

3–5 MARCH 2025 Houston, Texas

### Streamlining your CCUS Permit Application Using Generative AI

### A Multi-Agent Collaboration Approach

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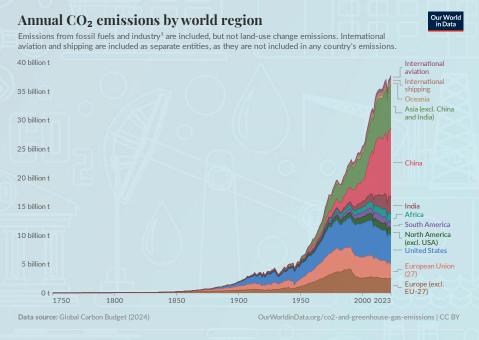
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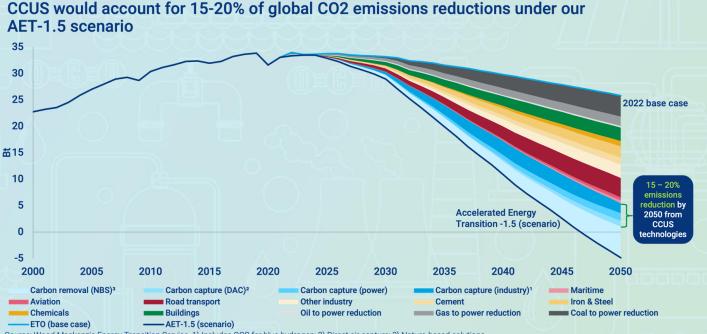


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# **Why CCUS Matters**

- CCUS is critical for achieving net-zero emissions.
- Rising global demand for safe, permanent CO<sub>2</sub> storage.
- Class VI wells provide a regulatory framework to protect underground sources of drinking water.





1. Fossil emissions: Fossil emissions measure the quantity of carbon dioxide (CO<sub>2</sub>) emitted from the burning of fossil fuels, and directly from industrial processes such as cement and steel production. Fossil CO<sub>2</sub> includes emissions from coal, oil, gas, flaring, cement, steel, and other industrial processes. Fossil emissions do not include land use change, deforestation, soils, or vegetation.

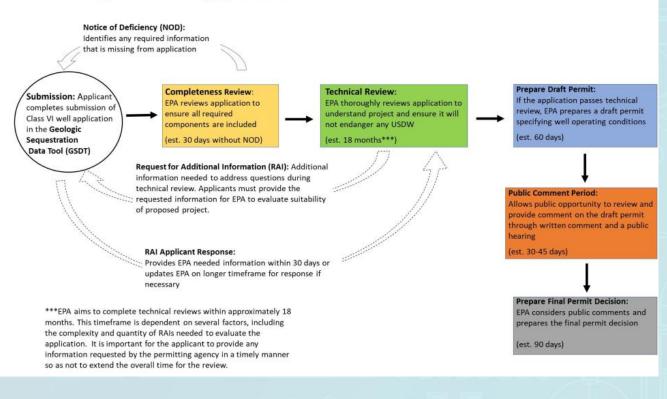
Source: Wood Mackenzie Energy Transition Service. 1) Includes CCS for blue hydrogen; 2) Direct air capture; 3) Nature-based solutions



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# **Challenges in Class VI Permitting**

### **Class VI permitting process**



• Complex Regulatory Requirements (e.g., 40 CFR Part 146 Subpart H).

• **Technical Depth**: Reservoir characterization, injection modeling, and risk assessment.

