Captured by Complexity

The Future of Regulating Carbon Capture and Storage

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Current technology allows us better means to prevent and recover from future and existing environmental damage caused by carbon dioxide (CO_2). Though other options for climate help may be available, an increasingly viable and popular option is carbon capture and storage (CCS). CCS is a complex process that involves removing CO_2 from emissions by (1) capturing CO_2, either at emission sources (e.g., power plants, natural gas processing facilities, and other industrial facilities) or directly or indirectly from the atmosphere; (2) transporting CO_2 by pipeline, rail, truck, or boat; and (3) permanently storing or burying CO_2 in a suitable underground location, such as in a geologic formation. While the use of CCS is fairly limited today, the United States leads global CCS development according to the Global CCS Institute's report entitled *Global Status of CCS 2024*. More specifically, in 2024, the United States was home to 276 CCS projects—presenting a 79% increase from 2023, and a 324% increase over its next-closest competitor, the United Kingdom—scattered across the United States and centered in states such as California, Illinois, Louisiana, North Dakota, Texas, West Virginia, and Wyoming. While some of these projects are fully operational, others are under construction or in the early stages of permitting and development.

This article provides an overview of CCS generally, including its potential benefits and associated criticisms, before examining some of the legal challenges by highlighting the complexities in the CCS process and the most common legal and regulatory hurdles that influence these technologies. There are legal challenges to CCS technologies, particularly in the realm of permitting the injection wells necessary for CCS projects, and other various factors will affect the degree to which CCS is used in the future. The difficulty of these initiatives is already fairly well known when it comes to carbon reduction, such as in the case of the infamous Initiative 2117 in Washington state—an act to repeal Washington's Climate Commitment Act, which requires the largest polluters to pay into a state fund to compensate for carbon emissions. Despite such difficulties, CCS provides a new frontier of seeing what may appeal to a wider audience when it comes to regulation. This article also explores the laws and regulations at both the federal and state levels, then discusses the current status of permitting efforts, and, finally, discusses what can be expected in 2025 and beyond.

What Is CCS, Why Do We Want It, and How Do We Get It?

CCS is a potentially transformative technology with far-reaching implications for the environment and sustainability efforts by targeting industrial activity in particular. It "can capture more than 90% of CO_2 emissions from power plants and industrial facilities;" yet the benefits to the environment are almost a byproduct of the CCS initiative. Ctr. for Climate & Energy Sol., *Carbon Capture*. For example, while CCS can be used for the injection of CO_2 in underground geologic formations, it also can be used for the injection of CO_2 to increase oil production from aging oil fields in a process known as enhanced oil recovery (EOR). There have been notable examples of this in Kansas, Oklahoma, and Texas with Chaparral Energy since the early 1980s, moving about 600,000 tons of CO_2 underground and using the same deposit sites to store CO_2 from fertilization production sites. While CCS also can be used to mitigate greenhouse gases (GHGs), thus mitigating climate change, it also can be used in the conversion of CO_2 into potentially commercially viable products, including cements, chemicals, fuels, and plastics. Additionally, there are beneficial financial incentives to developing and deploying CCS projects, including revenues from EOR, as well as federal tax credits. Currently, five industry sectors are involved with CCS projects and

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technologies, including chemical production, fertilizer production, hydrogen production, natural gas processing, and power generation.

Despite potential benefits to the economy and environment, CCS is not without its challenges and opponents. For example, the use of CCS technologies is not uniformly supported, including by those seeking to address climate change and reduce CO_2 emissions. For example, during pushes for CCS practices to become more widespread during the Biden administration, in 2021 over 500 organizations from Canada and the United States wrote in opposition to stop new sites from being built. Some argue that CCS supports continued reliance on, and combustion of, fossil fuels and that CCS presents serious concerns involving the safety and environmental uncertainties of long-term underground CO_2 storage. There is a concern of leakage into the areas surrounding these sites, and along with the fact that these technologies are so recent, it is argued that these methods are untested and therefore it is unknown what effect these storage sites will have over time. Additionally, there is general agreement that costs for constructing and operating CCS must decrease before the technologies can be widely deployed. Congress has attempted to address the economic efficiency challenge in recent years in two main ways: federal research and development and federal tax credits. These efforts demonstrate Congress's interest in the efficacy of the federal tax credits in promoting CCS projects, both in the development and deployment stages.

