Evolution of CO2 EOR and CCS in the United States

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Qualified Opportunities for CO_2 Storage

- Oil and gas fields
  - Storage in association with carbon dioxide (CO_2)-based enhanced oil recovery (EOR)
  - Storage in depleted oil and gas fields
- Saline formations

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U.S. CO_2 EOR Projects

Oil Production, 2014	
CO_2 EOR projects	136
Oil production, 1000 b/d	300
CO_2 Supplies	
Number of sources	17
Natural	5
Industrial	12
CO_2 supply, Bcfd	3.5
Natural	2.8
Industrial	0.7

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North Dakota CO_2 EOR Regulations

North Dakota has been regulating the drilling and production of oil and gas for a long time.

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North Dakota CO_2 EOR Regulations

- North Dakota has had Class II (EOR) primacy since 1983.
- Regulates the drilling and production of oil and gas in North Dakota.
- Mission:
  - To promote the development, production, and utilization of natural resources of oil and gas in such a manner as to prevent waste.
  - To authorize and provide for the operation and development of oil and gas properties in a manner for the greater ultimate recovery of oil and gas.
  - To fully protect the rights of all owners.
  - To encourage and authorize EOR to ensure the greatest possible economic recovery of oil and gas be obtained.

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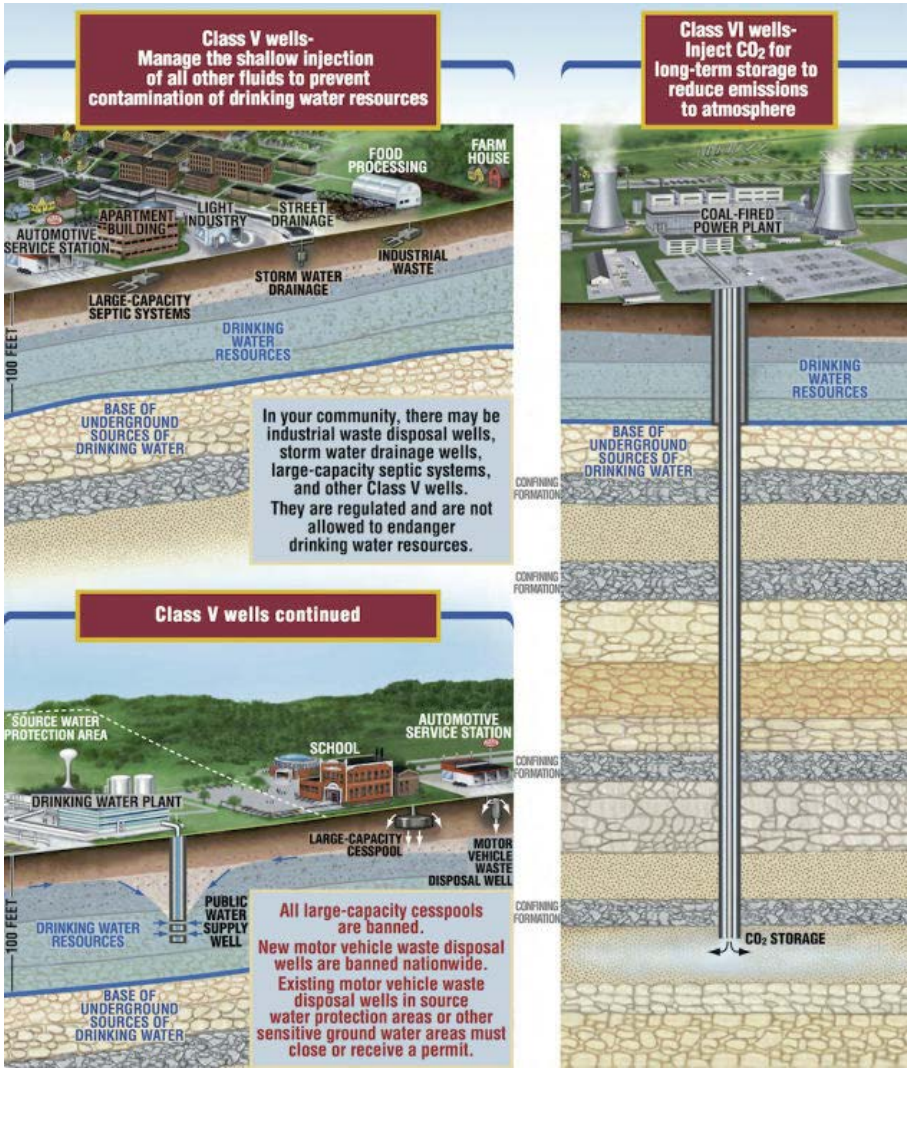
U.S. Environmental Protection Agency (EPA) Well Classification for Underground Injection Control