• Fragmented Information: Multiple data sources and stakeholders



# **Agentic Al Concept**

- Al-Driven Collaboration among specialized sub-agents.
- Supervisor Agent orchestrates tasks.
- Streamlined Access to authoritative knowledge bases.
  - AI Assistants enable line-of business personas speed up timeconsuming energy workflow steps
    - Geologist quickly characterizing reservoirs using Industry databases, commercial data subscriptions, and internal corporate files

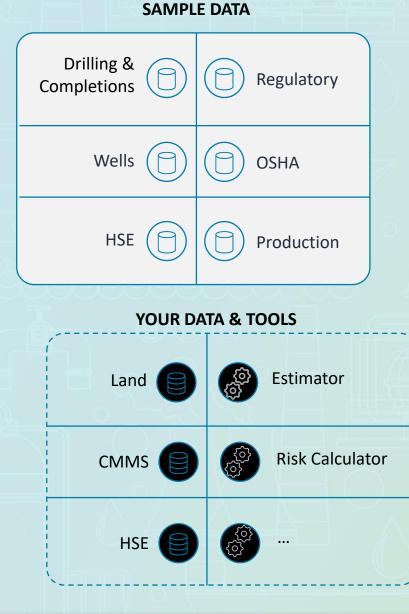


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## **Business Architecture**



PRE-BUILT AGENTS EXAMPLES
Maintenance
Production
Regulatory
Drilling
Reservoir

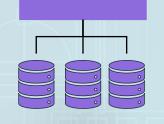


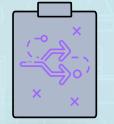


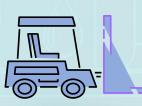
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# How does Agentic AI help line-of-business workers?











Reduce Deployment Complexity

Realize business value from use case focused personadriven GenAI in less time Data Accessibility

Democratize crucial corporate and commercial data

#### Built-In Energy Expertise

Organization and configuration aligned to energy & utilities scenarios and data sets Autonomous Actions

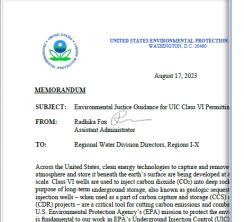
Agents can perform tasks, not just assist employees but act as one Open-Source

Customerdriven priorities and development roadmap



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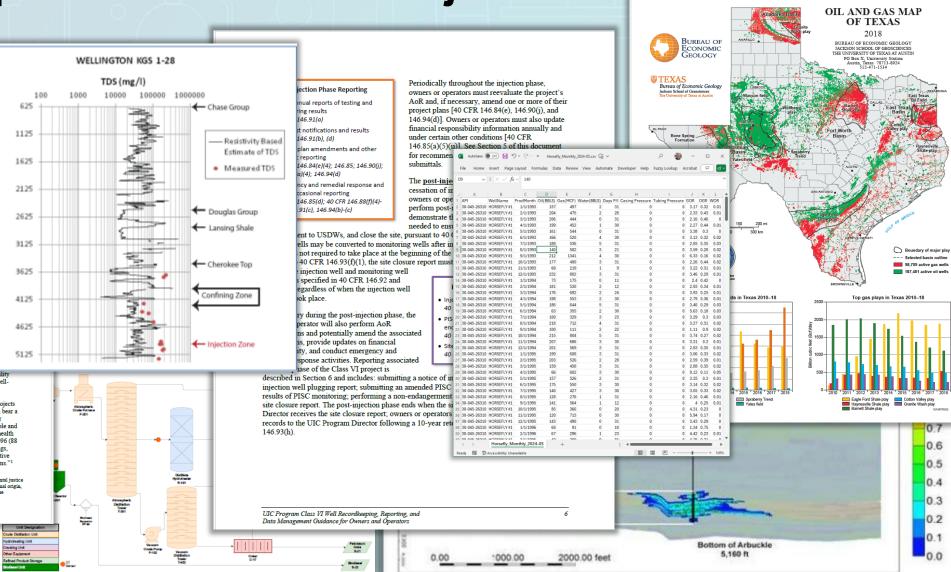
### **Industry Sample Data for CCUS Projects**



Class VI injection wells are regulated under an existing, rigorous Safe Drin permitting framework that protects underground sources of drinking water follows guidance from the Council on Environmental Quality to ensure tha carbon capture, utilization, and sequestration technologies are done in a res incorporates the input of communities, entails appropriate mitigation, and is science. The number of permit applications for UIC Class VI wells is increseveral states have expressed interest in seeking primary enforcement and permitting responsibility for UIC Class VI wells that the states expect will attract GS projects to their area and provide wellpaying jobs that can be implemented in an environmentally responsible way.

