



December 2021

CARBON CAPTURE AND STORAGE

Actions Needed to Improve DOE Management of Demonstration Projects

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GAO Highlight

Highlights of GAO-22-105111, a report to congressional committees

December 2021

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Actions Needed to Improve DOE Management of Demonstration Projects

Why GAO Did This Study

Key scientific assessments have underscored the urgency of reducing emissions of carbon dioxide (CO₂), the most significant greenhouse gas, to help mitigate the negative effects of climate change. CCS technologies have the potential to reduce CO₂ emissions from sources such as coal plants and industrial facilities. Since 2009, DOE has sought to establish the viability of CCS technologies through various demonstration projects. The 2021 Infrastructure Investment and Jobs Act authorized and appropriated billions of dollars in new investments in CCS demonstration projects.

Congress included a provision in the Energy Act of 2020 for GAO to review DOE's practices, successes, failures, and any improvements in executing CCS demonstration projects. This report examines (1) the outcomes of DOE-funded CCS demonstration projects and the factors that affected them and (2) DOE management of those projects. GAO reviewed laws, regulations, guidance, funding agreements, and other project documentation, and interviewed DOE officials and project representatives.

What GAO Recommends

GAO is making one matter for congressional consideration: that Congress consider implementing a mechanism for greater oversight and accountability of DOE CCS demonstration project funding. GAO is recommending that DOE (1) improve its project selection and negotiation processes and (2) more consistently administer projects against established, scopes, schedules, and budgets. DOE neither agreed nor disagreed with the recommendations.

View GAO-22-105111. For more information, contact Frank Rusco at (202) 512-3841 or ruscof@gao.gov.

What GAO Found

The Department of Energy's (DOE) investment of \$1.1 billion in carbon capture and storage (CCS) demonstration projects resulted in varying levels of success. Largely due to external factors that affected their economic viability, coal CCS projects were generally less successful than CCS projects at industrial facilities, such as chemical plants.

Coal projects. DOE provided nearly \$684 million to eight coal projects, resulting in one operational facility. Three projects were withdrawn—two prior to receiving funding—and one was built and entered operations, but halted operations in 2020 due to changing economic conditions. DOE terminated funding agreements with the other four projects prior to construction. Project documentation indicated and DOE officials and project representatives told GAO that economic factors—including decreased natural gas prices and uncertainty regarding carbon markets—negatively affected the economic viability of coal power plants and thus these projects.

Industrial projects. DOE provided approximately \$438 million to three projects designed to capture and store carbon from industrial facilities, two of which were constructed and entered operations. The third project was withdrawn when the facility onto which the project was to be incorporated was canceled.

GAO identified significant risks to DOE's management of coal CCS demonstration projects. These risks include the following:

High-risk selection and negotiation processes. DOE's process for selecting coal projects and negotiating funding agreements increased the risks that DOE would fund projects unlikely to succeed. Specifically, DOE fully committed to coal projects at their initial selection as opposed to allowing time for further review, as it did for selected industrial CCS projects. Additionally, according to DOE officials, the department used expedited time frames for coal project negotiations—less than 3 months as opposed to up to a year—based on DOE's desire to begin spending American Recovery and Reinvestment Act of 2009 funds quickly. These actions reduced DOE's ability to identify and mitigate technical and financial risks, a principle cited in DOE guidance.

Bypassing of cost controls. DOE, at the direction of senior leadership, did not adhere to cost controls designed to limit its financial exposure on funding agreements for coal projects that DOE ultimately terminated. As a result, the agency spent nearly \$472 million on the definition and design of four unbuilt facilities—almost \$300 million more than planned for those project phases. According to DOE documentation and officials, senior leadership directed actions to support projects even though they were not meeting required key milestones. DOE documentation also indicates that had Congress authorized an extension on the use of the funds, DOE might have continued funding some of these projects. By managing future CCS projects against established scopes, schedules, and budgets, DOE would be better positioned to mitigate its financial exposure if projects struggle. Additionally, absent a congressional mechanism to provide greater oversight and accountability—such as requiring regular DOE reporting on project status and funding—DOE may risk expending significant taxpayer funds on CCS demonstrations that have little likelihood of success.

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Abbreviations	
CCS	carbon capture and storage
CO ₂	carbon dioxide
DOE	Department of Energy
Recovery Act	American Recovery and Reinvestment Act of 2009

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December 20, 2021

The Honorable Joe Manchin III
Chairman
The Honorable John Barrasso
Ranking Member
Committee on Energy and Natural Resources
United States Senate

The Honorable Eddie Bernice Johnson
Chairwoman
The Honorable Frank Lucas
Ranking Member
Committee on Science, Space, and Technology
House of Representatives

Key scientific assessments have underscored the urgency of reducing emissions of carbon dioxide (CO₂), the most significant greenhouse gas, to help mitigate the negative effects of climate change. Among the strategies being developed to reduce CO₂ emissions is carbon capture and storage (CCS), a process that involves capturing CO₂ generated by human activities at its source—for example, coal-fired power plants and industrial facilities—and storing it permanently underground in geologic formations, such as depleted oil and gas reservoirs.¹ Captured CO₂ can also be used to enhance oil recovery, and research is ongoing regarding its use in other industrial processes. Reflecting CCS's potential as a strategy to reduce CO₂ emissions, the 2021 Infrastructure Investment and Jobs Act authorized and appropriated more than \$2.5 billion over fiscal years 2022 through 2025 for carbon capture demonstration projects.²

Nevertheless, implementing CCS technologies has proven to be a challenge in the past, particularly when factoring in the economic viability of building new facilities or retrofitting existing ones in order to capture CO₂. Beginning in 2009, DOE initiated numerous efforts to accelerate the development of CCS technologies. Among these, DOE initiated projects

¹CCS is sometimes referred to as CCUS—carbon capture, utilization, and storage. In addition, CCS is also sometimes referred to as carbon capture and sequestration.

²The Energy Act of 2020 also authorized \$2.6 billion for DOE to award for six CCS demonstration projects through 2025.

to demonstrate the feasibility of CCS technologies at commercial scale at both coal-powered electricity generation plants and industrial facilities. As we reported in September 2018, DOE spent approximately \$1.1 billion on nine large CCS demonstration projects from 2010 through 2017—six coal and three industrial—through cooperative agreements in which DOE shares a portion of project costs along with funding recipients, which are responsible for the remainder.³

In light of past and potential future federal government investments in CCS technologies, the Energy Act of 2020 included a provision for GAO to report on the successes, failures, practices, and improvements in DOE's administration of large CCS demonstration projects.⁴ This report examines (1) the outcomes of past DOE-funded CCS demonstration projects and the external factors that affected them and (2) how DOE's management of these projects contributed to their outcomes.