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CCS projects also present the unique property law issue of pore space ownership. Federal laws and regulations are not sufficient to address pore space ownership issues and, accordingly, these issues are often dictated at the state level. In the United States, the majority of states appear to follow what is referred to as the "American Rule," which provides that the mineral estate holder owns the minerals but not the geologic formation and that the surface owner owns the geologic pore space and has storage rights. In contrast, the English Rule dictates that the mineral estate holder owns both the natural resources and the pore space.

Ultimately, CCS projects and technologies must be closely monitored and regulated to establish a reliable framework encouraging responsible investment and operation and to provide for a smoother implementation for both regulators and the regulated community. These laws and regulations must verify the nature (i.e., the amount and composition) of CO_2 being stored underground, consider how CO_2 is behaving once stored underground, ensure long-term integrity and predictability of containment and storage, and account for any leakage that may occur and provide for early notifications in the event of any such leakage.

Many CCS projects will involve multiple private, local, state, tribal, and/or federal agencies for authorization and likely will require a series of reviews, permissions, and permits. Under the Safe Drinking Water Act (the SDWA), the U.S. Environmental Protection Agency's (EPA) Underground Injection Control (UIC) Program regulates the underground storage of captured emissions and, in doing so, requires a Class VI permit to both drill and actually inject gases underground. 40 C.F.R. pt. 144, tit. 40 (2025). However, aside from this, there are currently no federal regulations specific to CCS projects or pipelines. Instead, the development, construction, and operation of CCS projects are primarily regulated by individual state systems. To date, at least 21 states have promulgated regulations specific to CCS, though the scope of these regulations differs fairly significantly from state to state, resulting in a "patchwork" of different rules and regulations with respect to scope and control surrounding CCS projects. For example, some regulations relate to liability (in six states), storage funds (in six states), pore space ownership (in three states), CO_2 ownership (in six states), the percentage of pore space owners that must consent to a project (in three states), and interstate issues (in three states). Colum. Law Sch. Sabin Ctr. for Climate Change Law & Arnold & Palmer, *CCUS State Legislative Tracker*, CDR Law (last updated May 28, 2025).

How Is CCS Regulated by Federal Laws, Regulations, and Land Use Permitting?

While CCS does not fit neatly within the current regime of federal environmental law and regulation in the United States, several federal environmental laws and regulations enable federal agencies to influence CCS efforts and projects, often in coordination with state regulatory agencies. Below, we discuss those federal environmental laws and regulations that have the potential to affect CCS projects, although this discussion is not exhaustive and other laws and regulations may be at play, including, for example, the Coastal Zone Management Act, the Hazardous Liquid Pipeline Safety Act, the Hazardous Materials Transportation Act, and the National Historic Preservation Act.

Perhaps the most significant regulation on this issue is the SDWA's UIC Program. 40 C.F.R. pt. 144, tit. 40 (2025). The SDWA requires EPA to establish rules to protect underground sources of drinking water from endangerment. As part of this responsibility, EPA has developed its UIC Program to set rules for operating underground injection wells and establish minimum federal requirements for six classes of injection wells. Two such classes may impact CCS projects, including Class II wells (used exclusively to inject fluids that are associated with oil and natural gas production (e.g., wastewater from hydraulic fracturing and fluids used for EOR)) and Class VI wells (used to inject CO_2 into deep geologic formations for the purpose of storing

CO_2). Where EPA has delegated primacy to states to administer the UIC Program in full or in part, EPA has developed guidance and minimum requirements to support the state programs in their implementation, though in some jurisdictions EPA directly administers the UIC Program. These minimum requirements include, among other things, performance standards for well construction, operation, and maintenance; monitoring and testing; reporting and recordkeeping; site closure; financial responsibility; and post-injection site care, where appropriate.