People across the country have shared with EPA concerns about the safety of CCS and CDR projects as well as their concern that already environmentally overburdened communities may yet again bear a disproportionate environmental burden associated with geologic sequestration. Executive Order 12898 (39 FR 7629, February 16, 1994) directs federal agencies, to the greatest extent practicable and permitted by law, to identify and address, as a supportained, appropriation, Executive Order 14096 (38 FR 25251, Appl. 21, 2023) recently supplemented this direction and included, among other things, consideration of "effects (including risks) and hazards..., related to climate change and cumulative impacts of environmental and other burdens on communities with environmental justice concerns.<sup>-1</sup>

<u>https://www.fedenlatestian.gov/d/2021-60955/bp17</u> (see sections 2 and 3). The Executive Order defines environmental justice in part to mean "the just treatment and meaningful involvement of all people, regardies of informes, nace, color, and antional origin, Thola affiliation, or disability, in agency decision-making and other Federal activities that affect human health and the environment..."



...related to climate change and cumulative mities with environmental justice concerns."<sup>11</sup> and 3). The Executive Order defines environmental justice IJ people, regardless of income, race, color, autional origin, Federal activities that affect human bealth and the

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### **Agentic Workflow**

Name 🔺	Туре
40 CFR Part 52.pdf	pdf
40 CFR Parts 124, 144, 145, 146, and 147.pdf	pdf
Class_vi_permit_application_outline.pdf	pdf
Class2eorclass6memo_0.pdf	pdf
EPA Pamphlet_How Class VI Regulations Ensure Groundwater Protection.pdf	pdf
Geologic Sequestration of Carbon	

Geologic Sequestration of Carbon Dioxide Underground Injection Control (UIC) Program Class.pdf

### **Supervisor Agent (Orchestrator)**

Receives the user query.

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- Analyzes which Sub-Agent(s) need to be involved.
- Delegates tasks to Sub-Agent(s).
- Gathers, synthesizes, and finalizes the results from Sub-Agents into a coherent response.
- Delivers the final answer or next steps back to the user.

#### **Regulatory & Compliance Agent**

 Focuses on verifying compliance with regulatory frameworks, referencing EPA Class VI regulations and associated guidance documents.

pdf

- Advises on legal, environmental, and policy requirements.
- Collaborates with Technical Data Agent as needed to ensure technical data meets compliance requirements.

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	application_narrative_template.docx	docx
	approaches_to_geologic_sequestration_sit           e_stewardship_afer_site_closure_july_200           8.pdf	pdf
	Aquifers of texas.pdf	pdf
	August 2022 CCS Information Session.pdf	pdf
	CCS Webinar_8_11_22 Summary.pdf	pdf
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n M	E00006821-Class-VI-Injection- PermitSalient-Features-and-Regulatory- Challenges_Final.pdf	pdf
	Geology of texas.pdf	pdf
	IN-165-6A- 0001_Wabash_Draft_Permit.pdf	pdf
X	IN-167-6A- 0001_Wabash_Draft_Permit.pdf	pdf
	Oil and Gas Map of Texas.pdf	pdf