We focused our review on the nine large CCS demonstration projects that received DOE funding beginning in 2009. To address both objectives, for each project, we reviewed project documentation that describes project goals, expected budgets and schedules, actual budgets and schedules, and outcomes. This documentation included related legislation, funding opportunity announcements, DOE project selection announcements, cooperative agreements and modifications, and project technical reports. We analyzed these documents to identify project outcomes and the external factors that contributed to them, which we discussed with DOE officials and project representatives.⁵

Additionally, we reviewed DOE guidance as well as internal control standards and assessed DOE's actions in managing CCS demonstration projects against these criteria.⁶ We also interviewed DOE officials and

³DOE selected 11 projects, but two withdrew prior to receiving funding. GAO, *Advanced Fossil Energy: Information on DOE-Provided Funding for Research and Development Projects Started from Fiscal Years 2010 through 2017*, [GAO-18-619](#) (Washington, D.C.: Sept. 21, 2018).

⁴While the provision directed GAO to study the new CCS demonstration projects to be awarded through 2025, to satisfy the December 27, 2021, reporting deadline, this report focuses on existing DOE-funded CCS demonstration projects.

⁵We contacted representatives of all nine CCS demonstration projects that received DOE funding and received responses from five.

⁶Department of Energy, *Guide to Financial Assistance: A Guide to the Award and Administration of Financial Assistance* (Oct. 1, 2020). GAO, *Standards for Internal Control in the Federal Government*, [GAO-14-704G](#) (Washington, D.C.: Sept. 2014).

project representatives to obtain their perspectives on actions that DOE could take to improve its management of future iterations of CCS demonstration projects.

We conducted this performance audit from April 2021 to December 2021 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

Background

DOE's Office of Fossil Energy and Carbon Management (previously the Office of Fossil Energy) is responsible for carrying out DOE's fossil energy research and development program. This program includes federal research, development, and demonstration efforts on power generation; power plant efficiency; developing unconventional domestic oil and gas resources, such as from shale formations; and supporting CCS technologies. DOE's Office of Fossil Energy and Carbon Management also oversees the infrastructure, operations, and research and development activities at the National Energy Technology Laboratory. The National Energy Technology Laboratory has dual roles: it serves as project manager for advanced fossil energy research and development projects that receive financial assistance, and conducts applied research related to energy and environmental programs. The Office of Fossil Energy and Carbon Management and the National Energy Technology Laboratory collaborate on selecting and administering DOE awards for advanced fossil energy research and development projects.

DOE's efforts to administer its program for advanced fossil energy research and development take place across a spectrum of activities, including providing financial assistance for large demonstration projects. For example, DOE has provided funding for projects designed to improve methods for CCS, reduce CO₂ emissions, and develop beneficial uses for CO₂ from coal-fired power plants. CCS technologies are typically designed to capture and separate CO₂ from other gases produced by combusting or gasifying coal, then compressing the CO₂ and transporting it to underground geologic formations, such as saline aquifers—porous rock filled with brine—or depleted oil and natural gas reservoirs, for long-term storage. CCS technologies can also be used to capture CO₂.

emissions from industrial facilities, such as ethanol production plants and oil refineries.

DOE generally uses competitive funding opportunity announcements for federal financial assistance to solicit applicants for advanced fossil energy research and development projects. Each year, DOE sets priorities for its advanced fossil energy research and development program based, in part, on the amount of funding appropriated by Congress, as well as any direction that Congress may have specified for certain types of technology research and development, and DOE's own research and development plans. DOE advanced fossil energy research and development projects typically require multiple years to complete.

For those demonstration projects selected for funding, DOE and the selectee agree to technical progress milestones for each phase of each project—generally definition or preliminary design, design, construction, and operations—to help ensure that projects accomplish a specific research and development objective or set of objectives.⁷ As a risk mitigation measure, DOE establishes planned funding targets for its expenditures during each phase.⁸ As such, the department's financial exposure is limited to set amounts until the project reaches certain milestones. In order to receive DOE's approval to continue into a subsequent phase, a project must submit a continuation application to DOE that includes a report on the project's progress and accomplishments to date and presents a plan for the next phase. DOE officials told us that they review progress at each phase of a project and that project continuation is subject to the technical progress on the project; the funding recipient's compliance with all relevant terms of the agreement, including any financial terms; and the availability of DOE funds, based on congressional appropriations. If a project has not met its technical milestones, DOE may terminate the funding agreement. Alternatively, projects may also withdraw their participation at their discretion.

Beginning in 2009, DOE launched three CCS initiatives—two for projects related to coal plants and one for projects related to industrial facilities—that ultimately resulted in DOE selecting a total of 11 CCS demonstration

⁷These agreements are known as cooperative agreements. For the purposes of this report, we refer to project phases rather than budget periods because, for the projects described in detail, they reflected the same portion of the project.

⁸DOE can alter these targets through modifications to cooperative agreements.

projects, two of which withdrew from participation prior to receiving DOE funding.

Coal Projects

The Clean Coal Power Initiative was a cost-shared collaboration between the federal government and industry to increase investment in low-emission coal technology by demonstrating advanced coal-based power generation technologies, consistent with the Energy Policy Act of 2005.⁹ The goal of the Clean Coal Power Initiative was to accelerate the readiness of advanced coal technologies for commercial deployment and to prove the feasibility of integrating CO₂ reductions and power production.

Among the project requirements, DOE sought advanced coal-based projects that had progressed beyond the research and development stage to a point of readiness for operation at a scale that, once demonstrated, could be readily replicated and deployed into commercial practice within the electric power industry. Proposed CO₂ capture technologies were to be integrated within existing or new power plant facilities that used coal for at least 55 percent of their energy input and produced electricity for at least 50 percent of the energy output. Each project was to be broken down into four phases: (1) project definition and front-end engineering design (definition), (2) design, (3) construction, and (4) demonstration and operation. DOE anticipated awarding multiple cooperative agreements, with the cost share by the recipient being at least 50 percent for each phase. Projects under the Clean Coal Power Initiative were eligible to receive funds appropriated by the American Recovery and Reinvestment Act of 2009 (Recovery Act) in addition to program funds. DOE selected six demonstration projects for funding in its Clean Coal Power Initiative.

In addition to the Clean Coal Power Initiative projects, DOE initiated two additional coal-related demonstration projects under the FutureGen 2.0 initiative, which was intended to be the world's first full-scale oxy-combustion clean coal repowering of an existing power plant fully

⁹See 42 U.S.C. § 16513. DOE funded coal CCS demonstration projects in the third round of Clean Coal Power Initiative funding.

integrated with CO₂ transport and permanent geologic storage.¹⁰ FutureGen 2.0 resulted from DOE's restructuring in 2008 of the original FutureGen project it had initiated in 2003. The original FutureGen project was a planned construction of a 275-megawatt integrated gasification combined cycle power plant designed to capture and store CO₂, emit virtually no conventional air pollutants, and produce hydrogen fuel. When DOE restructured the program, it eliminated the hydrogen production requirement and leveraged funding from the Recovery Act. Furthermore, it aimed to retrofit an existing power plant with oxy-combustion technology rather than to build a new plant. DOE divided the FutureGen 2.0 projects into four phases: (1) project definition and pre-front-end engineering and design (definition); (2) design and permitting (design); (3) construction and commissioning; and (4) operations.¹¹

Industrial Projects

DOE's Industrial Carbon Capture and Sequestration initiative sought to demonstrate the feasibility of large-scale CCS projects to capture industrial sources of CO₂—including from manufacturing facilities, chemical plants, and refineries—and to develop innovative concepts for beneficial uses of captured CO₂.¹² The participant cost share was to be at least 20 percent of the total allowable project cost, but DOE's target for the participant's cost share for commercial-scale demonstration projects was 50 percent. The awards were to be divided into two phases. Phase 1 awards were to include limited DOE funding for initial work encompassing activities from project definition through preliminary design and permitting. After completing phase 1, funding recipients could then reapply for additional funding under phase 2, which would include DOE funding for portions of project design, construction, and operation subject to the

¹⁰Oxyfuel combustion burns coal using pure oxygen diluted with recycled CO₂ or water. As a result, oxyfuel combustion emits primarily CO₂ and water vapor, with some excess oxygen, facilitating the capture of the CO₂ by condensing the water in the exhaust stream.