Class VI Wells

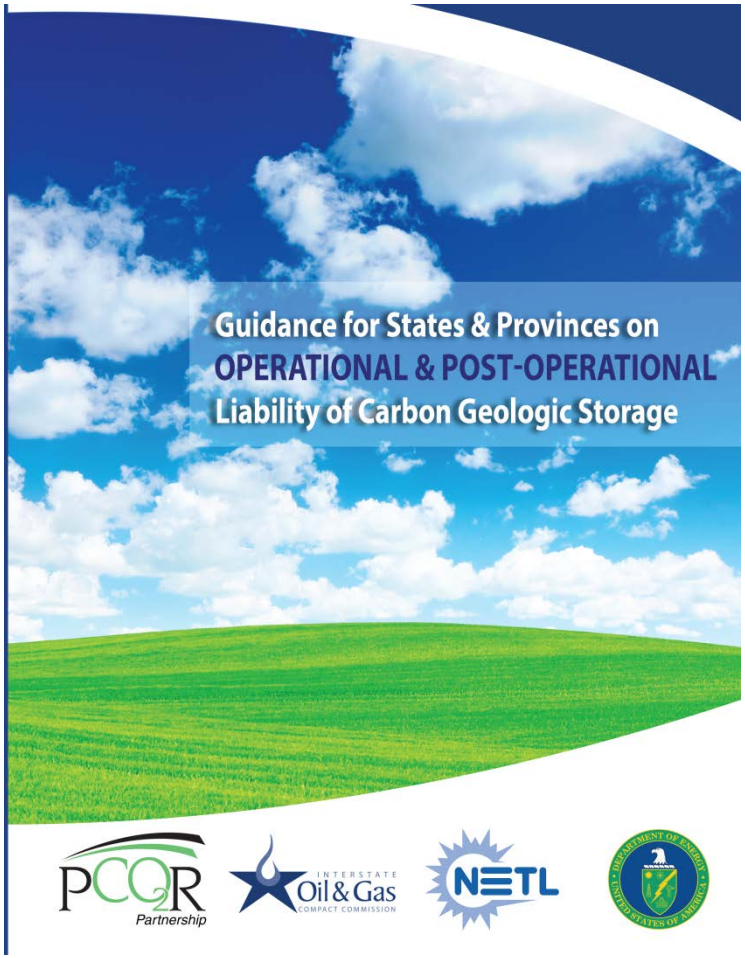
- The New Class VI – CO_2 storage
  - Extensive site characterization requirements.
  - Well construction using materials that are compatible and can withstand contact with CO_2 over the life of the geologic storage (GS) project.
  - Comprehensive monitoring of all aspects of well integrity, CO_2 injection and storage, and groundwater quality during the injection operation and the postinjection site care period.
  - Well's financial responsibility requirements to assure the availability of funds for the life (including postinjection site care and emergency response) of the GS project.
  - 940+ pages of new regulations and guidance documents

Class VI Wells

Areas of Concern

- The distinct transition from Class II to Class VI
  - Proposed rule states no transition as long as well is producing.
  - Final rule creates a potential transition point while well is still producing.
- Expands EPA's authority to include Class II primacy programs
  - Allows Class VI director to require Class II operator to perform tasks associated with Class VI wells.
- Failure to recognize landowner pore space ownership
- No mechanism/solution for long-term liability

