CO_2 Transportation

Indiana Center for Coal Technology Research

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June 5, 2008

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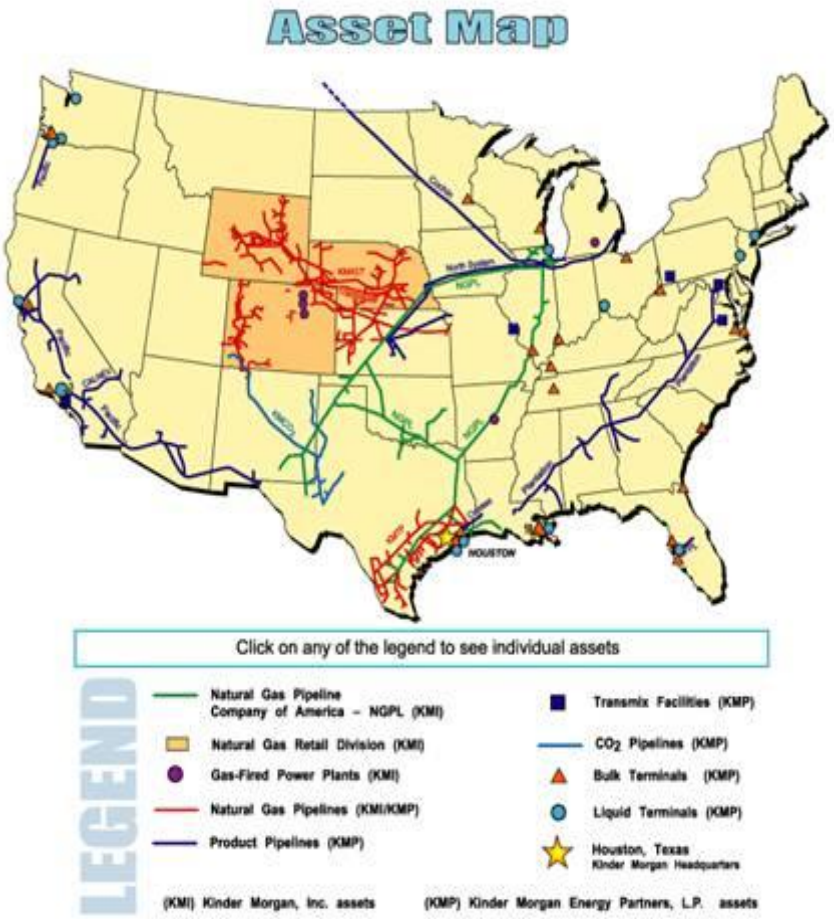
Discussion Topics

1. Introduction - Kinder Morgan CO_2
2. CO_2 Pipelines & Operations
3. The Future
4. Key CO_2 Pipeline Issues

Kinder Morgan



- Largest pipeline MLP
- Largest independent owner/operator of products pipelines
- Largest independent terminals operator
- Largest marketer and transporter of CO_2

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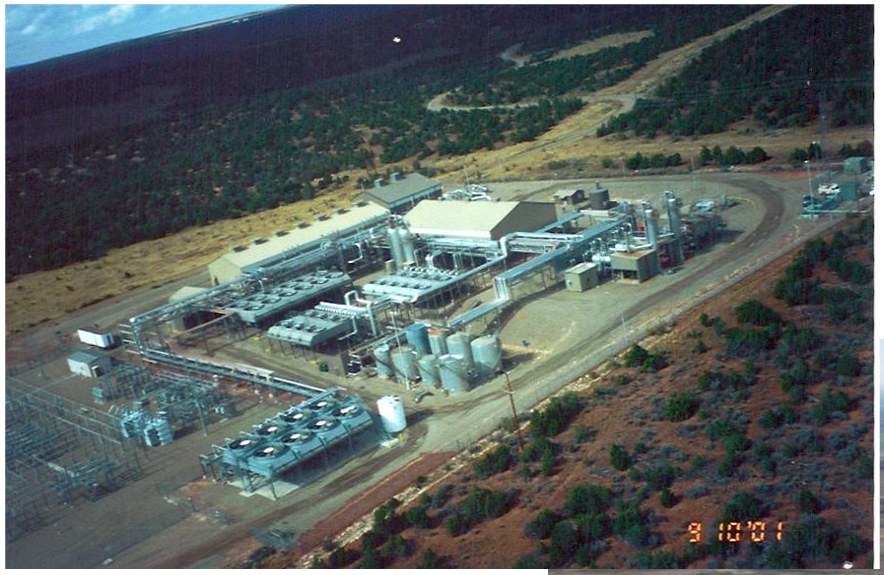
CO_2 Business: Major Capital Commitment & Extensive Expertise