¹¹For the purposes of this report, we refer to the first phase as definition and the second phase as design.

¹²The full name of this initiative was the Carbon Capture and Sequestration from Industrial Sources and Innovative Concepts for Beneficial CO₂ Use. The initiative was divided into two areas, one addressing large-scale demonstration projects and the other covering research and development projects. Coal-fired electric power generating facilities were generally ineligible. Specifically, plants with electric power output greater than 50 percent of total energy output that operate on more than 55 percent coal as a feedstock were ineligible.

project meeting performance milestones. DOE selected three projects for full funding under this initiative.

Coal CCS Projects Were Less Successful Than Industrial CCS Projects, Largely Due To Economic Factors

Of the 11 total CCS demonstration projects DOE selected for funding, three were built and entered operations. Specifically, one of the eight selected coal projects was completed and entered operations, and that facility halted operations in 2020. Two of the three CCS industrial demonstration projects DOE selected for funding were completed and remain operational. According to project documentation and DOE officials and project representatives we interviewed, projects were not completed—either because they withdrew from participation or DOE terminated their cooperative agreements—primarily in response to factors affecting their economic viability.

None of the Eight Coal CCS Projects That DOE Selected Are Operational, but Two of the Three Selected Industrial Projects Are Operational

DOE selected eight coal CCS projects for funding, of which one resulted in a completed, operational facility. Three coal projects withdrew from participating in DOE's Clean Coal Power Initiative—two prior to signing a cooperative agreement—and DOE terminated its cooperative agreements with the other four coal projects. In total, DOE invested nearly \$684 million in six of the eight coal projects the agency initially selected for funding (see table 1).

Table 1: Coal Carbon Capture and Storage Demonstration Project Outcomes, Final Phase, and Department of Energy (DOE) Funding

Project	Project outcome	Final phase entered	DOE funding totals (dollars)
American Electric Power	Withdrawn	Definition	16,880,268
Basin Electric	Withdrawn	None	0
FutureGen 2.0 Power Plant	Terminated	Design	116,666,759
FutureGen 2.0 Pipeline and Storage	Terminated	Design	83,857,100
Hydrogen Energy California	Terminated	Definition	153,428,898

Project	Project outcome	Final phase entered	DOE funding totals (dollars)
Petra Nova	Completed	Operations	195,132,425
Southern Company Services	Withdrawn	None	0
Summit Texas Clean Energy	Terminated	Definition	117,876,707
Total			683,842,157

Source: GAO analysis of DOE data and documentation. | GAO-22-105111

Note: Basin Electric and Southern Company Services withdrew from the project prior to entering into cooperative agreements and therefore did not enter a project phase. "Terminated" indicates that DOE terminated the cooperative agreements for these projects.

Completed projects. One of the eight selected coal CCS projects was completed and entered operations. However, the facility halted operations in 2020.

- **Petra Nova.** The Petra Nova project proposed to treat and capture at least 90 percent of the CO₂ emissions from a 240-megawatt equivalent flue gas slipstream at the W.A. Parish Electric Generating Station in Texas, and to capture and store up to 1.4 million metric tons of CO₂ annually. The captured CO₂ was to be compressed and transported through an approximately 80-mile pipeline to an operating oil field and used for enhanced oil recovery. The Petra Nova project was completed and achieved commercial operations in late 2016, and began a 3-year demonstration period in early 2017. However, the facility reportedly halted operations in May 2020, due to low oil prices.¹³

Withdrawn projects. Three projects withdrew from participating in DOE's Clean Coal Power Initiative—two prior to signing a cooperative agreement—because they determined that continued participation in the project was not economically viable.

- **Basin Electric.** Basin Electric proposed a project to capture 90 percent of the CO₂ from a 120-megawatt electric-equivalent gas stream at the company's power plant in North Dakota. Basin Electric withdrew from the initiative prior to signing a cooperative agreement, stating that based on more accurately defined costs, it was unable to develop a workable business plan, even with \$100 million of potential DOE funding.

¹³It was also reported that the facility's co-owner plans to bring the facility back online when economics improve. Carlos Anchondo, "Petra Nova exposes risk tied to low oil prices," *E&E News*, July 31, 2020.

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- **Southern Company Services.** Southern Company Services proposed to retrofit a CO₂ capture plant on a 160-megawatt flue gas stream at an existing coal-fired power plant in Alabama. Southern Company Services withdrew from the initiative prior to signing a cooperative agreement, citing DOE's accelerated negotiation schedule as not providing the company with sufficient time to plan adequately for committing to a nearly \$700 million investment.
 - **American Electric Power.** American Electric Power proposed to capture at least 90 percent of the CO₂ in a 235-megawatt flue gas stream at an existing power plant in West Virginia, including capabilities for permanently injecting CO₂ into belowground formations located near the capture facility. American Electric Power withdrew from the initiative at the conclusion of the definition phase, citing both a lack of legislative and regulatory support for cost recovery that it had expected at the time of its original application to DOE and limited support from other outside partners to help fund the cost. According to the project's final technical report, American Electric Power determined that without legislation to limit emissions and provide federal support for early CCS projects, it was not economically viable to invest in a CCS system at that time.

Terminated agreements. DOE terminated its cooperative agreements with four CCS coal projects, including both FutureGen 2.0 projects, prior to the initiation of construction activities.

- **FutureGen 2.0 projects.** The FutureGen 2.0 program in Illinois involved two key components: (1) a near-zero emission coal-fired power plant that would capture and compress at least 90 percent of the CO₂ emissions generated by the power plant, and nearly eliminate several other pollutants from the plant's emissions, and (2) a pipeline to move captured CO₂ from the plant to a storage site located about 30 miles to the east, where approximately 1 million metric tons of compressed and purified CO₂ per year would be injected into a saline formation. DOE terminated its agreements with the FutureGen 2.0 program in January 2015 after years of delays and reaching the deadline for spending Recovery Act program funds. Specifically, the power plant component of the project did not proceed to construction because it had not completed the necessary engineering, procurement, and construction negotiations or secured commercial financing. In addition, the integrated CO₂ pipeline and storage component of the project was unable to finalize financing without resolving the remaining issues with the power plant component.

