Scope for CO2 in Oil & Gas Production

-- A Technical Perspective

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Oil Production Overview, Worldwide

- Giant Fields ~ 50% of global production of crude oil
- Dominant Recovery Scheme ~ Waterflood
- Production Status ~ Persistent Decline

Scope for Gas-Based EOR (excluding Heavy Oil)

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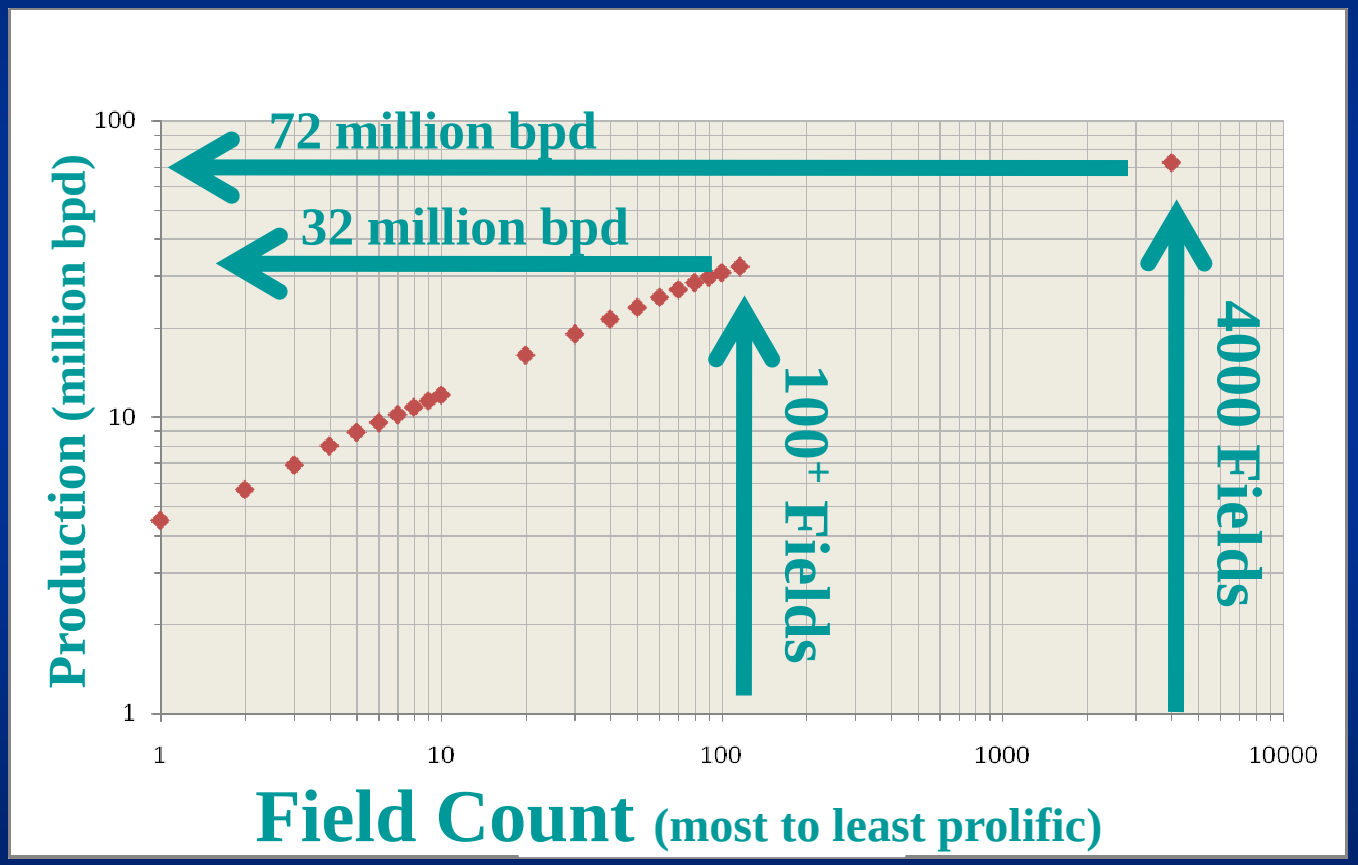
Crude Oil Aggregate Production*



*Based on data in: "The World's Giant Oilfields" (M.R. Simmons, 2000)