CO_2 Supply Operation
McElmo Dome CO_2 Plant

CO_2 -EOR Operations (SACROC)
CO_2 Compression and Processing Plant

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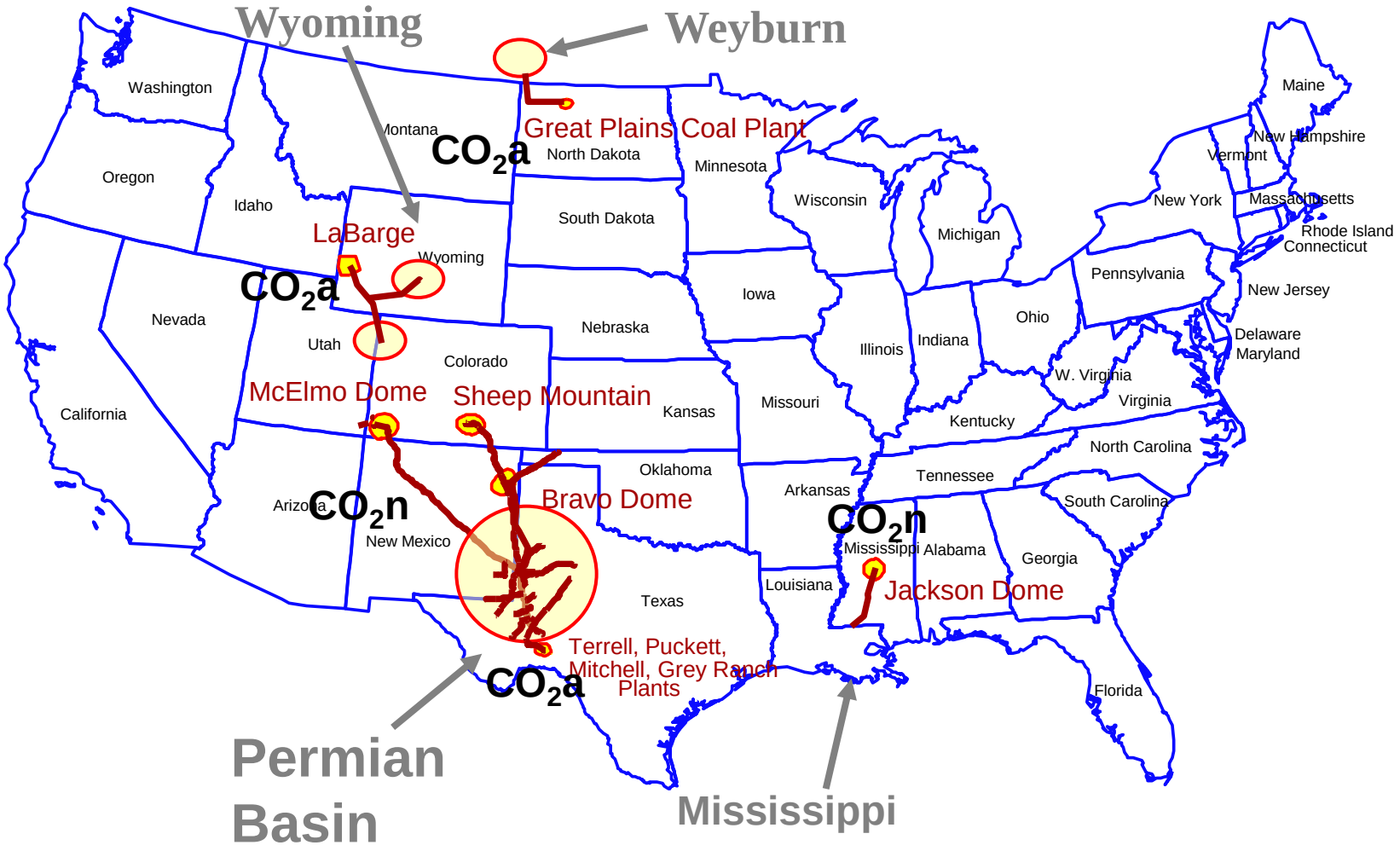
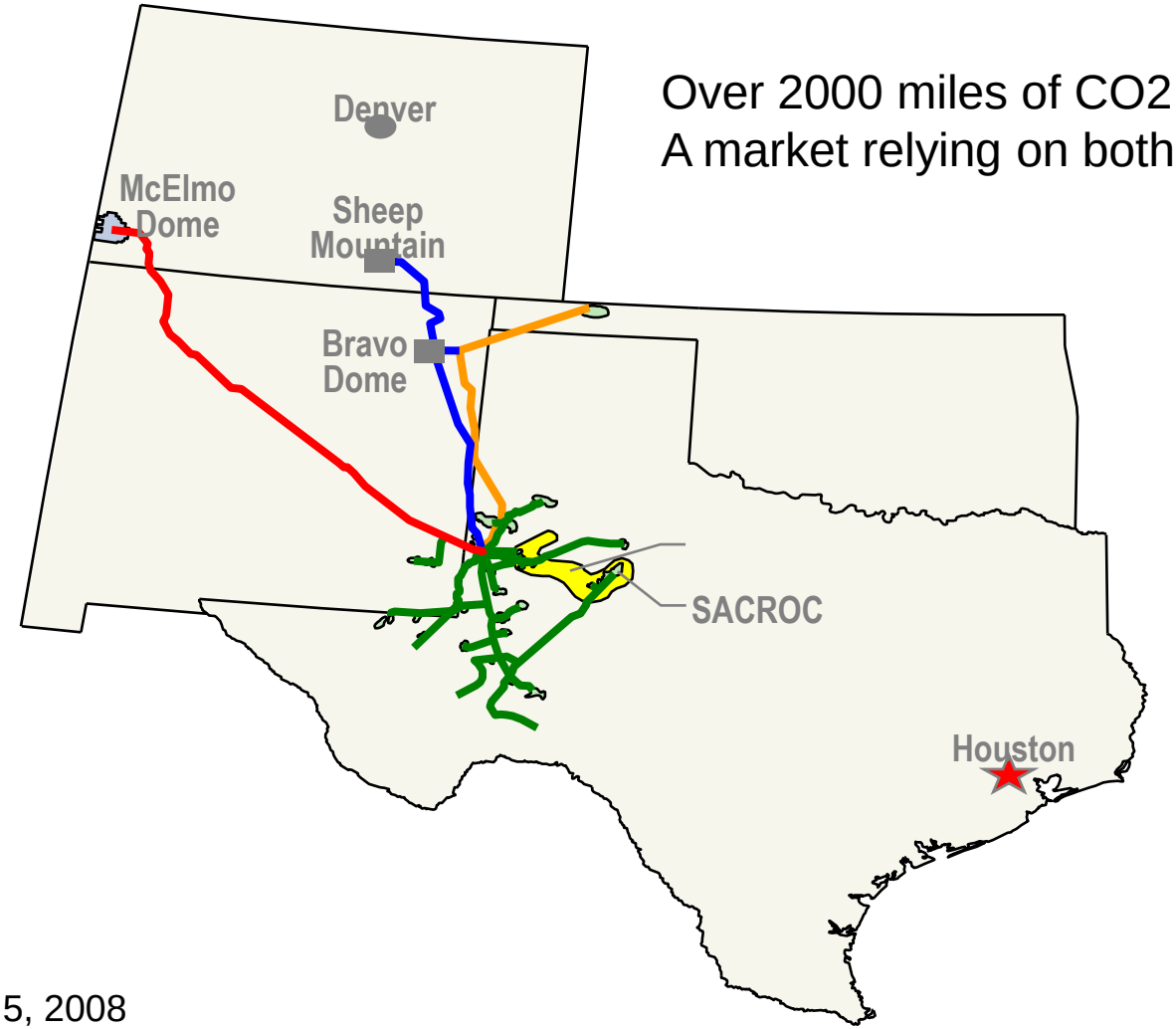
CO_2 Pipelines & Operations