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- **Summit Texas Clean Energy.** Summit Texas Clean Energy proposed to integrate CO₂ capture technology with a new 400-megawatt integrated gasification combined cycle plant in Texas. The plant was to produce about 190 megawatts of low-carbon electric power and capture 2 million tons of CO₂ per year for use in enhanced oil recovery operations in the Permian Basin of West Texas. DOE terminated its agreement with the Summit Texas Clean Energy project after the project failed to secure financial commitments beyond the project definition phase and DOE's Office of Inspector General issued a special report recommending that DOE suspend funding until the project could obtain additional private financing.¹⁴
 - **Hydrogen Energy California.** Hydrogen Energy California proposed a commercial scale integrated gasification combined-cycle power plant in California, with the ability to capture at least 90 percent of CO₂ emissions from the plant. If successful, this project would have captured and used over 2 million tons of CO₂ per year for enhanced oil recovery. The captured CO₂ would have been transported via a pipeline to an oil field approximately 4 miles from the power plant. DOE terminated its cooperative agreement with the Hydrogen Energy California project before it proceeded to construction, after extensive budget and schedule overruns and repeatedly missed milestones.

In contrast to the results from the CCS coal projects that DOE selected to fund, two of the three industrial projects that DOE selected for full funding resulted in completed facilities that remain operational as of October 2021.¹⁵ In total, DOE invested \$438 million in three industrial CCS projects (see table 2).

¹⁴Department of Energy, Office of Inspector General, *Special Report: The Department of Energy's Continued Support of the Texas Clean Energy Project Under the Clean Coal Power Initiative*, OIG-SR-16-02 (Apr. 26, 2016). The Inspector General determined that the project's inability to obtain required financing, and the adverse effect of changing energy markets on the demand for coal-based power plants, raised serious doubts about its continuing viability. In October 2021, DOE filed a lawsuit against Summit Power Group and another company, guarantors for Summit Texas Clean Energy (Summit), seeking to recover \$13.8 million, among other remedies. The lawsuit alleges that Summit Power Group and the other company convinced DOE to continue supporting Summit's project, despite project delays and other issues, by agreeing to pay DOE \$13.8 million if Summit did not complete the first phase of the project. It also alleges that Summit did not make the requisite repayment after failing to complete the first phase, and that despite this, Summit Power Group and the other company refused to fulfil their guarantees to pay DOE. See *U.S. v. CCM TCEP, LLC, and Summit Power Group, LLC*, 21-cv-01461 (D.Dela. Oct. 18, 2021).

¹⁵DOE selected 13 industrial projects for incremental funding for additional design and review before selecting three projects for full funding.

Table 2: Industrial Carbon Capture and Storage Demonstration Project Outcomes, Final Phase, and Department of Energy (DOE) Funding

Project	Project outcome	Final phase entered	DOE funding totals (dollars)
Air Products and Chemicals	Completed	Operations	284,012,496
Archer Daniels Midland	Completed	Operations	141,405,945
Leucadia Lake Charles	Withdrawn	Design	12,758,649
Total			438,177,090

Source: GAO analysis of DOE data and documentation. | GAO-22-105111

Completed projects. Two industrial CCS projects were completed and remain operational.

- **Air Products and Chemicals.** The Air Products and Chemicals project planned to capture and sequester 1 million tons of CO₂ per year from existing steam-methane reformers—which produce hydrogen from methane—at a facility in Texas. The CO₂ captured via this project was to be transported through a 12-mile connector pipeline to an existing interstate CO₂ pipeline and sequestered for use in enhanced oil recovery at an oil field elsewhere in Texas. This project was constructed; achieved commercial operation in 2013; and according to Air Products and Chemicals, remains operational as of October 2021.
- **Archer Daniels Midland.** The Archer Daniels Midland project planned to capture and sequester 1 million tons of CO₂ per year from an existing ethanol plant in Illinois. The CO₂ was to be sequestered in a well-characterized saline reservoir that the project participant owned that was located about 1 mile from the plant. The Archer Daniels Midland project was constructed; began storing captured CO₂ in 2017; and according to Archer Daniels Midland, remains operational as of October 2021.

Withdrawn project. One industrial CCS project was withdrawn due to the cancellation of an associated project.

- **Leucadia Lake Charles.** The Leucadia Lake Charles project planned to capture and sequester the largest amount of CO₂ of any of the proposed industrial CCS projects (4.5 million tons per year) from a new methanol plant in Louisiana.¹⁶ The CO₂ was to be delivered via a

¹⁶Methanol is one of the world's most widely used industrial chemicals in applications including paints and plastics, furniture and carpeting, automotive parts, windshield washer fluid, and fuel blending.

12-mile connector pipeline to an existing interstate CO₂ pipeline and sequestered via use for enhanced oil recovery in an oil field in Texas. In 2015, the Leucadia Lake Charles project was withdrawn because the associated methanol gasification facility on which the CCS technology was to be constructed was canceled.

Projects Were Not Completed Primarily Due to Factors Affecting Their Economic Viability

According to project documentation and DOE officials and project representatives we interviewed, projects that were not completed—either because they withdrew from participation or DOE terminated their cooperative agreements—were significantly affected by factors related to their economic viability. The coal projects, in particular, faced diminishing economic prospects caused by several factors, some of which were external to the projects. Specifically, these projects were negatively affected by (1) the volatility of the fossil fuel commodities markets and competition with natural gas, (2) uncertainty regarding potential carbon markets and tax incentives, (3) high expected project costs, and (4) the expiration of Recovery Act funds. Some projects had achieved technical milestones, such as completing engineering and design studies, negotiating power purchase agreements,¹⁷ or obtaining necessary permits, but because of one or more of these economic factors, projects withdrew or DOE terminated their cooperative agreements.

Market competition. Changes in the fossil fuel electricity markets posed a particular challenge for coal projects. DOE officials told us that the drop in natural gas prices and the added cost to install and operate CCS equipment made coal-powered electricity increasingly less price competitive relative to natural gas and other sources of power generation, which made these projects a less attractive investment and affected the projects' economic viability.¹⁸ Additionally, one project representative told

¹⁷Power purchase agreements are contracts in which a utility agrees to purchase power, generally over a term of 20 to 25 years.

¹⁸In 2013, the Congressional Research Service reported that there had been a drop in natural gas prices enabled by increasing supplies of natural gas largely due to horizontal drilling and hydraulic fracturing of shale gas formations. The decreased natural gas prices lowered wholesale electricity prices and stimulated a major switch from coal to gas-burning facilities. Given price competition from natural gas, among other factors, the Congressional Research Service projected that coal-fired generation would likely be smaller and more challenged in the future. Congressional Research Service, *Prospects for Coal in Electric Power and Industry*, R42950 (Feb. 4, 2013).

us that price changes in the oil market was the reason why DOE and the project agreed to extend and reevaluate the project's design in an attempt to find cost savings. However, even with these efforts, DOE terminated the cooperative agreement due in part to a lack of firm commitments from lenders and investors sufficient to finance the project beyond definition. Conversely, the industrial CCS projects were not as exposed to market volatility because they were not competing in electric power markets. Additionally, in combination with their smaller project budgets, they could be more easily self-financed, according to DOE officials.

