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# Barriers to CCS/CCUS

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This presentation includes forward-looking statements. Actual future conditions (including economic conditions, energy demand, and energy supply) could differ materially due to changes in technology, the development of new supply sources, political events, demographic changes, and other factors discussed herein (and in Item 1 of ExxonMobil's latest report on Form 10-K). This material is not to be reproduced without the permission of Exxon Mobil Corporation.

# Summary

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- Policy
- Regulation
- Economics
- LaBarge Experience

# Policy

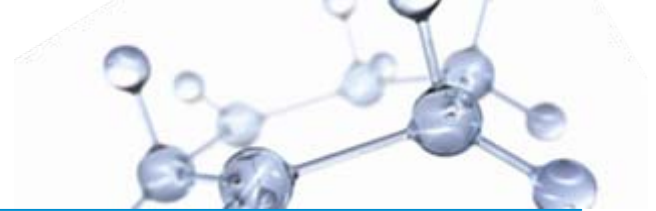
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- **Commercial investment based on sound, sustainable economics**
  - Research and demonstration facilitated by government support
  - Commercial ventures stand on their own merits
- **Clarity on pore space ownership**
  - Being addressed by some states
- **Address transfer/management of long term site responsibility**
  - Clear transfer of responsibility to competent authority, with indemnification
  - Consider throughput fee to manage post closure financial commitments
- **Clear, predictable management of CO<sub>2</sub> emission reductions**
  - Valuation of CO<sub>2</sub> - carbon tax vs. cap and trade
  - Fuel neutral
- **Public engagement/acceptance**

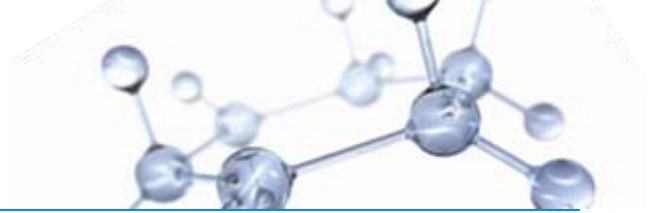
# Regulation

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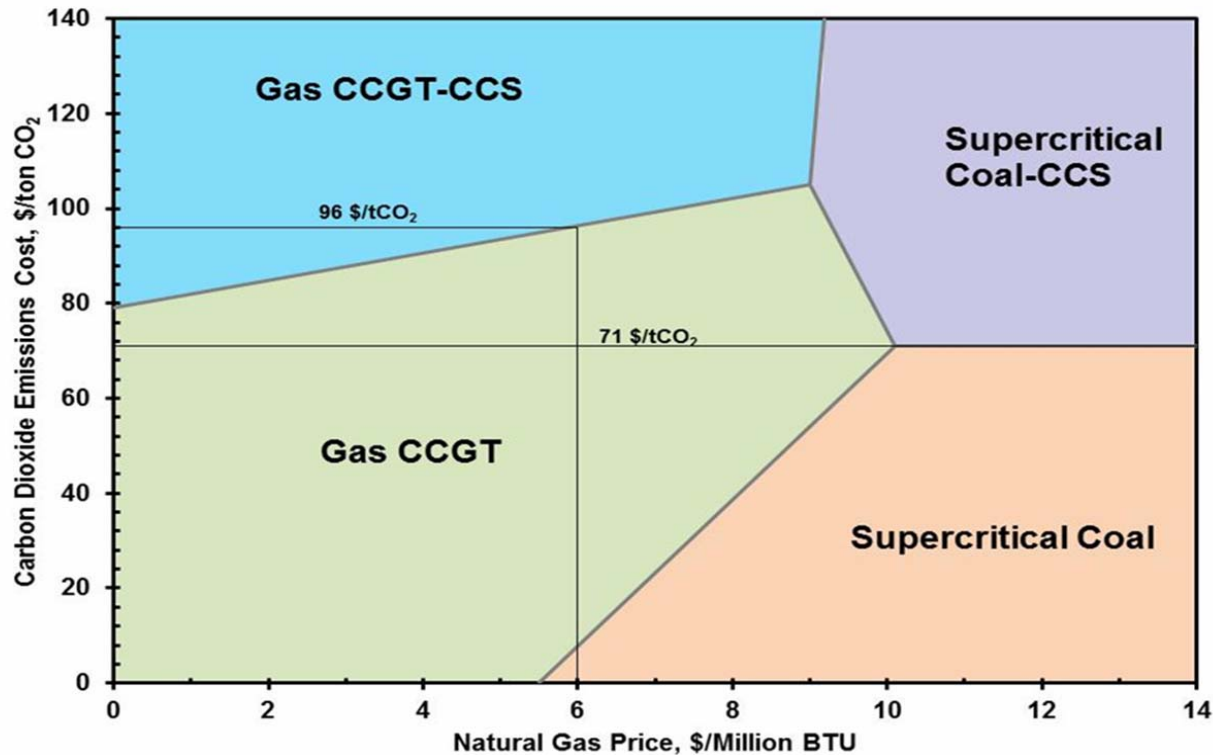