North American CO_2 Map



Permian Basin Infrastructure



Over 2000 miles of CO2 infrastructure.
A market relying on both CO_2n AND CO_2a.

LEGEND

- Cortez Pipeline
- Sheep Mountain Pipeline
- Bravo Pipeline
- CO_2 Distribution System

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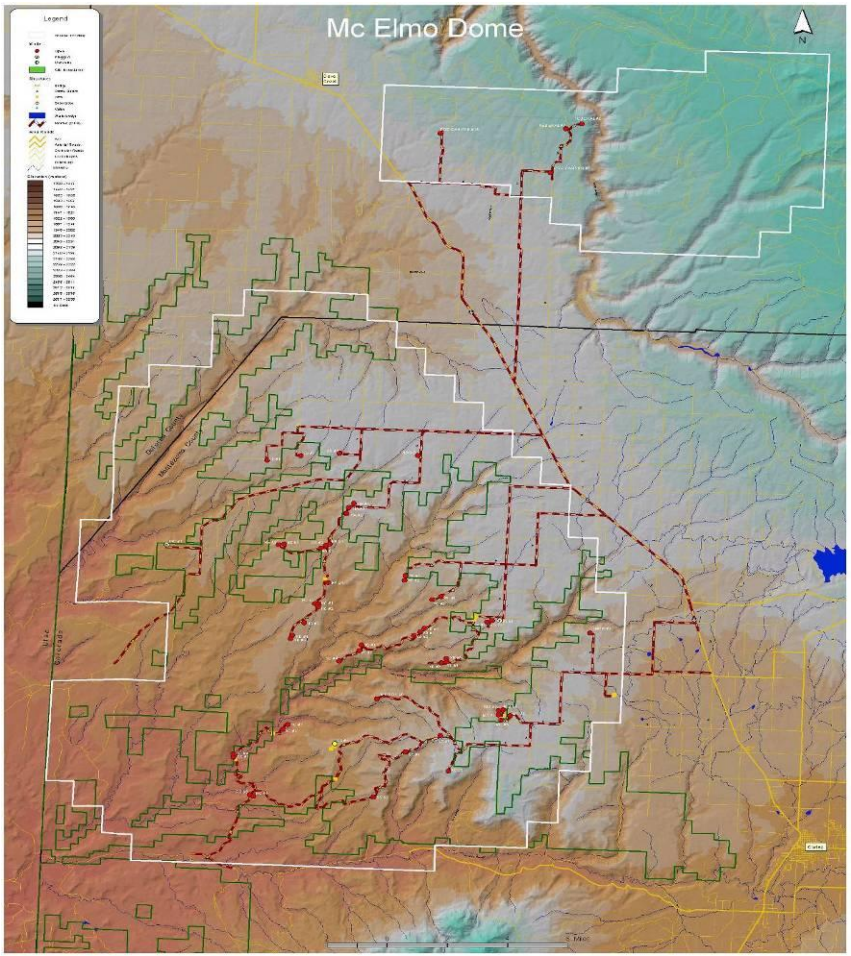
Source Field CO_2n – McElmo Dome