Another federal law that may impact CCS projects is the Clean Air Act and, more specifically, EPA's Greenhouse Gas Reporting Program (the GHGRP). The GHGRP sets forth various reporting requirements for suppliers of CO_2 (including CO_2 capture), underground injection, and geologic sequestration of CO_2. *Id*. pt. 98, tit. 40. After facilities submit and receive approval for their plan for monitoring, reporting, and verifying CO_2 sequestered underground, facilities then report basic information on CO_2 received for injection, data related to the amounts of CO_2 sequestered, and annual monitoring activities. The goal is for EPA to use this information to monitor the growth and effectiveness of CCS as a GHG mitigation technology over time and to evaluate relevant policy options. This rule is complementary to, and builds upon, EPA's requirements under the UIC Program.

Next, the National Environmental Policy Act (NEPA) is the principal federal law that dictates how environmental review and permitting works at the federal level by imposing procedural requirements on federal agencies. These procedural requirements involve federal agencies assessing the environmental and related social and economic effects of their proposed actions prior to making permitting decisions, among other things. This process is conducted by the federal agency or agencies that are connected to the project's particular federal nexus. CCS projects, in particular, may be subject to NEPA if they have a federal nexus, including, for example, by needing a significant federal permit or involving significant federal funding, as well as federal land (or waterways), or requiring federally managed infrastructure.

Another federal law that may impact CCS projects is the Clean Water Act (the CWA), which may require a federal permit if a CCS project or pipeline crosses water or wetlands. The U.S. Army Corps of Engineers, which issues permits for discharge of dredge or fill materials under section 404 of the CWA, requires a permit for any utility line crossing that requires the discharge of dredge or fill materials into "waters of the United States," and this includes "any pipe or pipeline for the transportation of any gaseous, liquid, liquescent or slurry substance for any purpose."

Additionally, EPA has issued a final rule revising the regulations for hazardous waste management under the Resource Conservation and Recovery Act (RCRA) to exclude CO_2 streams from the definition of hazardous waste where such streams are captured from emission sources, injected into UIC Class VI wells for carbon sequestration, and satisfy certain other conditions. Hazardous Waste Management System: Conditional Exclusion for Carbon Dioxide (CO_2) Streams in Geologic Sequestration Activities, 79 Fed. Reg. 350 (Jan. 3, 2014). EPA has taken the position that the management of CO_2 streams, when satisfying certain conditions, does not present a substantial risk to human health or the environment, making additional regulation pursuant to RCRA's hazardous waste regulations unnecessary.

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The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) may be triggered in the event of release of contaminants to the surface or subsurface that present an imminent and substantial danger to the environment. The Emergency Planning and Community Right-to-Know Act, on the other hand, may be triggered in the event of release to the surface or subsurface of listed extremely hazardous substances, thus requiring reporting and emergency planning. Some of the risks of CCS storage include leakage or rupture of a pipeline, leading to the release of CO_2, and if the release is continuous and stable in quantity and rate, it may qualify for reduced requirements under CERCLA. 40 C.F.R., pt. 355, subpt. C, tit. 40 (2025).

Finally, CCS projects or pipelines may trigger other laws and regulations protecting fish and wildlife and requiring review of potential impacts to threatened or listed species, including, for example, the Endangered Species Act; the Fish and Wildlife Conservation Act/Fish and Wildlife Coordination Act; the Magnuson-Stevens Fishery Conservation and Management Act; the Marine Mammal Protection Act; the Bald and Golden Eagle Protection Act; the Migratory Bird Treaty Act; and the Marine Protection, Research, and Sanctuaries Act. When pursuing site selection, CCS projects or pipelines, like other development projects, need to consider their potential impact and seek authorization or undertake appropriate mitigation actions when required.