Long-Term Liability and State/Federal Responsibilities



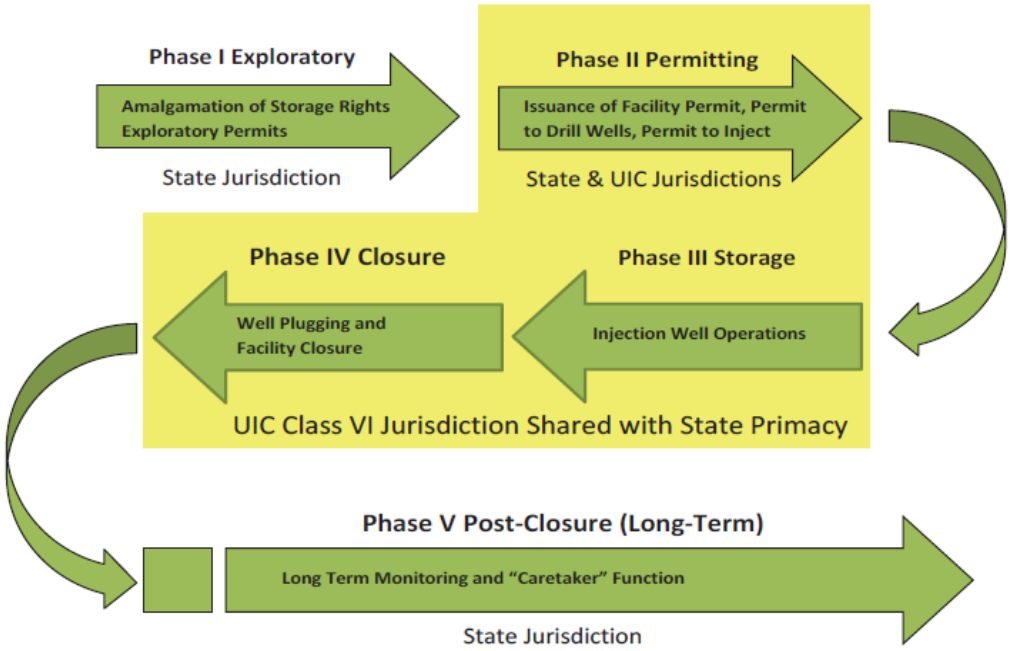
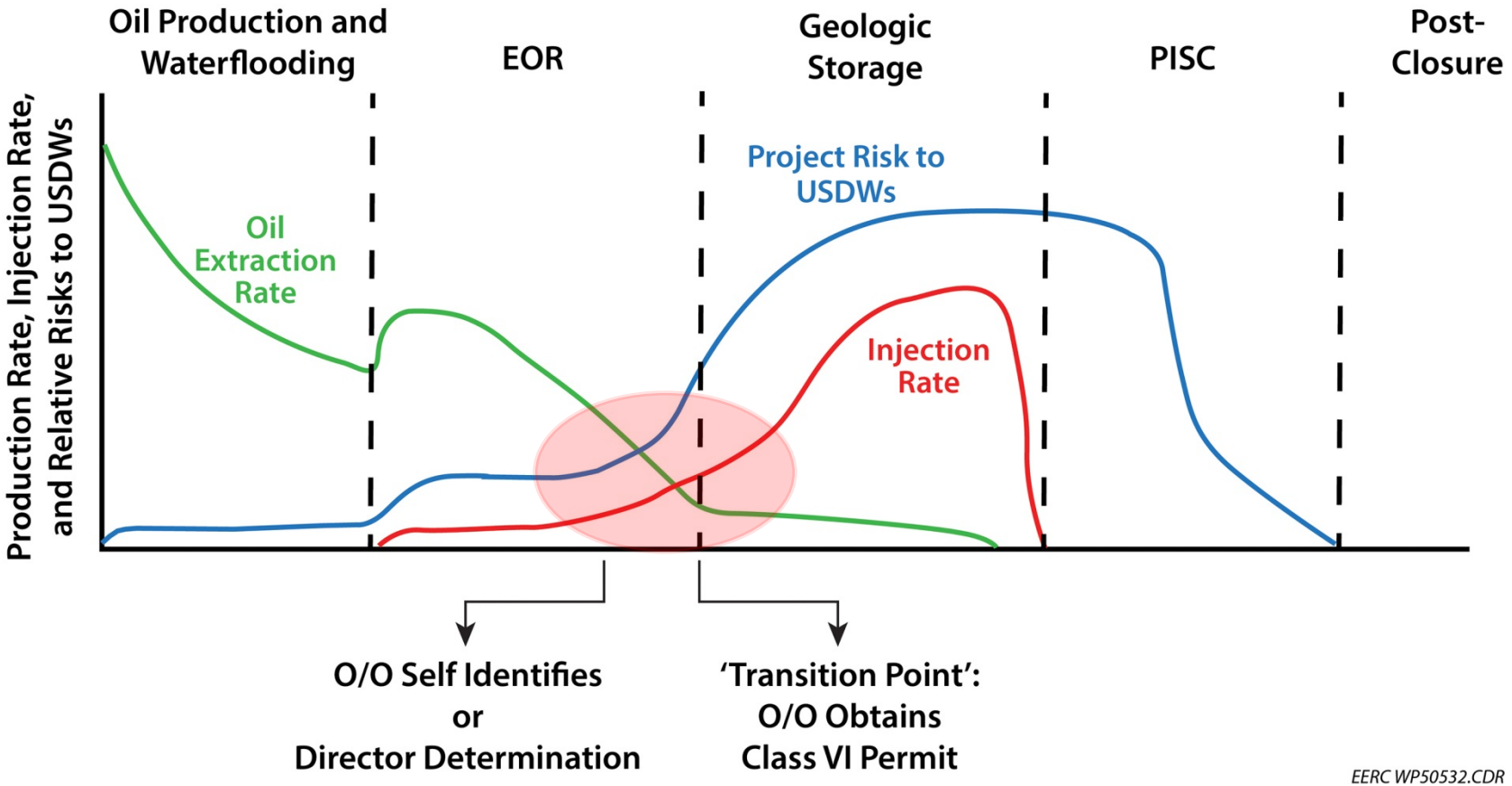


