Hydrogen and CCS

PIOGA Tech
Air Quality Technical Seminar

Kevin Garber

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Why hydrogen?

- Decarbonization pressures
  - Banks, shareholders & customers
  - ESG
  - Government mandates
  - Global competition
- Industry net-zero commitments
- How to get there?

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Why hydrogen?

- Most abundant element in the universe
- Production pathways
  - Blue hydrogen – from natural gas with CCS
  - Green hydrogen – from electrolysis
- Applications across the energy value chain
  - Power generation, transportation, energy storage, heavy industry
- Significant opportunities… and challenges

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Opportunities for the Region

- Natural gas producers & blue hydrogen
- Favorable regional geologies for CCS
- World-class infrastructure & energy knowledge
- Potential industrial, transport and power generation offtakers
- Well-positioned to be a regional hub

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Regulatory Frameworks

- For production, transportation and end use
- For example, many similarities, and some difference, to those for oil and gas pipelines
  - Economic (uncertainty…)
  - Environmental (EPA)
  - Safety (PHMSA & OSHA)
  - State frameworks

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Incentives

- Infrastructure Bill: $8B for at least 4 regional "clean" hydrogen hubs
  - Technology neutral, but no more than 2Kg CO2e per 1Kg hydrogen
- Existing and new DOE loan and grant funding for projects and R&D
- Potential 45X federal tax credit for hydrogen (up to $3/KG) in Reconciliation Bill

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Challenges

- Cost – target $1 to $1.50/Kg. Will require technology refinement, incentives
- For blue hydrogen, CCS permitting and pore space ownership must be addressed
- Compatibility with existing pipeline infrastructure
- Opposition to natural gas-based hydrogen
- General opposition to energy infrastructure

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Carbon Capture

- Property law considerations
- Permitting considerations

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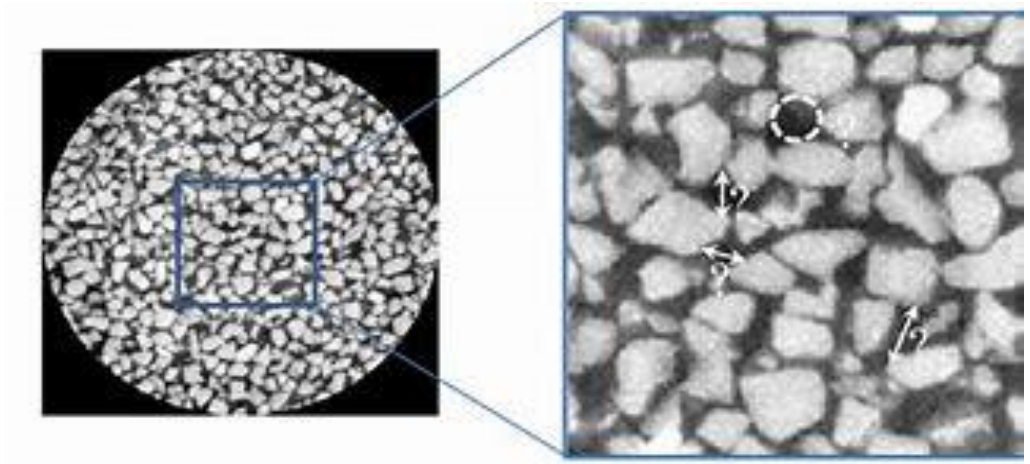
Property Law Principles

Who Owns the Pore Space?



(a) X-ray CT image of grain in 2D (b) Zoomed image

– The surface estate owns the geologic structures beneath the surface and the reservoir storage space

Lightning Oil Co. v. Anadarko E&P Onshore, 520 S.W.3d 39 (Tex. 2017);

IOGCC Model Law

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Property Law Principles

Four aspects of pore space rights:

1. Strata and pore space belong to surface estate

2. Mineral estate owns only a “fair chance” to recover OGM in the strata and pore space

3. Mineral estate owes “due regard” to surface estate

4. If a conflict, resolve using principles that govern surface use, including dominant and servient estates

Lightning Oil Co. v. Anadarko E&P Onshore, 520 S.W.3d 39 (Tex. 2017)

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Property Law Principles

What Interests Must Be Obtained/Considered for Geologic Sequestration?