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A Giant Field, So Far…

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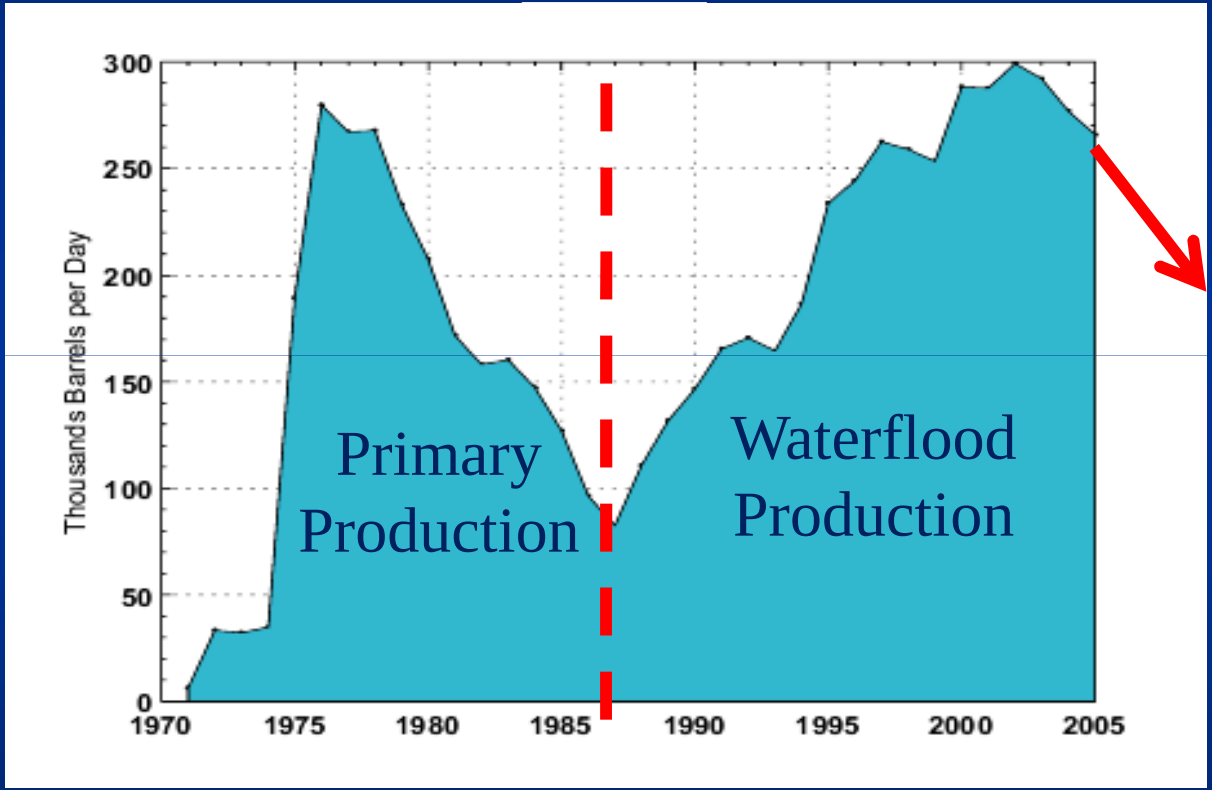
Another Giant Field…



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Implications of Oil Trend

- Gas-based EOR will rise
  - Especially in combination with waterflood (WAG)
- But which Gas?
  - Lean Gas
  - Rich Gas
  - Flue Gas
  - Nitrogen
  - CO2

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CO2 for EOR

- Pros:
  - Low MMP
  - High Density
  - Track Record
- Cons:
  - Need lots of CO2 (~1 MTPA per 100 million OOIP)
  - Over many years (30-40 yrs; can recycle after 10-15 yrs)
  - CO2 supply must be “cheap” & cause no major “allergies”

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Gas Production, Key Observations

1. Sour Gas → 40% of World Reserves
2. Exploration → Deep, Hot, Sour
3. Strong global demand, 1.8%/yr growth (double oil)
4. CO2-NG "Co-Production" common (~1 MT per 1 TCF)
5. CO2 Separation routine (Pipeline & LNG Req.)
6. Geologic Storage not routine, notable exceptions:
   - *Sleipner, Snøhvit, In-Salah, Gorgon (2014)*

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Implications of Gas Trend

- To unlock major gas reservoirs :
  - Producers will have to have CO2 plan / strategy:
    - 1st choice – EOR, if near oilfields
    - 2nd choice – Deep Saline Aquifer
    - 3rd choice – Other Subsurface (coal, shale…)
    - 4th choice -- Atmosphere

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Deep Saline Aquifers

- Key Considerations for Site Selection:
  - Offshore vs. Land
  - Confined vs. Unconfined
  - Non-Reactive vs. Reactive Formations

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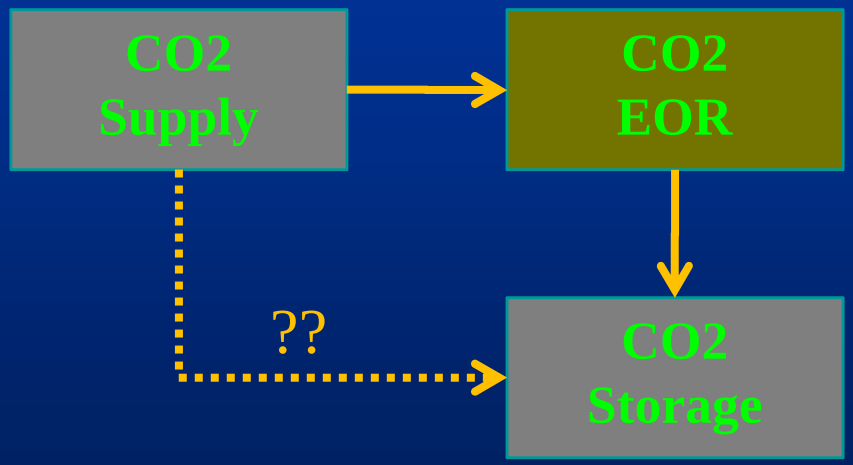
Summary

- Gas Production
  - CO2 Geologic Storage → highly likely in view of "sour" trend
- Oil Production
  - CO2 Geologic Storage→ can happen only if CO2 EOR proliferates



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