#### **Technical Data & Reporting Agent**

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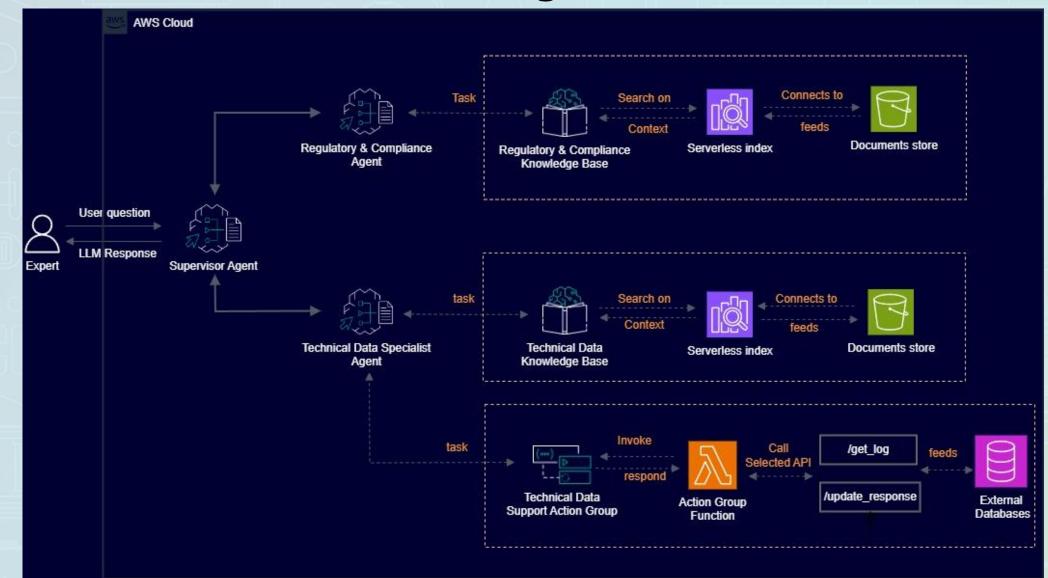
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- Processes and analyzes technical data (e.g., geological data, injection well design, modeling results).
- Prepares or evaluates application documentation required for Class VI well submissions.
- Collaborates with Regulatory Agent to confirm technical data aligns with regulatory needs.



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### **CCUS Multi-Agent Workflow**





What specific Class VI construction standards and casing requirements do I need to address in my permit application for a new injection well?	<b>Multi-agent collaboration trace timeline</b> For agents with Multi-agent collaboration enabled, each subsequently invoked Agent collaborator is displayed. Each bar within trace timeline can be clicked to show the specific breakdown for that Agent collaborator.			
	(1)supervisor Qu Time (second), 00s			
L≱.	Trace       Session summaries         Trace (1)			
	Orchestration and Knowledge Base After running a prompt in the test window, this orchestration trace allows you to explore the trace steps to understand the linear chain of thoug used by the agent's orchestration prompt component. If a knowledge base was invoked, the trace also allows you to see how the results from the knowledge base were summarized to generate an observation that is used for for orchestrating the next step or generating the response.			
Enter your message here	► Trace step 1 Show co			



### Case 1

What specific Class VI construction standards and casing requirements do I need to address in my permit application for a new injection well?



2

The specific Class VI construction standards and casing requirements for your permit application for a new injection well include:

#### **Regulatory Requirements:**

- 1. The well must be constructed to prevent fluid movement between Underground Sources of Drinking Water (USDWs) or unauthorized zones.
- 2. The design must allow for appropriate testing devices and workover tools.
- 3. The well must permit continuous monitoring of the annulus space between injection tubing and long string casing.
- 4. The casing and cement must have sufficient structural strength for the life of the project.
- 5. All materials must be compatible with expected fluids and meet or exceed standards from American Petroleum Institute, ASTM International, or comparable standards approved by the Director.