Uncertainty regarding carbon markets and tax incentives. Uncertainty about the future of carbon markets and the availability of tax incentives made it difficult to estimate whether projects could be economically viable. Project representatives told us that when DOE announced CCS project funding, they had anticipated that Congress would pass legislation to incentivize carbon capture, such as establishing a market for carbon dioxide.¹⁹ DOE officials told us that the non-passage of the legislation negatively affected the ability of funding recipients to fund their cost share of the project, and in some cases led to the project's decision to withdraw from participation in the Clean Coal Power Initiative. For example, American Electric Power withdrew after determining that it was not economically viable to invest in a coal CCS project without the legislative and regulatory support it had expected at the time of its application to participate in the Clean Coal Power Initiative. DOE officials also told us that the absence of federal incentives, such as those that would have been provided by a carbon market, reduced private industry interest in projects, particularly if DOE was unwilling to provide additional funding. A project representative told us that there was uncertainty at the time about the applicability and use of a tax credit for carbon sequestration, which made it challenging to estimate project economics.²⁰ However, the

¹⁹For example, the American Clean Energy and Security Act of 2009, H.R. 2454, 111th Cong., proposed several provisions concerning clean energy and reducing global warming pollution, which included establishing a cap-and-trade system for greenhouse gas emissions and setting goals for reducing such emissions. The legislation passed the House of Representatives in 2009, but was not taken up by the Senate for a vote.

²⁰The tax credit for carbon oxide sequestration—often referred to by its Internal Revenue Code section, 45Q—is computed per metric ton of qualified carbon oxide captured and sequestered. Usually this involves CO₂, although injection and sequestration of other carbon oxides (e.g., carbon monoxide) is also possible. The credit was added to the tax code in the Energy Improvement and Extension Act of 2008, Pub. L. No. 110-343, div. B, § 115, 122 Stat. 3765, 3829.

representative also said that changes Congress made to the tax credit in 2018 have largely clarified those previous uncertainties.²¹

High expected project costs. None of the five projects with estimated total budgets—combined federal and private funding—over \$500 million were completed.²² The coal projects were the most expensive, with an average estimated budget of over \$1.4 billion versus an average estimated budget of approximately \$360 million for the industrial projects. DOE officials said they considered projects with large estimated budgets, such as those over \$1 billion, to be especially challenging because of the amount of outside financing needed. Furthermore, officials said that investors viewed those projects as having high financial risk, raising their expectations for returns, which the projects could not meet, diminishing overall investor interest. Therefore, projects with a higher expected cost had difficulty obtaining financing for their cost share requirements, which was necessary before proceeding to construction.

Expiration of Recovery Act funds. The funds made available for this program by the Recovery Act expired at the end of fiscal year 2015, meaning that all Recovery Act funds obligated for these projects had to be expended by that date. If not, the Recovery Act appropriation accounts were closed and ongoing projects faced the prospect of needing to obtain additional private financing to make up any shortfall of Recovery Act funds. According to a project representative, the expiration of these funds made it difficult for the project to secure sufficient financing. In the case of FutureGen 2.0, DOE cited the projects' lack of progress in meeting milestones with the pending expiration of Recovery Act funds as a reason that it decided to terminate support for the projects.

In addition to challenging economic conditions for coal projects, CCS projects were subject to some regulatory and technical challenges,

²¹The Bipartisan Budget Act of 2018 expanded and extended the 45Q tax credit. See Pub. L. No. 115-123, div. D, tit. II, § 41119. 132 Stat. 64, 162. Changes included (1) a larger credit amount; (2) a start-of-construction deadline and 12-year claim period instead of the 75 million metric ton cap; (3) allowing the credit for CO₂ utilization in addition to enhanced oil recovery and direct air capture, as well as allowing smaller facilities to claim the credit; and (4) allowing owners of carbon capture equipment to claim tax credits instead of the person capturing the CO₂, which creates flexibility in ownership structures facilitating tax-equity investment.

²²The total budgets for Basin Electric and Southern Company Services were not established because the companies withdrew without entering into cooperative agreements with DOE.

though neither DOE nor any project representatives we interviewed indicated that these challenges alone led to decisions for projects to withdraw from or for DOE to terminate their cooperative agreements. One regulatory challenge for past projects—and potential future ones as well—noted by DOE officials and project representatives is difficulty obtaining permits for sequestration. For example, it took the Archer Daniels Midland project 6 years from the time it applied for a permit to begin underground sequestration, in part, because of new regulations and the fact that the project was one of the first to apply for such a permit.²³ DOE officials, as well as project representatives we interviewed, told us that some challenges facing future CCS projects will be access to underground storage space and the ability to obtain permits for underground sequestration. According to DOE officials and project documentation we reviewed, other technical challenges were specific to individual projects and highly variable, such as challenges integrating or scaling up the CCS technology. Ultimately, the DOE officials and project representatives we interviewed agreed that there were available solutions for the technical challenges and that economic considerations were largely responsible for decisions to terminate or withdraw from project agreements.

DOE's Management of Coal CCS Demonstration Projects Created Significant Risks to Project Success and Taxpayer Funds

DOE committed to coal projects at their initial selection—as opposed to selecting them conditionally subject to a period of further review and development, as it did for industrial CCS projects—and negotiated funding agreements on an accelerated schedule, thereby increasing the risk of funding projects that were unlikely to succeed. In addition, DOE bypassed cost controls at the direction of its senior leadership on four struggling coal projects in order to provide additional time to meet key milestones, ultimately spending nearly \$472 million before terminating those cooperative agreements prior to the construction of any facilities.

²³Class VI well permits are required for injecting CO₂ into geologic formations for permanent storage, and in Illinois are administered by the Environmental Protection Agency under the final rule at 75 Fed. Reg. 77230, promulgated on December 10, 2010.

DOE's Process for Selecting and Negotiating Coal CCS Demonstration Projects Increased Project Risk

DOE (1) did not use a multiphase down-selection process when making decisions regarding whether to fully fund projects and (2) employed an accelerated negotiation schedule when establishing the terms of cooperative agreements.

Not using a down-selection process. DOE officials we interviewed said that using a down-selection process—whereby DOE selects certain projects for initial funding and further review, and then selects a subset of those projects for full funding—is an effective means of reducing the risk of funding unsuccessful projects. However, DOE did not use a down-selection process when selecting coal CCS demonstration projects through either its Clean Coal Power Initiative or FutureGen 2.0 programs.²⁴

DOE officials contrasted DOE's selection of coal projects with how the department selected industrial CCS demonstration projects, in which DOE used a down-selection process to select 13 projects for initial funding to conduct additional design research prior to choosing three projects for full funding. DOE officials we interviewed said that they have also employed this process for the department's large-scale pilot project program, which began in 2017 and has included multiple rounds of down-selection.²⁵ DOE officials also told us that in both cases the additional time to allow projects to refine their designs, scopes, and plans allowed DOE to make more informed decisions about which projects were best positioned to succeed. Specifically, they noted that at the time of initial application, most coal demonstration projects had not conducted in-depth

²⁴The FutureGen 2.0 projects were selected noncompetitively at the direction of the Secretary of Energy, according to DOE officials.