Figure 1-1 CGS Project Flow Diagram

(Yellow boxes show concurrent state and UIC Class VI jurisdiction in Phases II, III, IV. Phase I and V show exclusive state jurisdiction.)

Transition Distinction Question



Phases of a Hypothetical Oil Production Project that Transitions to ER and Eventually GS, Illustrating Relative Risk.

Source: EPA Draft Underground Injection Control Program Guidance on Transitioning Class II Wells to Class VI Wells

North Dakota Liability Mechanism

2009 North Dakota Legislation Established Two Funds:

1) CO_2 Storage Facility Administrative Fund

- Used for defraying expenses in processing permit applications; regulating storage facilities during construction, operational, and preclosure phases; and making storage amount determinations.
- Fee paid by storage operators based each ton of CO_2 injected for storage, the amount set by commission rule.
- Based on anticipated expenses in regulating storage facilities during construction, operational, and preclosure phases.

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North Dakota Liability Mechanism

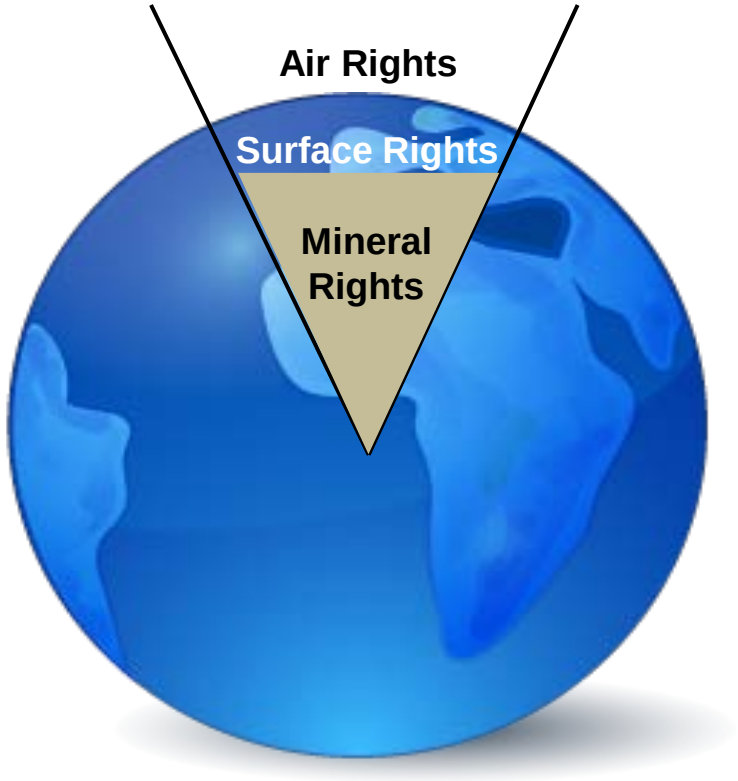
2009 North Dakota Legislation Established Two Funds:

2) CO_2 Trust Fund

- Storage operators pay the fee on each ton of CO_2 injected for storage.
- Fee amount set by commission rule.
- Based on anticipated expenses associated with the long-term monitoring and management of a closed storage facility.

North Dakota Property Ownership

- Land ownership includes:
  - Air rights.
  - Surface rights.
  - Mineral rights (severable).
  - Pore space
- 2009 North Dakota legislation established
  - Pore space belongs to the owner of the overlying surface.
  - Severing pore space is prohibited.
  - Leasing pore space is allowed.



North Dakota's Regulatory Time Line

2008
North Dakota CO_2 Storage Workgroup formed.

2009
North Dakota State Legislature:
- Rules that pore space belongs to property owner.
- Rules that severing pore space is prohibited.
- Establishes CO_2 Storage Facility Fund and CO_2 Trust Fund.

2010
North Dakota establishes regulatory framework for geologic storage.

2010 (December)
EPA issues proposed Class VI injection well regulation.

2011
North Dakota sets goal to obtain Class VI primacy.

2011 (September)
EPA designated acting regulatory authority for Class VI wells.

2012
- North Dakota submitted draft Class VI primacy application to EPA.
- EPA returned draft with additional requirements.

2013
North Dakota State Legislature amends regulatory framework to meet federal requirements.

2013 (June)
Primacy application resubmitted

2013 (July)
EPA returns application with comments requesting additional changes.

2013 (August)
EPA acknowledges receipt of North Dakota Class VI application:
- 30-day public comment period

2013 (September)
End of 30-day comment period. No request for public hearing.

2013 (October)
Finalized memorandum of agreement with EPA.

2015 (April)
Waiting for EPA to approve primacy application.

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Bell Creek Project Overview

- The Bell Creek oil field is operated by Denbury Onshore, LLC, which is conducting a commercial EOR project.
- CO_2 is sourced from gas-processing plants.
- The Plains CO_2 Reduction (PCOR) Partnership, one of 7 Regional Carbon Sequestration Partnerships designated by U.S DOE, is studying CO_2 storage associated with a commercial-scale EOR project.

