

Update on EPA Activities for Geologic Sequestration of Carbon Dioxide

EPA Science Advisory Board Meeting
December 1, 2016



Background

- EPA has spent over 10 years analyzing geologic sequestration (GS) issues to ensure continued protection of human health and the environment
- GS regulatory development has been closely coordinated across applicable statutes
 - Underground Injection Control (UIC) Program: Standards and requirements for permitting wells used to inject CO₂ underground
 - Greenhouse Gas Reporting Program (GHGRP): Monitoring and reporting that provides facility-level accounting for GS
 - Both rules were finalized in 2010; EPA briefed SAB Environmental Engineering Committee on GS rule development in August 2010
- EPA has worked closely with other federal agencies on related GS efforts



Underground Injection Control Program



Underground Injection Control Program

- The Safe Drinking Water Act (SDWA)
 - Prohibits any injection which endangers an underground source of drinking water (USDW)
 - Authorized the creation of the Underground Injection Control (UIC) Program to ensure USDW protection
- Underground injection is the practice of emplacing fluids in porous rock or soil formations through wells
- Within the UIC Program, there are six well classes that manage injection of a range of fluids
- Underground sources of drinking water (USDWs) supply more than 90% of all public drinking water systems



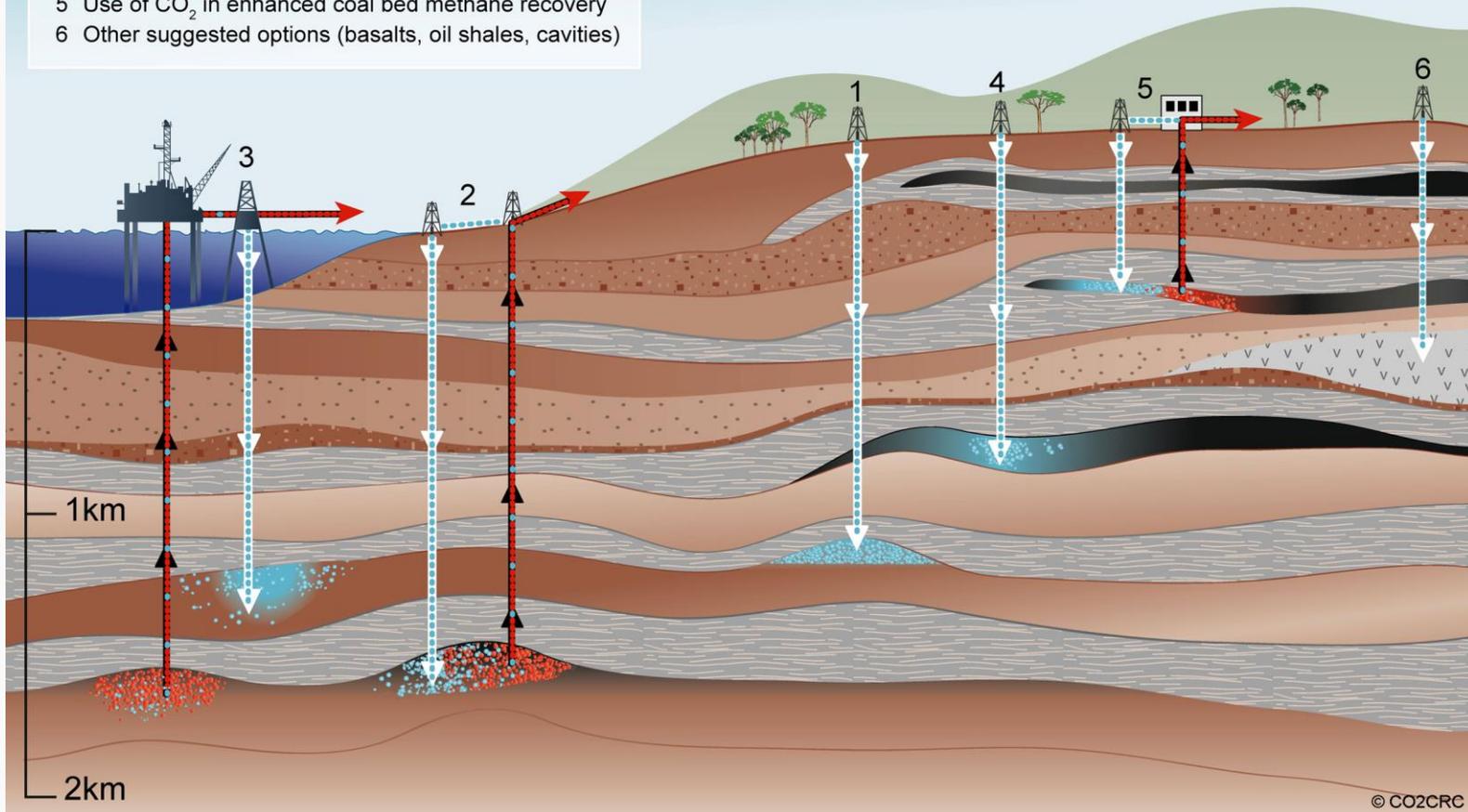
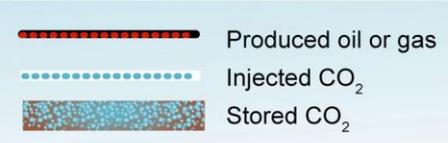
Class VI Rule: Geologic Sequestration