²⁵The purpose of DOE's large-scale pilot project program is to support the design, construction, and operation of large-scale pilots for transformational coal technologies aimed at enabling step change improvements in coal-powered system performance, efficiency, and cost of electricity. This program included three phases, with a down-select between each. Phase I (Feasibility) was aimed at supporting recipients' efforts to secure team commitments (including host sites and recipient cost share for phase II); update the preliminary cost estimate and schedule for design, construction, and operation; and complete an environmental information volume. Projects selected for phase II (Design) completed a Front-End Engineering Design study, secured construction/operation cost share funding, and completed the National Environmental Policy Act process. Finally, DOE selected two projects for phase III (Construction/Operation), which supports construction and operation of the large-scale pilot facilities.

design and engineering work, meaning that DOE assumed a great deal of risk in selecting them for full funding.

Using an accelerated negotiation schedule. DOE officials told us that under normal circumstances, it can take up to a year to conduct due diligence and negotiate terms before defining and finalizing all of the terms in a cooperative agreement. However, DOE accelerated the pace of negotiations for the Clean Coal Power Initiative projects—down to less than 3 months—because, according to DOE officials, the agency wanted to spend Recovery Act funds as quickly as possible. DOE officials we interviewed told us that as a result of using an accelerated negotiation schedule, issues related to the need for in-depth technical reviews, among others, were not resolved before cooperative agreements were signed, resulting in agreements that included conditional—rather than final—terms. DOE officials told us that the agency's ability to enforce conditional terms of cooperative agreements, such as technical progress requirements, is limited once an agreement is signed because DOE has less enforcement power to compel funding recipients to take certain actions than it does in other forms of contractual agreements with the private sector, such as procurement contracts. Therefore, they said that any conditional terms included in cooperative agreements increase the risks associated with a project by lessening DOE's ability to link funding to recipient's actions. An accelerated negotiation schedule also created risks for potential funding recipients because their plans might not be fully mature at the time of entering into an agreement with DOE. For example, Southern Company Services cited the accelerated negotiations as insufficient and the reason that it withdrew its project. Specifically, the company noted that the original negotiation schedule was to be possibly a year in length, which would have allowed evaluation and a complete understanding of the full financial commitment required.

DOE officials we interviewed stated that they believed DOE had forgone a down-selection process and used an accelerated negotiation schedule for selecting coal CCS projects for two primary reasons. First, they told us that the projects were expected to require more time for engineering and construction than industrial CCS projects because of their scale and complexity but nonetheless would be subject to the spending deadline of September 2015 for funds provided for this program by the Recovery

Act.²⁶ Additionally, these officials told us that there was an imperative to spend the funds quickly in order to support the Recovery Act purpose of spurring economic activity.

Although this spending deadline might have posed a challenge, DOE was responsible for using the funds consistent with prudent management as directed by the Recovery Act.²⁷ Additionally, DOE's actions were inconsistent with project management principles outlined in DOE's *Guide to Financial Assistance*, which defines numerous principles that can be applied to administering cooperative agreements, including identifying and mitigating technical and financial risks when implementing strategies. Further, *Standards for Internal Control in the Federal Government* states that agency management should identify, analyze, and respond to risks related to achieving the agency's defined objectives.²⁸ DOE's selection and negotiation processes for coal CCS projects were not consistent with this principle, as they unnecessarily increased the technical and financial risks that DOE accepted by fully committing to projects upon their initial selection and using an accelerated schedule to negotiate cooperative agreements. By amending its selection process to incorporate a down-selection as well as reserve adequate time for negotiations—as it has in other instances—DOE would have greater assurance that any CCS demonstration projects it selects in the future would be more likely to succeed.

²⁶As noted, DOE did not take the same approach to selecting and negotiating the schedule for industrial CCS demonstration projects, which were also funded by the Recovery Act, and which were generally more successful in terms of being built and becoming operational.

²⁷Specifically, the Recovery Act directed that the President and the heads of federal departments and agencies shall manage and expend the funds made available in the act so as to achieve the act's specified purposes, such as providing investments needed to increase economic efficiency by spurring technological advances in sciences and to invest in environmental protection, including commencing expenditures and activities as quickly as possible consistent with prudent management. Pub. L. No. 111-5, § 3(b), 123 Stat. 115, 116.

²⁸[GAO-14-704G](#).

DOE Bypassed Cost Controls and Spent Almost \$300 Million More Than Planned on Four Unsuccessful Coal CCS Projects

DOE bypassed cost controls designed to limit its financial exposure in funding the four coal CCS demonstrations whose cooperative agreements the department ultimately terminated: the two FutureGen 2.0 projects, the Hydrogen Energy California project, and the Summit Texas Clean Energy project. Consequently, DOE exceeded its planned early-phase funding targets on projects for which no facilities were constructed.

To varying degrees, when projects were unable to meet certain performance milestones, DOE (1) authorized reductions in funding recipient cost share requirements below the levels defined in the original cooperative agreements, (2) increased its planned early-phase funding by repeatedly shifting project funds from subsequent construction and operations phases, and (3) accelerated disbursement of Recovery Act funds.²⁹ Cumulatively, DOE spent nearly \$472 million on four coal CCS projects that were never built—almost \$300 million more than what DOE had initially planned to fund up to that point (see table 3).

Table 3: Department of Energy (DOE) Funding for Coal Carbon Capture and Storage Projects Whose Cooperative Agreements DOE Ultimately Terminated

Project	Planned DOE funding (dollars)	Actual DOE funding (dollars)	Increase (dollars)	Percentage of planned
FutureGen 2.0 Pipeline and Storage	46,030,081	83,857,100	37,827,019	182
FutureGen 2.0 Power Plant	39,771,244	116,666,759	76,895,515	293
Hydrogen Energy California	75,000,000	153,428,898	78,428,898	205
Summit Texas Clean Energy	15,001,312	117,876,707	102,875,395	786
Total	175,802,637	471,829,464	296,026,827	268

Source: GAO analysis of DOE data and documents. | GAO-22-105111

Note: These figures represent planned funding relative to the phase each project was in at the time DOE terminated its cooperative agreement.

Decreased project cost share requirements. For each project, DOE decreased the project's cost share requirement below the percentage

²⁹DOE also increased its contribution to the construction phases of the Summit Texas Clean Energy and Hydrogen Energy California projects by \$100 million each and decreased the expected contribution of the funding recipients by the same amount. However, DOE terminated these cooperative agreements before the projects entered construction.

defined in the original cooperative agreement and increased the government's cost share to compensate. For example, in 2013, DOE authorized decreases in both of the FutureGen 2.0 projects' cost share requirements even after identifying significant risk to the projects' collective success. Specifically, for the pipeline and storage project, DOE authorized decreases in funding recipient's cost share for design and construction from 17 percent to 1 percent and operations from 100 percent to 84 percent. Likewise, for the power plant project, DOE authorized a decrease in the funding recipient's cost share for design from 20 percent to 1 percent.

