Carbon capture, utilization and storage

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Components of Carbon Capture, Utilization and Storage (CCUS)

The CCUS Supply Chain:

- Capture
  - Pre combustion
  - Post Combustion
  - OxyFuel
- Transport
- Utilization and Storage
  - Enhanced oil recovery
  - Storage in depleted oil and gas fields
  - Saline aquifer storage
Current commercial scale projects CCUS

Some observations for successful projects...
- Almost all successful projects include CO$_2$ Enhanced Oil Recovery as a driver
- Coal-fired and saline storage projects have required funding from the Department of Energy
  - Petro Nova, $190M
  - Archer Daniels Midland, $141M
- Up and coming projects....
  - Project Tundra in North Dakota
    - Lignite-fired
    - Planned 100mi pipeline
    - Hosting the North Dakota CarbonSAFE Project ($9.4 from DOE)
  - Wyoming CarbonSAFE at Dry Fork Station
    - Adjacent to the WY Integrated Test Center
    - Proximal EOR
    - Proximal saline storage
Department of Energy Carbon Storage Initiative

- Wellbore Integrity and Mitigation
- Storage Complex Efficiency and Security
- Monitoring, Verification, Accounting (MVA), and Assessment
- Regional Carbon Sequestration Partnerships Initiative
- Characterization Field Projects (Onshore & Offshore)
- Fit for Purpose Projects
Opportunity no.1: Regional Carbon Sequestration Partnership Initiative

- 2003 (Characterization Phase)
- 2005 (Validation Phase)
  - 19 small-scale field projects in a variety of projects
- 2008 (Development Phase)
  - Large-scale field laboratories (1MT)

Regional Carbon Sequestration Partnerships (RCSPs)
Projects… will address key research gaps in the path toward the deployment of carbon capture and storage (CCS) technologies, including the development of commercial-scale (50+ million metric tons CO$_2$) geologic storage sites for CO$_2$ from industrial sources…

Projects under CarbonSAFE aim to develop integrated CCS complexes that are constructed and permitted for operation in the 2025 timeframe.

Get there through sequential Phases…

- **Phase 1** Integrated CCS Pre-Feasibility,
- **Phase 2** Storage Complex Feasibility,
- **Phase 3** Site Characterization,
- **Phase 4** Permitting and Construction.

What about Carbon Capture? That’s a different DOE program.
CarbonSAFE (Storage, Assurance, and Facility Enterprise)

Round 1 Awards
- Phase I: Pre-feasibility
- Phase II: Feasibility
CarbonSAFE (Storage, Assurance, and Facility Enterprise)

And then there were 6.....
What is Wyoming CarbonSAFE?

Goal: Wyoming CarbonSAFE is focused on investigating the feasibility of practical, secure, permanent, geologic storage of carbon dioxide (CO₂) emissions at Dry Fork Station.

Timeline:
Phase I: 2017-2018 (Prefeasibility, $1.1M)
**Phase II: 2018-2020 (Feasibility, $9.77)**
Phase III: 2020-2023 (Geologic Characterization)
Phase IV: 2023-2025 (Construction and Deployment)

Things we are looking for:
- Is there sufficient volume in the subsurface to store commercial quantities of CO₂?
- Can the CO₂ be injected safely? Stored permanently?
- What are the risks/costs/legalities?

Project Team: University of Wyoming-School of Energy Resources, Basin Electric Power Cooperative, Energy and Environmental Research Center, Advanced Resources International and others.
Dry Fork Station (Basin Electric Power Coop)

- Wyoming Integrated Test Center (WY-ITC)
  - Completed fall 2017
  - Test CO₂ capture/CCUS technologies
  - $20 Million public/private investment
  - NRG COSIA Carbon XPRIZE ($20M global competition to develop breakthrough technologies for CO₂ emissions)

Dry Fork Station
- Built in 2007
- 385 MW Power Plant
- 3.3 Million tons of CO₂/year

WY-Integrated Test Center (ITC)
- Completed fall 2017
- Test CO₂ capture/CCUS technologies
- $20 Million public/private investment
- NRG COSIA Carbon XPRIZE ($20M global competition to develop breakthrough technologies for CO₂ emissions)
CarbonSAFE Wyoming: Research Area

Note: The Industry, State, and Federal commitments
**Gillette WY-Low Carbon Research Hub**

- **Storage:** Saline reservoirs (Wyoming CarbonSAFE)
  - Located below Dry Fork Station
- **Utilization:** CO$_2$-EOR opportunities
  - Proximal EOR fields
  - Proximal to CO$_2$ pipeline
- **Capture/Utilization:** WY Integrated test Center
  - *Breathe* (Bangalore, India) – common fuel and petrochemical feedstock.
  - *C4X* (Suzhou, China) – chemicals and bio-composite foamed plastics.
  - *CarbonCure* (Dartmouth, Canada) – stronger, greener concrete.
  - *Carbon Upcycling UCLA* (Los Angeles, CA, USA) – CO$_2$ absorbing concrete replacements.
  - *JCOAL & Kawasaki Heavy Industry* (Japan) – CO$_2$ Capture
  - *MTR/UK?* (CA/KY) Capture
Advantages of CCUS in Wyoming

✓ Capable Coordination Team: Experienced and diverse coordination team (University, Industry and Community)
✓ CO₂ Source: Engaged Industry Partners- Coal fired power plant and the ITC CO₂ Capture and Utilization test facility
✓ CO₂ Transport: Existing statewide CO₂ pipeline and pipeline ROW’s
✓ Saline Storage: Text book geologic reservoirs for storage
✓ Pore Space Ownership: Pore space ownership is defined
✓ Regulatory: CCUS friendly regulatory environment, pending application for WY Class VI primacy
✓ Induced seismicity: Low risk of induced seismicity
✓ Public Awareness: Energy educated community
✓ Favorable Economics: Proximal enhanced oil recovery and CO₂ transport opportunity
✓ Trained Workforce: CCUS industry jobs analogous to energy industry jobs
Thank you. Any questions?

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Meet the CarbonSAFE Team