"It Depends"

- Surface estate
- Gas storage owner, if separate
- Mineral estate if sequestration interferes with extraction (e.g., migration)
- Study the lease and title history

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Potential Non-Statutory Liability

- Potential liabilities:
  - Seismicity
  - Sudden release
  - GW contamination
  - Displacement of resources
- Legal theories
  - Strict liability
  - Negligence
  - Nuisance
  - Trespass
  - Waste
- PRPs
  - Operator
  - Mineral owner
  - CO_2 owner
  - CO_2 generator
  - Surface owner
  - State sponsor

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State Programs

North Dakota

- Key Features of Statute
  - Permitting; financial assurance
  - Amalgamating property interests; 60% rule
  - Preservation of OGM rights
  - Project completion
    - Release and transfer of title
- Regulations modeled on EPA Class VI

N.D. Code Title 23, Ch. 38;

N.D Admin Code Ch. 43-05-01

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State Programs

West Virginia (2009)

- Key Features of Statute
  - Permitting for sequestration
  - Preservation of OGM rights
  - CO_2 Working Group
    - 2011 Report to the Legislature

Va. Code 22-11A-1 et seq.

- Proposed UIC Class VI regulations

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State Programs

Pennsylvania

- Regional CO_2 Transport Infrastructure Action Plan (10/1/2020 MOU)
  - "Large-scale carbon management"
    - Regional CO2 transport infrastructure
    - Carbon hubs

- DCNR, Bureau of Geological Survey
  - Workgroups and reports

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Federal CCS Regulatory Frameworks

Which Environmental Programs?

- Air – New source review; GHG reporting; RMP; New Source Performance Standards
- Water – UIC
- Waste – RCRA
- Site Development – Endangered Species Act; NEPA; stormwater; wetlands; 404 permits

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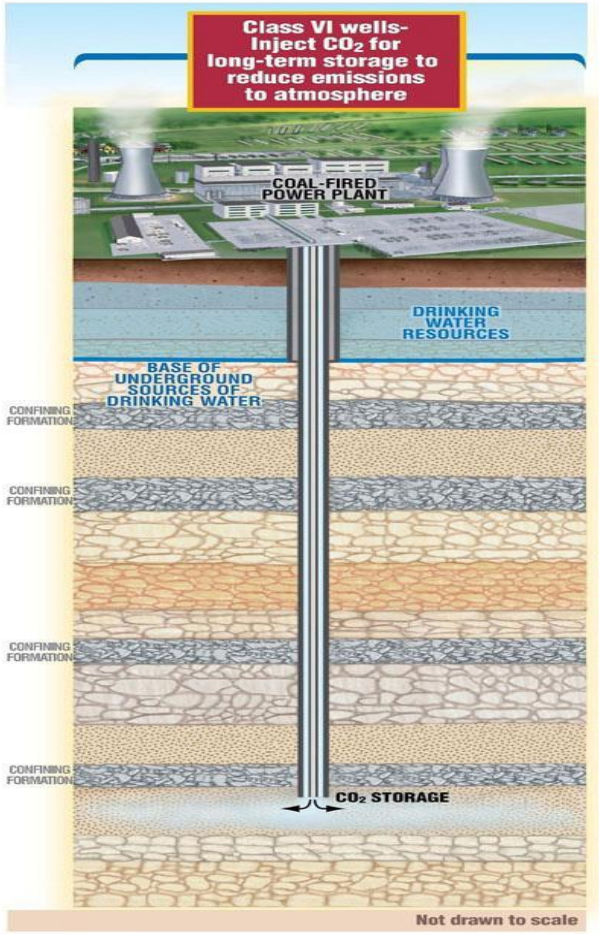
Federal CCS Regulatory Frameworks

Underground Injection Control program (40 CFR Part 146)

- Class II – fluids (CO_2, brine) for EOR and liquid hydrocarbon storage

vs

- Class VI – geologic sequestration of CO_2



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Federal CCS Regulatory Frameworks

Comparison Class II to Class VI

	Class II (EOR)		Class IV (CCS)
Financial Responsibility	Plug and abandonment		Post-closure long-term site care; corrective action
Mechanical Integrity	Every 5 years		Annually
GW Monitoring	Discretionary		Mandatory
Seismicity	None		Required
Post-Injection Site Care	None		Continuous after injection; 50- yr post closure
Emergency and Remedial Response	None		Plan required; notify and implement if a release

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Federal CCS Regulatory Frameworks