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How States Regulate CCS

A significant driver of the development of CCS projects—in addition to the desire to develop and implement technologies to curtail carbon emissions—is economic benefit via federal tax credits. CCS provisions in the bipartisan Infrastructure Investment and Jobs Act, included an expansion of 45Q tax credits and funding opportunities for CCS projects. Pub. L. No. 117-58, 135 Stat. 429 (Nov. 15, 2021). It is worth highlighting that the House of Representatives has passed a sweeping tax reconciliation bill that makes significant changes to the U.S. energy tax credit regime. Originally enacted in 2008, reformed in 2018, and expanded and extended in 2022, the 45Q tax credit for carbon capture, utilization, and sequestration (CCUS) projects passed by the U.S. Congress is the most significant carbon capture–specific incentive available globally and is spurring the progress of dozens of projects across the country. As a result of 45Q tax credits, state-level incentives, and grant funding from the U.S. Department of Energy (DOE), the United States is home to more than 58 CCS projects at various stages of planning and development, with at least 19 facilities being fully operational. Ian Tiseo, *Carbon Capture and Storage (CCS)—Statistics & Facts*, Statista (Sept. 6, 2024). The facilities are scattered across the United States, with clusters of CCS facilities in Colorado, Illinois, Texas, Utah, and Wyoming. Almost all of these facilities require captured emissions to be permanently stored in deep geological formations via Class VI wells. As discussed above, these Class VI wells are permitted under EPA's UIC Program. Although the tax reconciliation bill does not reflect any major changes to the 45Q tax credit for the underlying credit, the bill provides that transferability is repealed for projects that begin construction more than two years after enactment, and overall the energy tax credits are generally in flux and facing potential elimination. John Eliason et al., *Client Alert: Reconciliation Bill Passes House: Detailed Analysis of Energy Tax Credit Changes*, Orrick (May 27, 2025).

In preparation for these anticipated projects and to shape their development, states interested in technology innovation and emissions undertook a three-phase process. The first phase involved identification of the state's priorities with respect to maximizing use of federal funding and the resources through which funding would make CCS projects viable within the state. The first phase also included designating a single state official to coordinate use of the funds and identify priority programs and milestones as well as identifying key stakeholders across various sectors in the state.

In the second phase, the state focused on collaboration among and between the state principals, stakeholders, and the public regarding the desired use and capacity to embrace and accommodate CCS projects. Typically, the individual states accomplished phase two through monthly meetings, hosting information sessions, updating websites, hosting public forums, and other such tools to educate and inform all the necessary parties, entities, and the public.

The third phase involved implementation, whereby the state identified and secured matching funds via federal grant applications as soon as possible to increase the state's competitiveness and potential success. The individual states then tracked relevant federal funding and continuously updated their individual priorities and needs. Throughout this process it was shown that states such as Louisiana and West Virginia learned from what North Dakota and Wyoming were doing to successfully develop their CCS projects while remaining open to adapting their plans to emulate and improve their successes.

Current Status of State Permitting Efforts

EPA has approved UIC primacy programs for multiple well classes in 31 states and three territories. If a state, territory, or tribe does not obtain primacy for all or some UIC well classes, then EPA implements the program directly through one of its regional offices. Currently, EPA implements the UIC Program for all well classes in seven states and three territories. Apart from the Navajo Nation and Fort Peck Class II programs, EPA directly implements the UIC Program in Indian country.

The successful use of CCS as a decarbonization tool depends on the security of stored CO_2 in deep geological formations, including the integrity and long-term stability of the storage reservoir. Geologic CO_2 storage is governed by robust regulations that provide considerable environmental safeguards via the UIC Program, which regulates the construction, operation, permitting, and closure of injection wells that are used to store fluids in the subsurface. Permanent geologic storage of CO_2 is regulated under EPA's Class VI permitting program, and these Class VI wells are a necessary component of any CCS project.