- The McElmo Dome field was discovered in the 1930's
- The Unit encompasses 200,000+ acres and is located in the four corners area near Cortez, Colorado
- Shell and Mobil first began field development in 1976
- First production was in 1983

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Domestic CO_2 Industry Operational Achievements

Over the past 30+ years, the oil and gas industry has:

- Produced and and safely transported more than 11 TCF of CO_2 from 7 sources.
  - 1.2 TCF of which came from sources that otherwise would have been vented.
- Constructed over 3100 miles of CO_2 mainline pipeline systems.
- Produced in excess of 1.2 billion barrels of incremental oil.
- Secured operating practices of:
  - Corrosion management, Metallurgies, Elastomers
  - Separation, Dehydration and Hydrocarbon extraction
  - Compression/pumping
  - Injection and production well completion and operation

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CO_2 Pipelines – Gas Pipelines

- Use same steel metallurgy as Natural Gas Pipelines
  - Keep CO_2 dry
- Higher operating pressures
  - Gas – 600 psig to 1200 psig
  - CO_2 – 2000 to 3000 psig
  - Why? Maintain CO_2 in dense phase (>1300 psig) to allow pumping rather than compression.
- Pumps rather than compression
  - Energy savings
- CO_2 - PHMSA regulated under CFR Part 195, "Transportation of Hazardous Liquids by Pipeline"

Environmental Health and Safety

CO2 pipelines are:

- Designed and constructed to meet or exceed CFR 49 Part 195, Transportation of Hazardous Liquids by Pipeline
- Protected from damage by
  - 24 hour monitoring by Control Center
  - Membership in statewide one-call
  - Compliance with Common Ground Alliance Best Practices
  - Patrolled by air 26 times per year
- Protected from corrosion by:
  - Annual pipe to soil survey of pipeline
  - Five year cycle of Close Interval Surveys
  - Assessments of High Consequence Areas under Pipeline Integrity Management program

SCADA: Operational Control

- 24 hour monitoring and control of Pipeline Facilities
- Full remote control to:
  - Start/stop pump stations
  - Flow control of meter facilities to customers
  - Shut-down and closure of valves during an emergency

Pipeline Integrity Management

- Assess, evaluate, repair and validate the integrity of the pipeline systems to meet or exceed the requirements of CFR Part 195.452, Pipeline Integrity Management
- Worked with PHMSA to utilize External Corrosion Direct Assessment to assess High Consequence areas
- Worked with high-resolution Magnetic Flux Tool manufacturers to develop pig to run in CO_2
- Completed high-resolution Magnetic Flux Tool run in November 2007 on the oldest CO_2 PL

CO_2 Pipeline Specifications

Following are specifications for CO_2 pipeline quality CO_2.

9.1 Specifications. The Product delivered by Seller or Seller's representative to Buyer at the Delivery Point shall meet the following specifications, which herein are collectively called "Quality Specifications":

(a) **Product.** Substance containing at least ninety-five mole percent (95%) of Carbon Dioxide.

(b) **Water.** Product shall contain no free water, and shall not contain more than thirty (30) pounds of water per mmcf in the vapor phase.

(c) **Hydrogen Sulfide.** Product shall not contain more than twenty (20) parts per million, by weight, of hydrogen sulfide.

(d) **Total Sulfur**. Product shall not contain more than thirty-five (35) parts per million, by weight, of total sulfur.

(e) **Temperature.** Product shall not exceed a temperature of one hundred twenty degrees Fahrenheit. (120ºF).

(f) **Nitrogen.** Product shall not contain more than four mole percent (4%) of nitrogen.

(g) **Hydrocarbons**. Product shall not contain more than five mole percent (5%) of hydrocarbons and the dew point of Product (with respect to such hydrocarbons) shall not exceed minus twenty degrees Fahrenheit (-20oF).

(h) **Oxygen.** Product shall not contain more than ten (10) parts per million, by weight, of oxygen.

(i) **Other.** Product shall not contain more than 0.3 (three tenths) gallons of glycol per MMcf and at no time shall such glycol be present in a liquid state at the pressure and temperature conditions of the pipeline.