Geologic Sequestration



Geological Storage Options for CO₂

- 1 Depleted oil and gas reservoirs
- 2 Use of CO₂ in enhanced oil recovery
- 3 Deep unused saline water-saturated reservoir rocks
- 4 Deep unmineable coal seams
- 5 Use of CO₂ in enhanced coal bed methane recovery
- 6 Other suggested options (basalts, oil shales, cavities)





Class VI Rule

Considerations for GS

- Large Volumes
- Buoyancy
- Viscosity (Mobility)
- Corrosivity



UIC Program Elements

- Site Characterization
- Area of Review (AoR)
- Well Construction
- Well Operation
- Site Monitoring
- Post-Injection Site Care
- Public Participation
- Financial Responsibility
- Site Closure

New well class established
in 2010: Class VI



Class VI Implementation

- Technical guidance development
- Class VI permitting
- Geologic Sequestration Data Tool development
- Stakeholder, co-regulator and Federal Partner coordination



Class VI Technical Guidance Development

- Suite of 12 documents focused on technical program elements and administrative procedures
 - Provide recommendations for meeting requirements
 - Identify rule flexibilities
 - Discuss site-specific approaches to meeting Class VI requirements
- Informed by permitting experience and subject to public comment



Class VI Permitting

- **Archer Daniels Midland**

- *Injection zone:* The Mt. Simon Sandstone
- *Confining zone:* The Eau Claire Formation
- *Permitted volume in CCS#2:* 6 million tons of CO₂
- *Permitted total project duration for CCS#2:* 15 years
 - 5 years of injection; 10 years of post-injection site care

- **The FutureGen Alliance (Cancelled)**

- *Injection zone:* The Mt. Simon Sandstone and Elmhurst Formation
- *Confining zone:* The Eau Claire Formation
- *Permitted volume via four injection wells:* 22 million metric tons of CO₂
- *Permitted total project duration:* 70 years
 - 20 years of injection; 50 years of post-injection site care



Class VI Permitting

- **Berexco, LLC**

- *Injection zone:* The Arbuckle Group
- *Confining zone:* The Simpson Group, Chattanooga Shale, and the Pierson Formation
- *Proposed volume:* 26,000 – 40,000 tons of CO₂
- *Proposed total project duration:* 1.75 years
 - 9 months of injection; 1 year of post-injection site care



For more information:

- Underground Injection Control Program:
<https://www.epa.gov/uic>
- Class VI-specific information:
<https://www.epa.gov/uic/class-vi-wells-used-geologic-sequestration-co2>
- Class VI guidance documents:
<https://www.epa.gov/uic/class-vi-guidance-documents>



Greenhouse Gas Reporting Program (GHGRP)