- Performance based approach highly desired
  - Flexibility and case specific consideration is vital
  - Goal or objective based rules
  - Consider “field rule” approach
  - Limit prescriptive requirements to those supported by sound science and experience
- CCUS with EOR is not currently addressed in either UIC Class II or Class IV
  - Application of Class VI type regulations is not practical and will not encourage CCUS
  - Recommend a subset of UIC Class II for CCUS/EOR
    - Primary objective would be enhanced monitoring and accounting

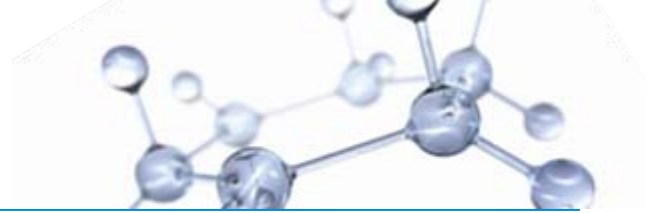
# Economics



- Capture costs will dominate CCS/CCUS economics/opportunities
  - Remains largest cost reduction impact opportunity



# CCUS and EOR



- CCUS/EOR provides potential economic advantage over CCS
- Case specific EOR evaluation should consider:
  - Resource recovery potential (remaining reserves)
  - Reservoir response to CO<sub>2</sub>
  - Capex of facility/infrastructure upgrades
  - CO<sub>2</sub> cost and other Opex
- Example CO<sub>2</sub> EOR threshold prices as a function of CO<sub>2</sub> cost and representative Capex and Opex:

CO2 Supply Cost (\$/ton)	Capex: \$6/bbl Opex:\$10/bbl	Capex: \$9/bbl Opex:\$15/bbl	Capex: \$12/bbl Opex: \$20/bbl	Capex: \$15/bbl Opex:\$25/bbl
20	\$54	\$77	\$103	\$127
40	\$62	\$85	\$110	\$134
60	\$70	\$92	\$117	\$141
80	\$78	\$100	\$124	\$148
100	\$85	\$108	\$132	\$156

# Overview of LaBarge Field



- Gas composition
  - Field discovered in 1963, production startup in 1986
  - Lowest methane content natural gas commercially produced today. Major components are:
    - 65% Carbon Dioxide (CO<sub>2</sub>)
    - 21% Methane (CH<sub>4</sub>)
    - 7% Nitrogen (N)
    - 5% Hydrogen Sulfide (H<sub>2</sub>S)
    - 0.6% Helium (He)
- Advancement in gas separation technologies was necessary for development
- Logistical challenges include remote location, extreme environmental conditions, and sensitive habitat
- Greenfield development of CO<sub>2</sub> Enhanced Oil Recovery (EOR) market
  - Aging oil fields provided opportunity
  - CO<sub>2</sub> sales since start of production, 1986
- Globally significant helium resource

# Technical Solutions – Acid Gas Injection

- Original 1,300 LT/D sulfur recovery unit mothballed
- Separated H<sub>2</sub>S/CO<sub>2</sub> blend (60% H<sub>2</sub>S, 40% CO<sub>2</sub>) injected via two built for purpose wells
- 65 MMcfd capacity at 3100 psi
- Injection is into the water leg of the producing formation, ± 17,000' subsurface
  - Injection and production wells are >50 miles apart.
- Safe operation of system since start-up in 2005.



