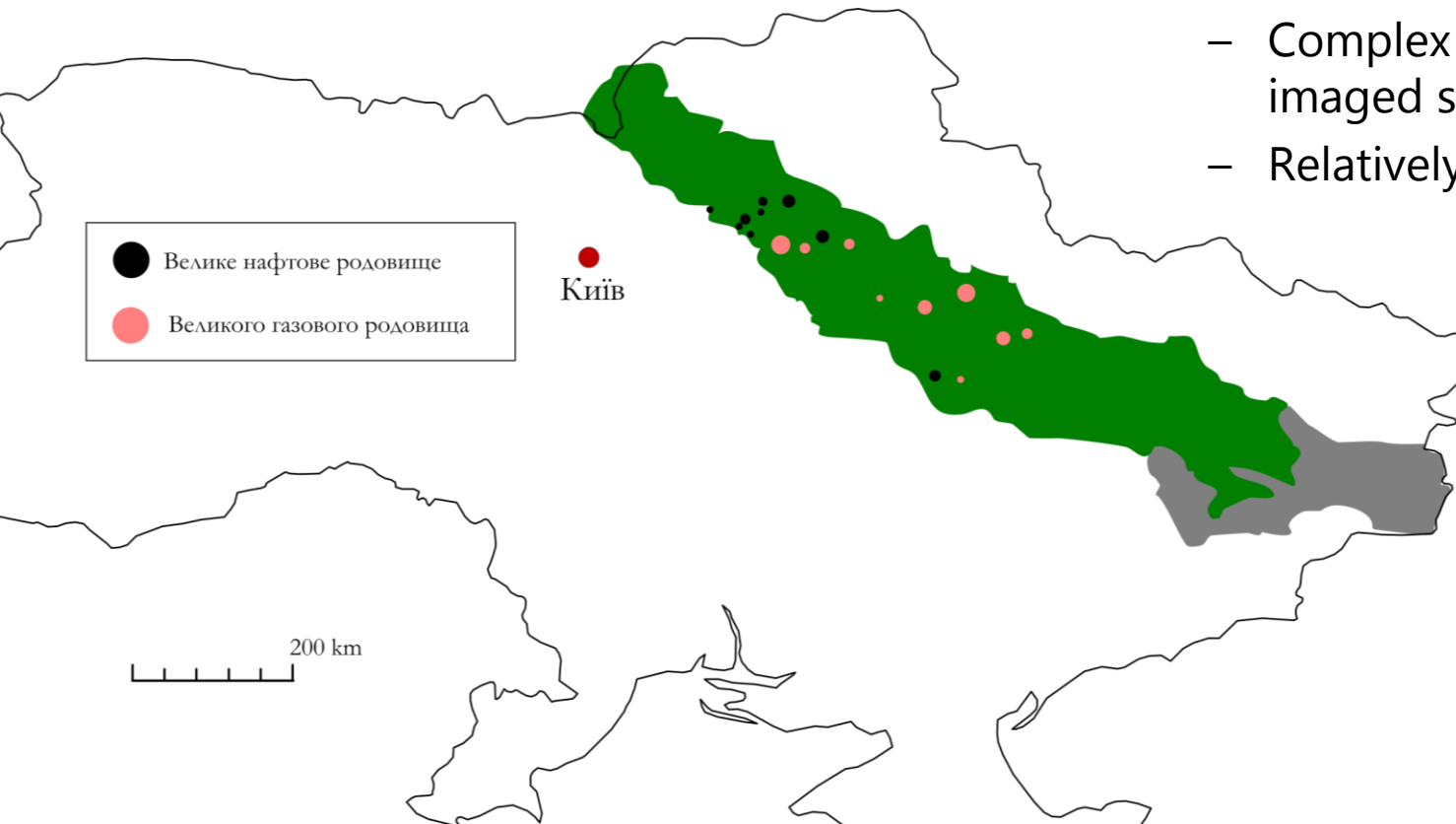


## Ethanol & Biogas Production

- Growing Industry
- Many underutilised Alcohol plants
- Attracting Investment
- Large Potential
- Sustainable ?



- Low average recovery rates
- Mature fields
- Complex oil charge/trapping mechanisms
- Complex and poorly imaged structural geology
- Relatively deep





Actors	Driving Forces
<b>State</b>	Increased ultimate oil recovery
	Increase of energy security
	Builds CO <sub>2</sub> storage business
	Provide a market for Ukrainian goods – manufacturing
	Increased oil production will result in large tax benefit
<b>Oil &amp; Gas Operators</b>	Increased & continued return from existing capital investment
	Delayed decommissioning costs
	Predictable and reliable resource delivery (once CO <sub>2</sub> injection established)
<b>CCS Industry</b>	Operational experience
	Value chain and infrastructure building
	Cross industry knowledge sharing
	Detailed storage characterisation



- Why CO<sub>2</sub> EOR ?
  - All parties gain from perusing the technology
- What CO<sub>2</sub> Source ?
  - Ammonia production offers a good first step (but others available)
- How much will capture and transport cost ?
  - Affordable CO<sub>2</sub> is available
- How much oil can be recovered ?
  - Dependent on reservoir conditions

**Thank You**



**Keith Whiriskey**

**keith@bellona.org**