Background on Greenhouse Gas Reporting Program

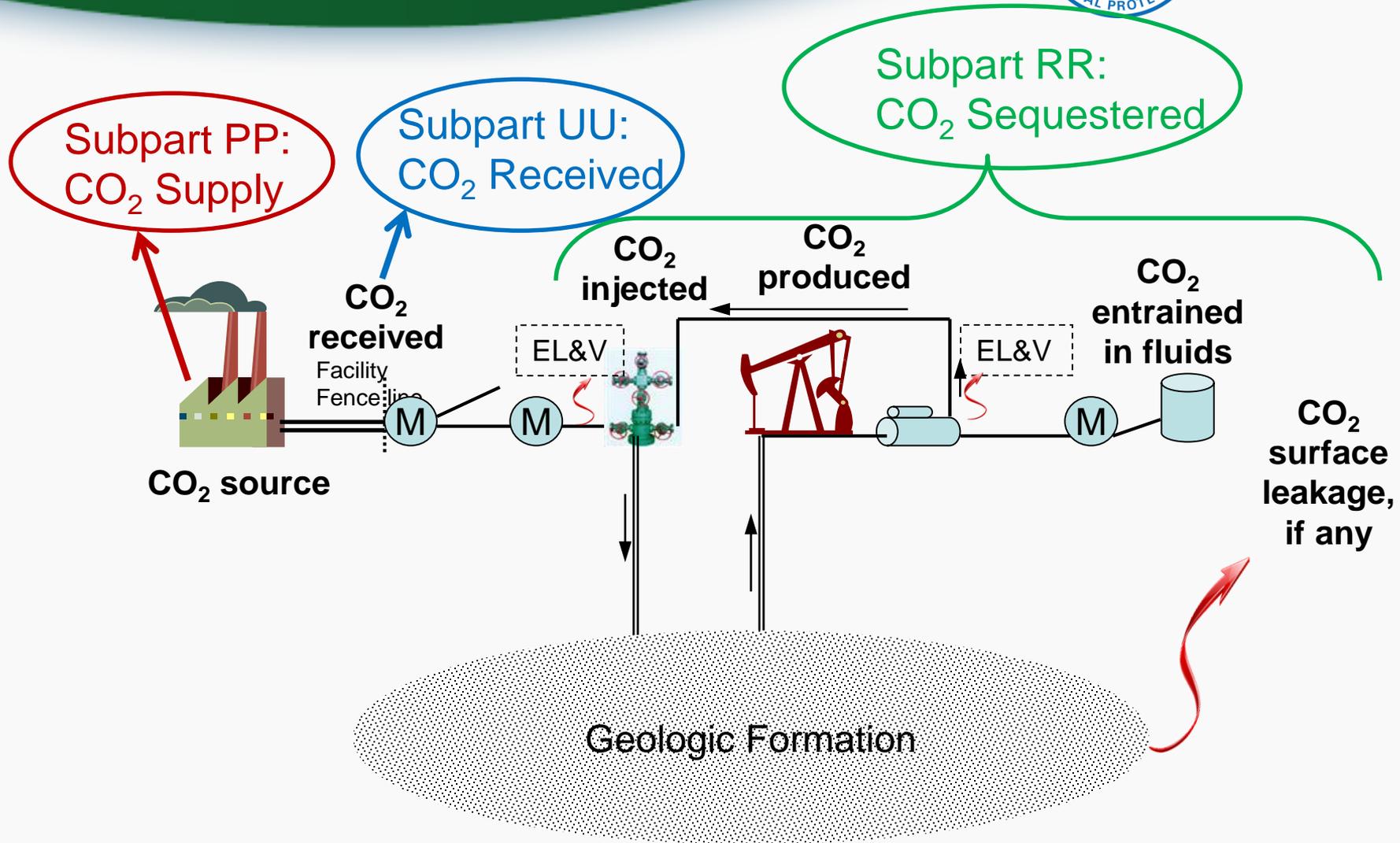
- Launched in response to Fiscal Year 2008 Consolidated Appropriations Act
- Annual reporting of greenhouse gases by 41 source categories
- Direct reporting to EPA electronically
- EPA verification of greenhouse gas data