AGI Compression Trains

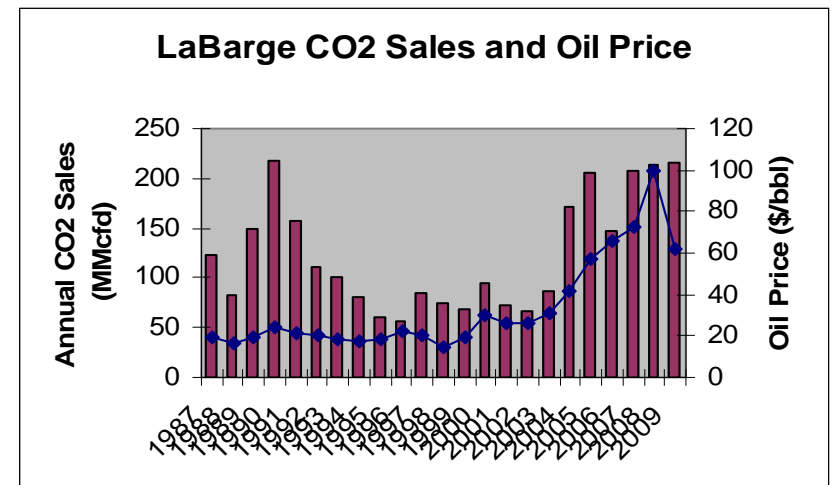


Injection Well

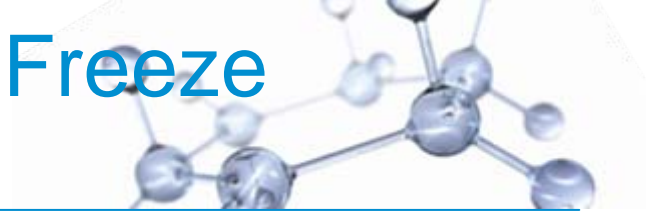


# Technical Solutions – CO<sub>2</sub> Sales Expansion

- CO<sub>2</sub> sales capacity fully contracted since start-up in 1986
  - Actual takes sensitive to oil price
  - Take averaged  $\pm \frac{1}{2}$  contracted volume through early 2000's
- CO<sub>2</sub> sales track oil price
- Recent price increases supported expansion of sales capacity
  - 110 MMcfd increase, 340 MMcfd total sales capacity
  - 3Q2010 start-up