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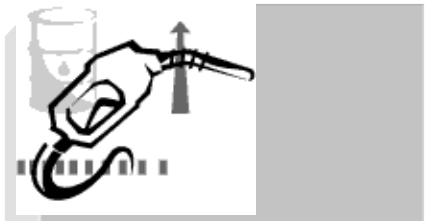
Future Possibilities

Multifaceted Issue



$120 + per bbl

Key issues on parallel paths.

EOR
Expansion/ Growth

Kyoto
GHG Reduction

CO_2

Leading to some areas of mutual interest - ***CO_2 emissions.***

But where, how, by whom, and when?

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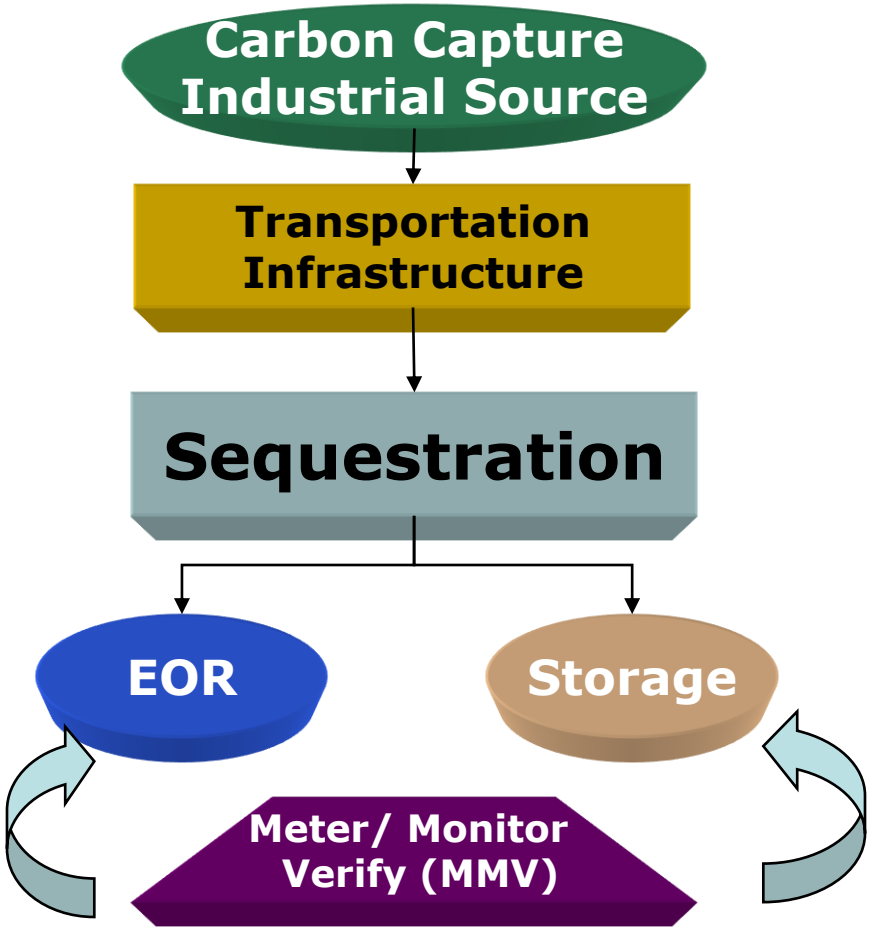
Future Possibilities