In response to requests from the projects, DOE also decreased funding recipient cost share requirements in the Clean Coal Power Initiative cooperative agreements it ultimately terminated. Specifically, for the Summit Texas Clean Energy Project, it authorized decreases in the funding recipient's cost share in components of the project's first phase from 50 percent to 40 percent in 2012 and subsequently from 40 percent to 20 percent in 2014. Likewise, for the Hydrogen Energy California project, DOE authorized a decrease in components of the project's cost share requirement for its initial phase from 50 percent to 20 percent in 2011.

Increased early-phase funding targets. DOE increased early-phase funding targets multiple times by shifting budget allocations from subsequent phases in order to provide continued support when projects were unable to meet milestones, resulting in an average of about \$51 million in DOE cost share per project being moved forward.³⁰ Specifically, DOE shifted budgets forward at least five times for the FutureGen 2.0 pipeline and storage project (about \$41 million for DOE's share), seven times for the FutureGen 2.0 power plant project (about \$71 million for DOE's share),³¹ 12 times for Summit Texas Clean Energy (about \$73 million for DOE's share), and twice for Hydrogen Energy California (about \$20 million for DOE's share).

Accelerated Recovery Act fund disbursement. For each project, DOE authorized the accelerated use of Recovery Act funds. Specifically, in 2013, DOE authorized an accelerated disbursement rate of 99 percent for the Future Gen 2.0 power plant project until all Recovery Act funds were

³⁰In taking these actions, DOE moved both its and projects' cost shares forward.

³¹This total accounts for one DOE action that shifted \$4.2 million from project design to construction.

expended. Likewise, in 2010, DOE authorized an accelerated disbursement rate of up to 80 percent for the Summit Texas Clean Energy and Hydrogen Energy California projects.

DOE documentation and testimony from officials indicate that senior departmental leadership directed actions that reduced project cost share requirements, increased early-phase funding targets, and accelerated Recovery Act fund disbursement. For example:

- The Secretary of Energy directed the reduction in the funding recipients' cost share requirements for the FutureGen 2.0 projects even though the Office of Fossil Energy had identified significant risks to the projects in terms of schedule, cost, and ability to obtain financing. In particular, the Office of Fossil Energy found that (1) the proposed FutureGen 2.0 schedules were very optimistic and aggressive; (2) there was a significant probability that unforeseen and unexpected risks would arise, resulting in large increases in project costs; and (3) there was uncertainty as to whether the project's power purchase agreement would provide adequate revenue. In its rationale for authorizing the reductions in cost shares, DOE stated that the FutureGen 2.0 funding recipients had been consistent in their position that they were unwilling to provide any additional funding to the FutureGen 2.0 program unless the program obtained financing and until all of the Recovery Act funding was expended.
- A senior official within the Office of Fossil Energy repeatedly directed that the early-phase funding target for the Summit Texas Clean Energy project be increased. For example, in 2015, that official approved two early-phase increases in DOE's contributions that totaled to about \$8.4 million, with those amounts being shifted from later project phases that ultimately never occurred. As with other actions, these increases were generally in response to a project's inability to obtain funding, a key milestone.
- Senior DOE officials issued a memorandum requesting that the department accelerate the disbursement of Recovery Act funds for Clean Coal Power Initiative projects, including the Summit Texas Clean Energy and Hydrogen Energy California projects.³² Specifically, the memorandum stated this was imperative because funding recipients had anticipated some form of carbon legislation at the time the projects were solicited, and that in the absence of a regulatory

³²DOE's rationale for accelerating Recovery Act disbursement for the FutureGen 2.0 projects was included in its rationale to increase DOE's cost share.

framework for carbon dioxide emissions, most companies would not proceed with the development of such projects without significant financial incentives. Additionally, this memorandum cited the Recovery Act's purpose to help industry maintain employment and hire new employees. Further, the memorandum contended that a larger government stake in the early stages of a project would enhance potential investor or lender outlooks of these projects, thereby improving the prospects for securing financing, which DOE had identified as the greatest risk to these projects' success.

DOE documentation and testimony indicate that these actions were intended to provide the projects with the greatest opportunities to succeed while also supporting the Recovery Act purpose of promoting economic activity. DOE officials also told us that the department had to balance competing priorities—including administration priorities, statutory provisions, and emergent needs of the project—when considering project requests to amend the financial terms of cooperative agreements. However, DOE's actions to provide projects with greater funding did not result in project success. In January 2015, DOE terminated the cooperative agreements for both FutureGen 2.0 projects, citing project delays and Congress's decision not to extend the Recovery Act expenditure deadline as its reasons. In total, DOE invested about \$117 million on the power plant and \$84 million on the pipeline and storage project, representing about 293 percent and 182 percent, respectively, of what it had initially planned to spend on their design phases.

Additionally, DOE determined that the Summit Texas Clean Energy project faced significant challenges in obtaining private financing as early as 2012 but continued to fund it for years thereafter. In April 2016, DOE's Inspector General raised serious concerns about the financial risks the department was undertaking and recommended that funding be suspended until the project could obtain additional financing.³³ In particular, the Inspector General determined that the project's inability to obtain required commercial debt and equity financing, and the adverse effect of changing energy markets on the demand for coal-based power plants, raised serious doubts about its continuing viability. DOE terminated the project's cooperative agreement in August 2016, after

³³Department of Energy, Office of Inspector General, *Special Report: The Department of Energy's Continued Support of the Texas Clean Energy Project Under the Clean Coal Power Initiative*, OIG-SR-16-02 (Apr. 26, 2016).

spending nearly \$118 million on the project's definition phase, nearly eight times what it had originally planned.

Further, according to DOE documentation, the Hydrogen Energy California project missed a number of key, early milestones, which DOE characterized as fundamental project concerns highlighting the risk to completion. Specifically, the project failed to secure agreements for the CO₂ storage; obtain necessary progress on term sheets for the power purchase agreements with utilities; and complete consistent draft engineering, procurement, construction cost, and contract terms. DOE terminated its cooperative agreement with the Hydrogen Energy California project in 2016, after spending \$153 million on its definition phase—more than twice the initially planned amount.

DOE's actions in not consistently adhering to cost controls designed to mitigate its financial exposure in the event that projects did not meet their performance milestones resulted in nearly half a billion dollars spent on four unbuilt coal CCS demonstrations. These actions were also inconsistent with (1) Recovery Act language directing agencies to commence expenditures and activities as quickly as possible consistent with prudent management and (2) DOE's *Guide to Financial Assistance*, which lists numerous principles that can be applied to the administration of cooperative agreements, including managing and reporting projects against established scopes, schedules, and budgets. By taking actions to more consistently adhere to the principles of its *Guide to Financial Assistance* in any future CCS demonstration projects—specifically, managing and reporting projects against established scopes, schedules, and budgets—DOE would be better positioned to mitigate its financial exposure if projects struggle.