ADM Class VI Permits

1. CCS#1 (2/12/2015)
   - Rate – 0.3 tpy
   - Max total volume – 1 ton
   - $39M financial assurance
2. CCS#2 (Issued 9/23/14, modified 12/18/2017)
   - Rate – 1.0 tpy
   - Max total volume – 6 tons
   - $92M financial assurance

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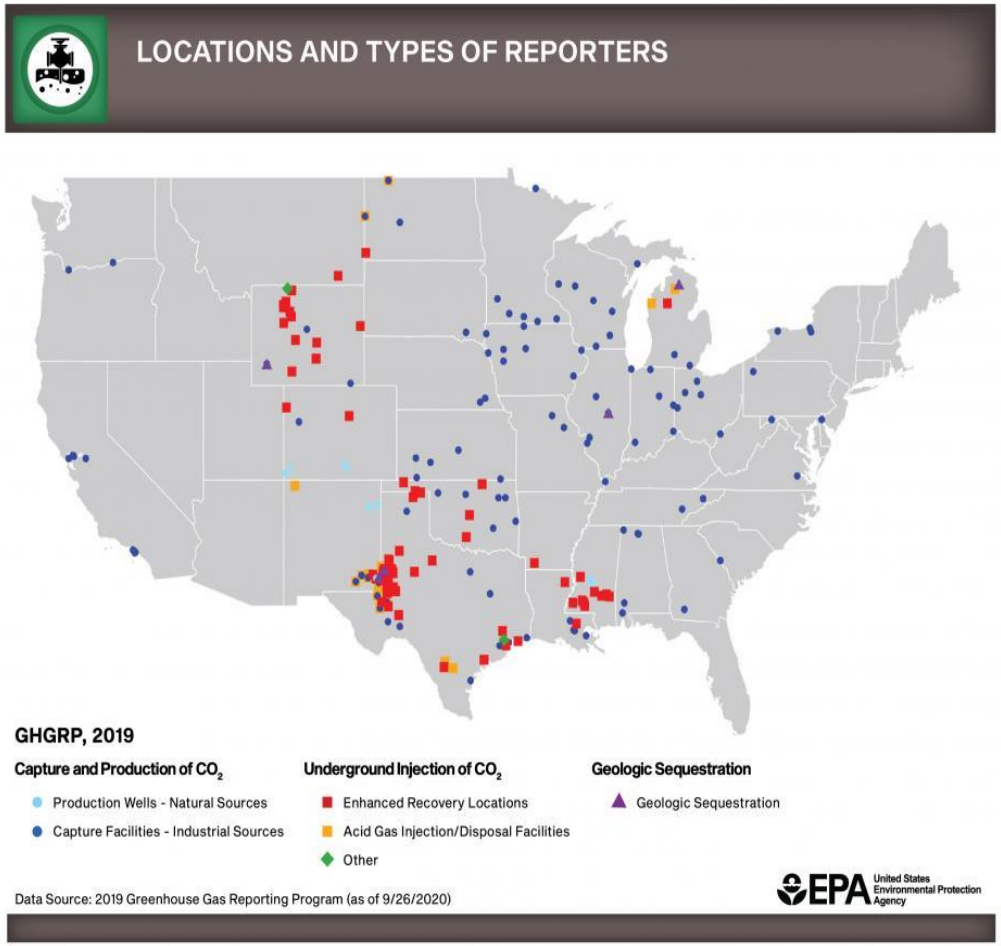
Federal CCS Regulatory Frameworks

GHG Reporting

- Subpart PP (40 CFR 98.420) – CO_2 capture

vs

- Subpart RR (40 CFR 98.440) – Geologic sequestration
  - *Monitoring, Reporting and Verification Plan (MRV) for Class VI*



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Infrastructure Investment and Jobs Act

CCUS Provisions (§ 40302, et seq.)

1. Capture Technology - $100M for DOE grants in the Carbon Capture Technology Program, including engineering/design of CO_2 transportation (40303)

2. CO_2 Transportation Infrastructure Finance - $2.7B federal financing for transportation projects of $\geq$ $100M (40304)

3. Sequestration - $2.5B funding for large-scale sequestration projects; feasibility, site characterization, permitting (40305)

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Infrastructure Investment and Jobs Act

CCUS Provisions (§ 40302, et seq.)

4. Permitting - $25M for Class VI permitting programs and $50M for states seeking primacy (40306)

5. Carbon Removal – $3.5B for four regional direct air capture hubs, each with 1M tpy capture (40308)

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