1. Based on CO_2 captured from industrial processes

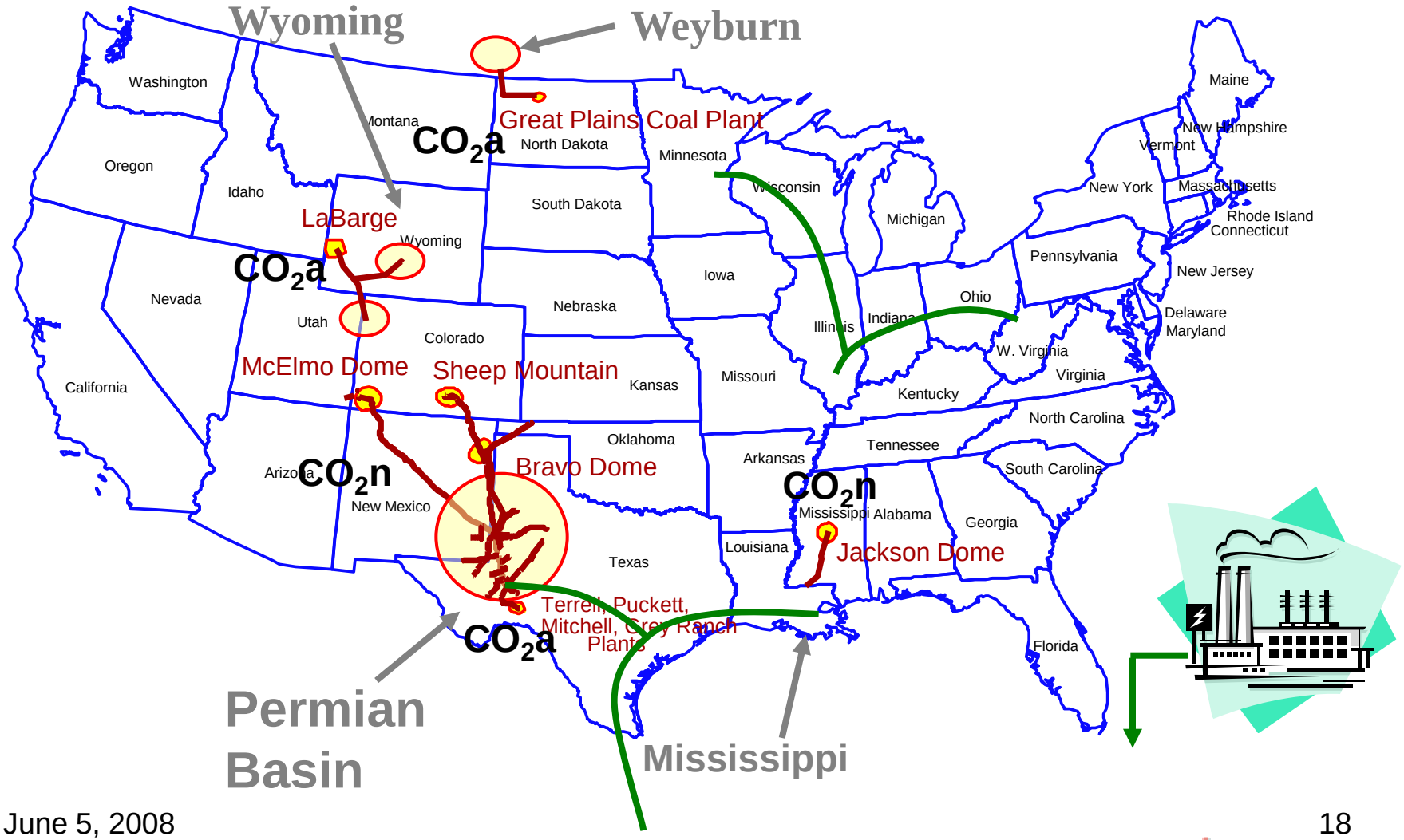
2. Pipeline infrastructure to accommodate all needs