#### **Technical Requirements:**

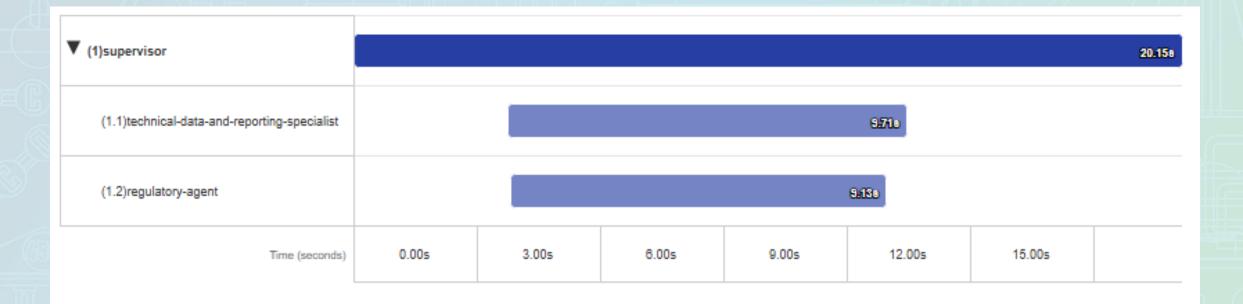
- 1. The well must be constructed with materials and cements that can withstand exposure to carbon dioxide and CO2/water mixtures throughout the project's lifetime.
- 2. The wells must be cased and cemented to prevent fluid movement between USDWs.
- 3. They must be equipped with an automatic surface shut-off system that activates if operating parameters deviate from permit limitations.
- 4. The well must allow for continuous monitoring of the annulus space between injection tubing and long string casing.
- 5. Must permit the use of appropriate testing devices and workover tools.
- 6. The casing and cement must have sufficient structural strength for the project's lifetime.
- 7. Injection must occur through tubing with a packer set at a depth opposite a cemented interval.
- Operators must submit specific technical information including:
- Depth of setting
- Carbon dioxide stream characteristics (chemical content, corrosiveness, temperature, density)
- Maximum proposed injection and annular pressure
- Injection rate specifications
- Tubing and casing sizes
- Tubing tensile, burst, and collapse strengths

Please ensure that your permit application includes these requirements to meet Class VI regulations.



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### **Multi-agent collaboration trace timeline**





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### **Agent Interaction breakdown**

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"input": {

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"agentCollaboratorName": "Supervisor-Technical",

"input": {

....

"text": "Please provide the technical data requirements for a new injection well, focusing on construction standards and casing requirements as per Class VI regulations.",

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### Case 2

What are the public notification and stakeholder engagement requirements before submitting a Class VI permit application?"



The public notification and stakeholder engagement requirements before submitting a Class VI permit application include:

- Beginning stakeholder outreach as early as possible in the permitting process, even before issuing a draft permit.
- Providing notice through various means such as newspaper advertisements, radio, mailings, or emails to interested parties.
- Sending specific notifications to state and local oil and gas regulatory agencies, state agencies regulating mineral exploration and recovery, the Director of the Public Water System Supervision program, and all agencies with jurisdiction over wells in the state.
- Utilizing the Internet and social media to explain potential GS projects, describe technologies, and post information about project developments, including schedules for hearings and opportunities for involvement.

This approach ensures accessibility and transparency to a wide audience.

▼ (1)supervisor							13.658
(1.1)regulatory-agent					74070		
Time (seconds)	0.00s	2.00s	4.00s	6.00s	8.00s	10.00s	

### }, "rationale": {

"text": "The User's goal is to understand the public notification and stakeholder engagement requirements before submitting a Class VI permit application.\n(2) No additional information has been provided.\n(3) The best action plan is to delegate this task to the Regulatory & Compliance Specialist to gather the necessary regulatory information.\n(4) The next step is to contact the Regulatory & Compliance Specialist.\n

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# **Key Takeaways**

Agentic AI brings clarity and efficiency to Class VI permitting.

 Modular Workflow ensures specialized expertise in both regulatory and technical spheres.

 Comprehensive Knowledge Bases keep guidance accurate and updated.



# **Future Vision**

• Additional Sub-Agents: Financial Modeling, Community Outreach, Liability Management, Timeline specialist.

- Multi-Lingual Support for international CCUS projects.
- **Continuous Learning**: ML enhancements from new industry datasets and completed permit applications.