In addition to DOE taking actions to improve its project administration practices, an opportunity exists for Congress to help protect any future coal CCS demonstration project funding. Specifically, DOE's actions to bypass cost controls came at the direction of senior departmental leadership, in spite of project underperformance relative to milestones and DOE analyses indicating significant risks to project success. Additionally, DOE documentation indicates that had Congress authorized an extension on the use of the Recovery Act funds, the department might have continued funding some of these projects and, in turn, could have placed at risk hundreds of millions of additional dollars that DOE had committed to spending on these projects through their construction and operation. Therefore, improving program-level practices—such as adhering to guidance—might not sufficiently address the risk of senior

department leadership placing taxpayer funds at risk if future coal CCS demonstrations struggle. Given the more than \$2.5 billion in appropriated funding for new CCS demonstration projects,³⁴ and DOE leadership's role in directing actions to not consistently adhere to project cost controls, implementing a congressional mechanism to provide greater oversight and accountability of DOE CCS demonstration expenditures—such as requiring regular DOE reporting on project funding and status—could help reduce the risk to taxpayer funds. Absent such a mechanism, DOE may be at risk of expending significant funds on CCS demonstration projects with little likelihood of success.

Conclusions

CCS technologies have the potential to help mitigate global climate change, but implementing them has proven to be a challenge. To address this challenge, in the last decade, DOE initiated 11 large-scale demonstration projects, spending about \$1.1 billion, with the aim of accelerating the development and commercial deployment of CCS technologies. However, the demonstrations ended with three of 11 projects—including one coal project—being built. As DOE and Congress consider investing billions more in a new round of CCS demonstration projects, it is crucial that they take into account lessons learned from past projects in order to reduce risks to future projects' success and taxpayer funds.

First, DOE's decisions to commit to fully funding coal CCS projects upon their initial selection, and to negotiate the cooperative agreements for those projects on an accelerated schedule, increased the risk of funding projects that were unlikely to succeed. By amending its selection process to incorporate a down-selection as well as reserving adequate time for negotiations—as it did for the industrial CCS demonstration and subsequent large-scale pilot project program—DOE could better ensure that in any future CCS demonstration program it will select and negotiate projects more likely to succeed.

Second, DOE compounded the risks resulting from its project selection and cooperative agreement negotiation decisions by bypassing cost controls that were designed to limit the government's financial exposure

³⁴As previously discussed, the 2021 Infrastructure Investment and Jobs Act authorized and appropriated more than \$2.5 billion over fiscal years 2022 through 2025 for carbon capture demonstration projects.

on its coal CCS projects. Specifically, when those projects struggled to meet key performance milestones, DOE amended the terms of its cooperative agreements, which put significantly more federal funds at risk. By taking actions to more consistently adhere to the principles in DOE's *Guide to Financial Assistance* in any future CCS demonstration projects—specifically, managing and reporting projects against established scopes, schedules, and budgets—DOE would be better positioned to mitigate its financial exposure.

Finally, improving program-level practices alone might not sufficiently address the risk of senior DOE leadership placing taxpayer funds at risk if future CCS demonstration projects struggle to meet key performance milestones. Implementing a congressional mechanism to provide greater oversight and accountability of DOE CCS demonstration project expenditures—such as requiring regular DOE reporting on project funding and status—could help reduce the risks to taxpayer funds. Absent such a mechanism, DOE is at risk of expending significant funds on CCS demonstration projects that have little likelihood of success.

Matter for Congressional Consideration

Congress should consider implementing a mechanism—such as requiring regular DOE reporting on project funding and status—to provide greater oversight and accountability of DOE CCS demonstration project expenditures. (Matter for Consideration 1)

Recommendations for Executive Action

We are making the following two recommendations to DOE:

The Principal Deputy Assistant Secretary for the Office of Fossil Energy and Carbon Management should incorporate into any future CCS demonstration project selections a down-selection and allow adequate time for negotiations prior to entering cooperative agreements. (Recommendation 1)

The Principal Deputy Assistant Secretary for the Office of Fossil Energy and Carbon Management should take actions to more consistently administer future CCS demonstration projects against established scopes, schedules, and budgets. (Recommendation 2)

Agency Comments

We provided a draft of this report to DOE for review and comment. In its written response, reproduced in appendix I, DOE neither agreed nor disagreed with our two recommendations. DOE indicated that it is working to establish a new Office of Clean Energy Demonstrations that will be best positioned to evaluate our recommendations and develop a corrective action plan. We continue to believe that implementation of these recommendations would improve DOE's management of future CCS demonstration projects. DOE also provided technical comments, which we incorporated as appropriate.

We are sending copies of this report to the appropriate congressional committees, the Secretary of Energy, and other interested parties. In addition, the report is available at no charge on the GAO website at <https://www.gao.gov>.

If you or your staff have any questions about this report, please contact me at (202) 512-3841 or ruscof@gao.gov. Contact points for our Offices of Congressional Relations and Public Affairs may be found on the last

page of this report. GAO staff who made major contributions to this report are listed in appendix II.



Frank Rusco
Director, Natural Resources and Environment

Appendix I: Comments from the Department of Energy



Department of Energy

Washington, DC 20585

December 3, 2021

Mr. Frank Rusco
Director
Natural Resources and Environment
U.S. Government Accountability Office
441 G Street N.W.
Washington, DC 20548

Dear Mr. Rusco,

The U.S. Department of Energy (DOE) appreciates the efforts of the General Accountability Office (GAO) engagement team on GAO Draft Report, entitled: “*Carbon Capture and Storage: Actions Needed to Improve DOE Management of Demonstration Projects (GAO-22-105111)*.” The GAO draft report provides valuable information regarding lessons learned from past DOE Carbon Capture and Storage projects and recommendations to address project management and other issues identified by GAO.

The Department of Energy is currently working to establish a new Office of Clean Energy Demonstrations. This office will be best placed to evaluate the GAO report and recommendations and develop an appropriate corrective action plan to address the GAO recommendations. Because this office is still being established, DOE will provide a detailed response to the GAO recommendations after receipt of GAO’s final report, as required by 31 U.S.C. 720.

GAO should direct any questions regarding this response to Thomas Griffin, Director, Office of Financial Policy and Audit Resolution, at 202-586-1585.

Sincerely,

Christopher S. Johns
Deputy Chief Financial Officer

Agency Comment Letter

Text of Appendix I: Comments from the Department of Energy

Page 1

December 3, 2021

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Natural Resources and Environment
U.S. Government Accountability Office
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Sincerely,

Christopher S. Johns
Deputy Chief Financial Officer

Appendix II: GAO Contact and Staff Acknowledgments

GAO Contact

Frank Rusco, (202) 512-3841 or ruscof@gao.gov

Staff Acknowledgments

In addition to the contact named above, David Marroni (Assistant Director), Matthew Tabbert (Analyst-in-Charge), Bethany Benitez, John Delicath, Wil Gerard, Cindy Gilbert, and Daniel Will made significant contributions to this report.

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