Source Categories Covered by GHGRP



Power	Refining & Petrochem	Other Chemicals	Combustion	Waste	Metals	Minerals	Pulp & Paper	High GWP Gases
<ul style="list-style-type: none"> - Electricity Generation - Electrical Equipment Mfg. - Electrical Equipment Use 	<ul style="list-style-type: none"> - Petroleum Refineries - Petrochem. Production 	<ul style="list-style-type: none"> - Adipic Acid - Ammonia - Hydrogen Production - Nitric Acid - Phosphoric Acid - Titanium Dioxide 	<ul style="list-style-type: none"> - Stationary Combustion 	<ul style="list-style-type: none"> - Industrial Waste Landfills - Industrial Wastewater Treatment - MSW Landfills 	<ul style="list-style-type: none"> - Aluminum - Ferroalloy - Iron & Steel - Lead - Magnesium - Silicon Carbide - Zinc 	<ul style="list-style-type: none"> - Cement - Glass - Lime - Misc. Carbonate Use - Soda Ash 	<ul style="list-style-type: none"> - Pulp & Paper 	<ul style="list-style-type: none"> - Electronics Mfg. - Fluorinated GHG Production - HCFC-22 Prod./HFC-23 Destruction - Pre-Charged Equipment Import/Export - Industrial Gas Suppliers
Petroleum & Natural Gas Systems			Fuel Suppliers			Carbon Capture & Sequestration		Mining
<ul style="list-style-type: none"> - Onshore Production - Offshore Production - Gathering and Boosting (RY 2016) - Natural Gas Processing - Natural Gas Transmission/Compression - Natural Gas Transmission/Pipeline (RY 2016) - Natural Gas Distribution - Underground Natural Gas Storage - Liquefied Natural Gas Storage - Liquefied Natural Gas Import/Export 			<ul style="list-style-type: none"> - Coal-Based Liquid Fuels Suppliers - Natural Gas and Natural Gas Liquids Suppliers - Petroleum Product Suppliers 			<ul style="list-style-type: none"> - Geologic Sequestration of CO₂ - Injection of CO₂ - CO₂ Suppliers 		<ul style="list-style-type: none"> - Underground Coal Mines
							<div style="border: 1px solid black; padding: 5px; text-align: center;"> Direct Emitters Suppliers CO₂ Injection </div>	

CCS Related Source Categories



Key
M = Meter
EL&V = Equipment Leaks and Vented Emissions



Subpart RR: Geologic Sequestration of Carbon Dioxide

- Provides a mechanism to report to EPA the amount of CO₂ sequestered on an annual basis
- Facilities subject to Subpart RR include:
 - Any well or group of wells that inject a CO₂ stream for long-term containment in subsurface geologic formations
 - All wells permitted as Underground Injection Control Class VI wells
- Facilities that conduct enhanced oil recovery are not required to report under Subpart RR unless:
 - The owner or operator chooses to opt-in and report under Subpart RR, or
 - The well is permitted as an Underground Injection Control Class VI well



Subpart RR Monitoring, Reporting Verification (MRV) Plans

- All facilities subject to Subpart RR must develop and implement an EPA-approved monitoring, reporting and verification (MRV) Plan
- Major elements of Monitoring, Reporting and Verification Plan:
 - Delineation of the monitoring areas
 - Identification of potential surface leakage pathways for CO₂
 - Strategy for detecting and quantifying surface leakage of CO₂
 - Strategy for establishing the expected baseline for monitoring CO₂ surface leakage
 - Site-specific variables



Subpart RR Reporting

- Once the facility has an approved Monitoring, Reporting and Verification Plan, the following are required to be reported annually:
 - Amount of CO₂ received, data used to calculate the amount, and the source of the received CO₂ (if known)
 - Mass balance equation inputs (amounts of CO₂ injected, CO₂ produced, CO₂ emitted by surface leakage, CO₂ emitted from equipment leaks and vented CO₂ emissions) and the amount of CO₂ sequestered
 - An annual monitoring report



Subpart RR Reporting

- In December 2015, EPA approved its first Subpart RR MRV plan
 - Facility is Denver Unit, an EOR facility located in Texas and managed by Occidental Permian, Ltd.
 - The facility voluntarily chose to develop and submit the MRV plan



For more information

- Greenhouse Gas Reporting Program:
<http://www.epa.gov/ghgreporting>



Engagement With Other Federal Agencies



Engagement with Other Federal Agencies

- EPA has worked closely with federal agencies on related GS efforts
- National Risk Assessment Partnership (NRAP)
 - NRAP is a multi-organizational effort that leverages broad technical capabilities across the Department of Energy (DOE) to develop tools that can be applied to risk assessment for long-term storage of CO₂
 - Brings together researchers from five DOE national laboratories: National Energy Technology Laboratory, Los Alamos National Laboratory, Lawrence Berkeley National Laboratory, Lawrence Livermore National Laboratory, and Pacific Northwest National Laboratory
 - EPA provides input through NRAP's stakeholder group



Engagement with Other Federal Agencies

- EPA participates in the annual project review meeting of DOE geologic sequestration R&D projects
 - Advanced storage R&D (e.g., GS technologies and simulation; risk assessment; monitoring, verification, accounting)
 - Storage infrastructure (e.g., Regional Carbon Sequestration Partnership large-scale field projects)
- Quarterly and ad hoc meetings with DOE, the U.S. Geological Survey and other federal agencies engaged on GS activities