# New Technology – Controlled Freeze Zone™

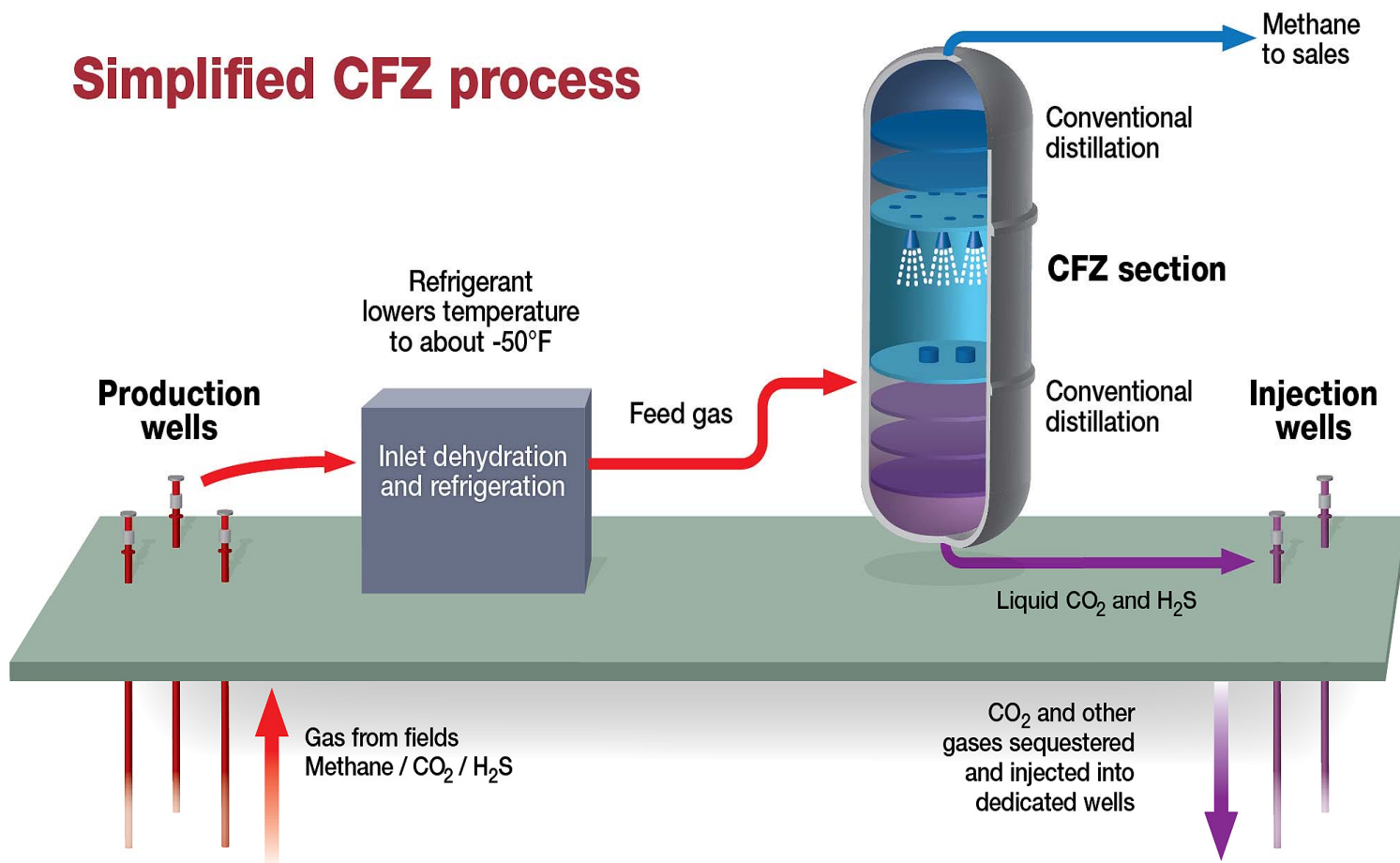


- **Controlled Freeze Zone™ (CFZ) is a single step cryogenic separation process.**
  - Simple process, done at pressure, energy efficient
  - Separates CO<sub>2</sub> and H<sub>2</sub>S
  - Targets sour natural gas treatment
- **Technology developed and tested by ExxonMobil in mid 1980's**
  - Induces controlled freezing and re-melting of CO<sub>2</sub> in a specially-designed distillation tower section
  - CO<sub>2</sub> and H<sub>2</sub>S removed as a readily injectable, high pressure liquid
- **No limits on inlet CO<sub>2</sub> or H<sub>2</sub>S concentration**
- **Commercial scale demonstration under construction at SCTF site**
  - Start-up and initial testing underway
  - Initial test results are positive

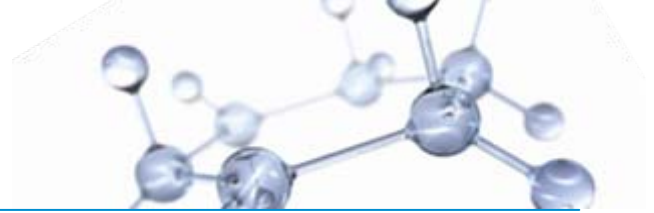
# New Technology – Controlled Freeze Zone™



## Simplified CFZ process



# Conclusions

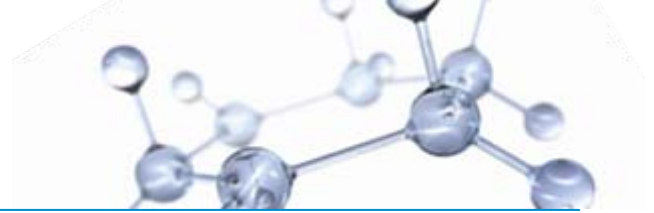


- Safe CO<sub>2</sub> management and commercialization have been a priority since the start of LaBarge production in 1986
- SCTF operations have demonstrated the safety and viability of large scale CO<sub>2</sub> capture
  - CO<sub>2</sub> avoided equivalent to a ±650 MW coal fired power plant
- Over 75% of the produced CO<sub>2</sub> controlled
- ExxonMobil's CFZ™ is being commercially demonstrated





# Questions?



Shute Creek Treating Facility