Arizona and Texas are at various stages of pursuing primacy over Class VI permitting, which would allow the states to assume primary regulatory authority over Class VI wells. Primacy is granted where states have requirements at least as protective as federal standards. The process is lengthy, yet once achieved, state primacy affords the state with autonomy in overseeing Class VI wells and signifies a significant shift from federal EPA oversight to the state agency and thus allows the state to better control the development of CCS projects.

To date, only four states have been granted primacy over Class VI wells. Those states are, in the order of granting, North Dakota, Wyoming, Louisiana, and West Virginia. Arizona and

Texas are actively seeking Class VI primacy; both have a historical presence in this activity. North Dakota currently has 17 well applications pending. Louisiana, the next state to obtain primacy, currently reports 95 well applications. Wyoming currently reports six well applications. West Virginia, the most recent state to achieve primacy over Class VI wells (achieved in January 2025), currently reports three well applications. As of April 2025, EPA has issued eight final permit decisions, with 55 projects under review and 162 well applications under review.

Further, with respect to carbon sequestration projects, as of March 2025, EPA has issued four permits under the UIC Program and currently has over 130 permit applications under review. One of the four permitted projects—the first to begin storing CO_2—was recently hit with a notice of violation from EPA, which alleged issues with one of the operator's monitoring wells. This has renewed concerns about the potential risks of geologic carbon storage and has strengthened calls for additional government and industry oversight. However, even with the increased concern regarding the risks associated with geologic carbon storage, the drive to establish carbon capture facilities continues.

Lofty Goals with Big Rewards in Potential Jeopardy

Currently, the greatest barrier to widespread carbon capture in the United States is cost. A study performed by the U.S. Government Accountability Office determined that of the 11 carbon capture projects it studied, eight were terminated or withdrawn before construction due to lack of economic viability, resulting in only three operational projects. The International Energy Agency, a Paris-based autonomous intergovernmental organization established in 1974 that provides policy recommendations, analysis, and data on the global energy sector, has announced a goal to achieve net zero emissions by 2050. Experts agree that for this goal to be achieved, the global carbon capture market must increase from 40 million tons per year in 2020 to 5,635 million tons in 2050. This growth is dependent on an increase in carbon capture employment levels to an upper estimate of 44,000 carbon capture industry employees in 2030 and nearly 2 million employees in 2050. If this is accomplished, then carbon capture can achieve 14% of the global GHG emission reductions needed by 2050, which could be crucial to obtaining this goal.

Regardless of its regulatory and economic challenges, carbon capture is seen as a long-term solution for helping decarbonize industries across the United States. The policy and significant investment in research and development and the financial incentives underscore the expectation of significant growth in this industry over the next few decades. Some have forecasted that the CCS market in the United States will reach approximately $7,916.3 million by 2035. Nikhil Kaitwade, *USA Carbon Capture and Storage Market Size and Forecast Outlook (2025 to 2035)*, Future Mkt. Insights Inc. (Feb. 16, 2025). However, to support the level of anticipated growth, policy support and tax incentives are a necessity—both factors that are in jeopardy under the tax reconciliation bill. While CCS is a demonstrated technology, without an underlying policy initiative to decarbonize industries and state and federal funds to support it, CCS may be a decarbonization solution that amounts to a failure to launch. Since January 20, 2025, U.S. Secretary of Energy Chris Wright has announced the termination of 24 awards issued by the Office of Clean Energy Demonstrations, Department of Energy. Sean Wolfe, *Energy Secretary Terminates $3.7B-Worth of Biden-Era Projects Focusing on Carbon Capture, Decarbonization*, Renewable Energy World (May 30, 2025). Although it seems such significant cuts are a proverbial "death knell" for CCS, Secretary Wright attributes the cuts not to a fledgling interest in decarbonization and CCS, but rather to an effort to subject Biden-era projects to Trump-era "due diligence to ensure we are utilizing taxpayer dollars to strengthen our national security, bolster affordable, reliable energy sources and advance projects that generate the highest possible return on investment." It seems for now, at least when it comes to CCS, the political "tea" is too murky to read the leaves.

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