3. Dual Objectives
   - EOR (Commercial)
   - Storage (Kyoto compliance)

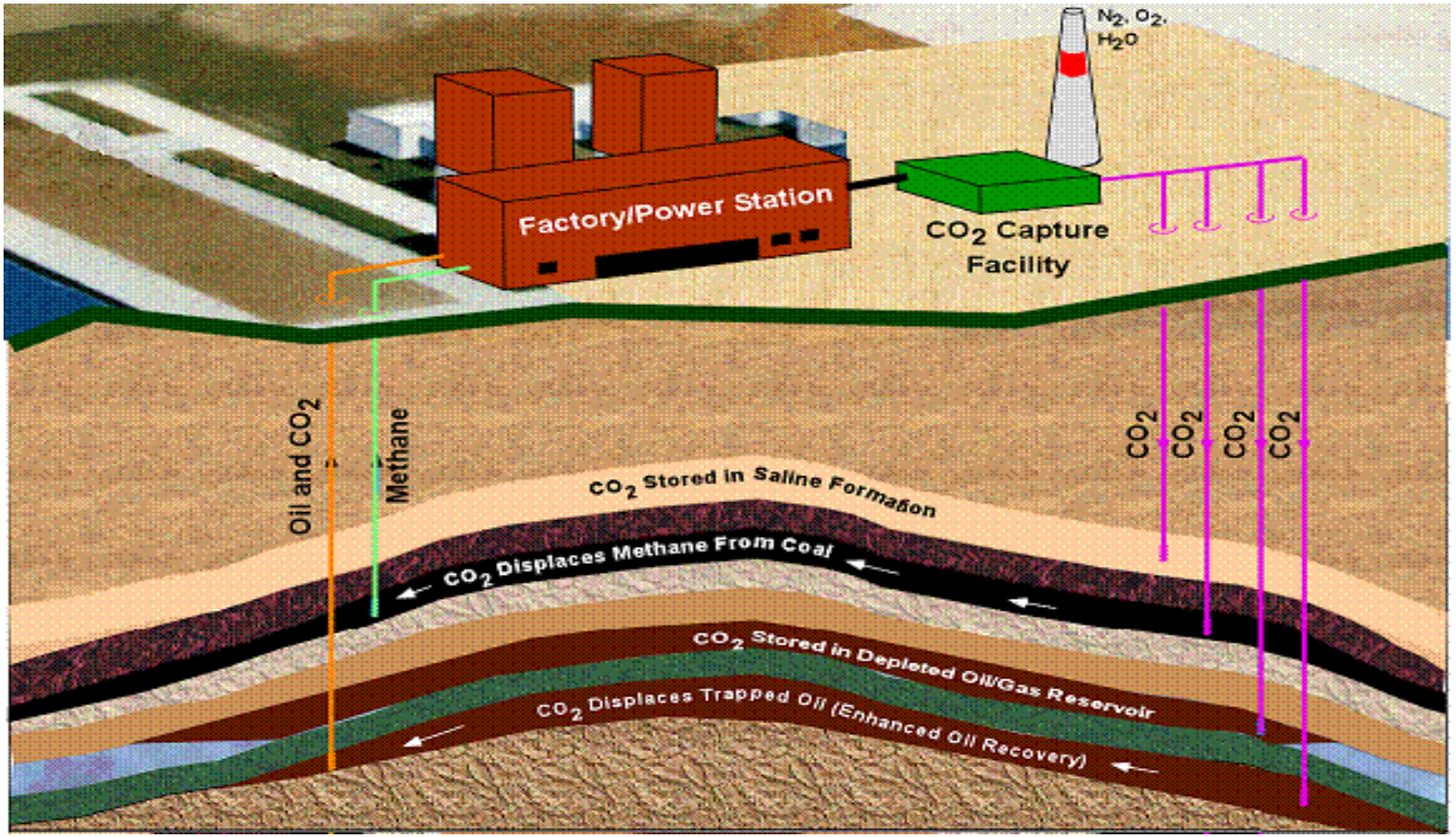
4. Complex/ New Systems



Carbon Highway



Sequestration: The Simple View



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Key CO_2 Pipeline Issues

- Permitting of new CO_2 Pipelines
  - Eminent Domain
  - Environmental
- Issue of mixed gases versus current PL Quality specification
- Ownership and liability of sequestered CO_2
- Regulation of CO_2 Pipeline Tariffs should be initially avoided
- EOR fields should <u>not</u> be excluded from consideration as sequestration sites
- The transportation of CO2 should qualify under the MLP structure rules

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