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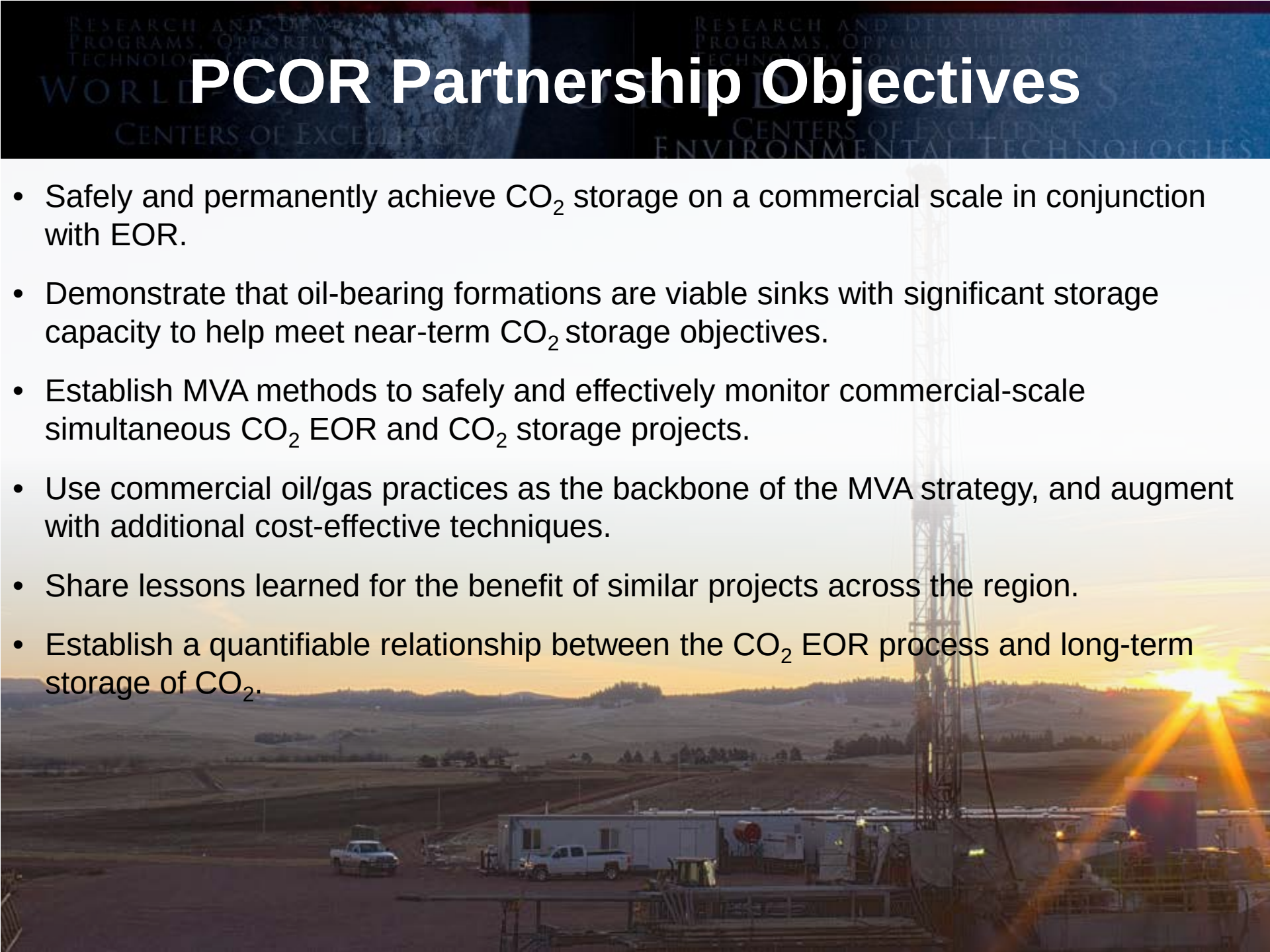
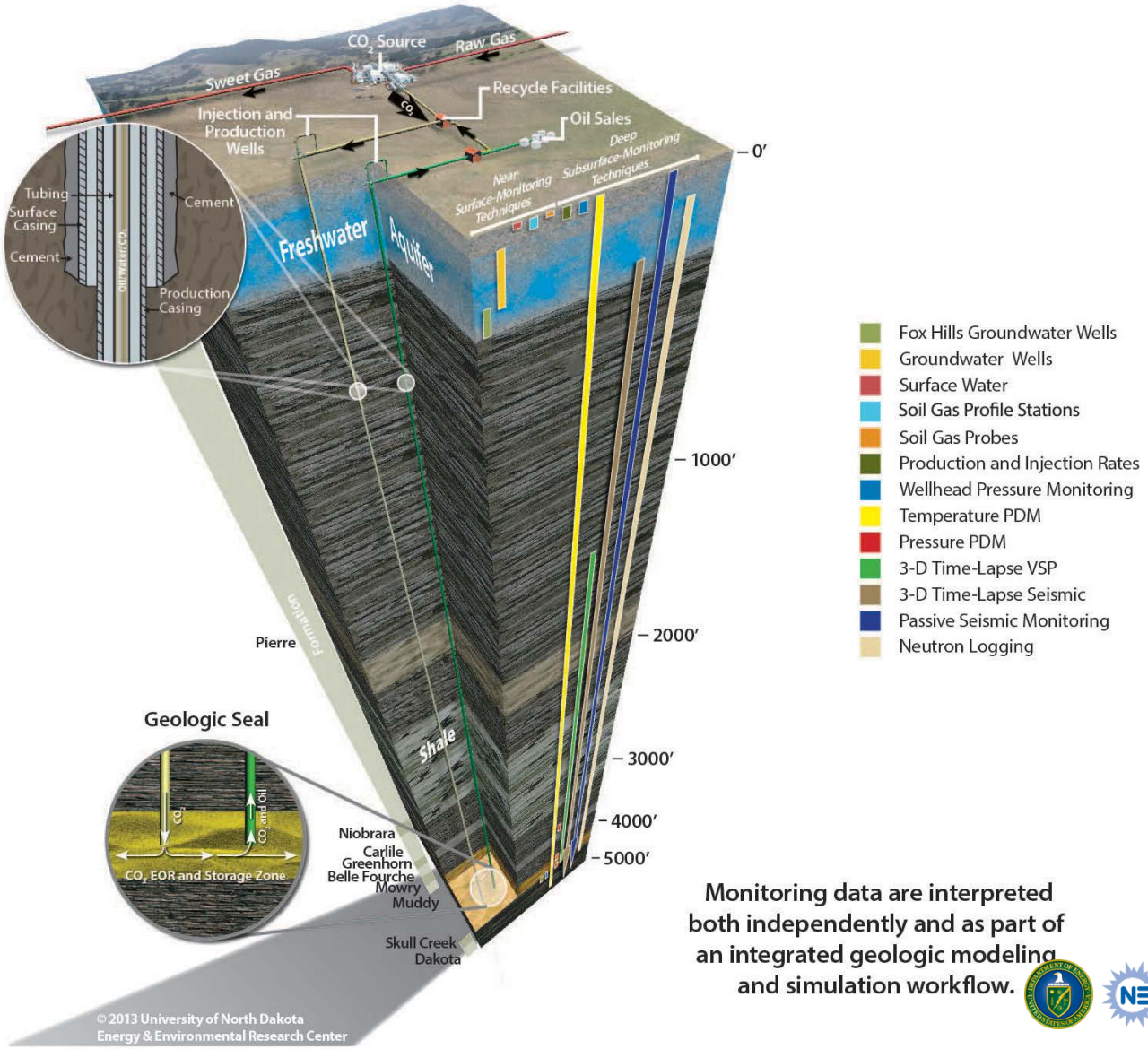
PCOR Partnership Objectives

- Safely and permanently achieve CO_2 storage on a commercial scale in conjunction with EOR.
- Demonstrate that oil-bearing formations are viable sinks with significant storage capacity to help meet near-term CO_2 storage objectives.
- Establish MVA methods to safely and effectively monitor commercial-scale simultaneous CO_2 EOR and CO_2 storage projects.
- Use commercial oil/gas practices as the backbone of the MVA strategy, and augment with additional cost-effective techniques.
- Share lessons learned for the benefit of similar projects across the region.
- Establish a quantifiable relationship between the CO_2 EOR process and long-term storage of CO_2.



Bell Creek Monitoring



Monitoring data are interpreted both independently and as part of an integrated geologic modeling and simulation workflow.

Thank You

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