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DOE's Carbon Capture and Storage (CCS) and Carbon Removal Programs

Federally funded research and development (R&D) on carbon capture and storage (CCS) and carbon removal is supported primarily by the U.S. Department of Energy (DOE). This In Focus summarizes recent authorizations and appropriations for these activities.

Background

CCS is a process that is envisioned to capture human-generated carbon dioxide (CO₂) at its source and store it underground to prevent its release to the atmosphere. Captured carbon can also be utilized in products, as opposed to being stored underground, in a process called carbon capture, utilization, and storage (CCUS). Carbon dioxide removal (CDR, sometimes called carbon removal or negative emissions technologies) is a suite of technologies and practices that aim to remove CO₂ from the atmosphere and store it underground or in living organisms. CDR often involves natural CO₂ sinks like forests and croplands, but it can also involve technologies like direct air capture (DAC). Further discussion of some of these technologies and historical appropriations for related DOE R&D activities is provided in CRS Report R44902, *Carbon Capture and Sequestration (CCS) in the United States*.

CCS (with or without utilization) and CDR both are viewed as potential options to address climate change, though they address different aspects. CCS equipment can reduce CO₂ emissions from point sources (e.g., power plants or other industrial facilities), potentially resulting in low-carbon facilities. DAC facilities can be located anywhere and can be potentially carbon negative if the DAC process uses non-emitting energy sources. CDR involving living organisms (e.g., based on agricultural soils or forestry practices) is often site-constrained by habitat and related factors.

Program Authorizations

DOE's carbon capture R&D activities date back to at least 1997 and have historically centered on two components: carbon capture technology for coal-fired power plants and underground geologic storage reservoirs. In appropriations reports leading up to 2020, Congress recommended that DOE expand its focus to include carbon capture for other sources and some types of CDR.

Congress codified these and other objectives for DOE's carbon capture and carbon removal R&D in P.L. 116-260, the first major amendments to DOE's statutory R&D program objectives since 2007. Most authorizations are provided by the Energy Act of 2020 (Division Z of P.L. 116-260). The USE IT Act (enacted as part of Division S of P.L. 116-260) provided additional guidance for DOE carbon utilization R&D.

The Energy Act of 2020 provides policy direction for DOE's CCUS R&D activities in Title IV—Carbon Management. Sections 4002, 4003, and 4004 address carbon capture, carbon storage, and carbon utilization, respectively. In part, the law directs DOE to fund carbon capture demonstration projects at varying stages of technological maturity, and to continue funding carbon storage projects. Funded carbon capture projects must be applied to different types of facilities, such as natural gas-fired power plants and facilities outside the power sector. The law also directs DOE to fund research to identify novel uses of carbon and CO₂. DOE's CCUS R&D activities pursuant to Title IV are authorized at \$1,284.0 million in FY2021; \$1,285.3 million in FY2022; \$1,131.6 million in FY2023; \$1,132.9 million in FY2024; and \$1,084.4 million in FY2025 (all values rounded to the nearest tenth).

The Energy Act of 2020 provides policy direction for DOE's CDR R&D activities in Title V—Carbon Removal. Section 5001 establishes a new DOE research program on CDR, to be coordinated with the U.S. Department of Agriculture and other relevant federal agencies. Section 5001 identifies six CDR options DOE should support: DAC, bioenergy with CCS, enhanced geological weathering, agricultural practices, forest management and afforestation, and planned or managed carbon sinks. Section 5001 also establishes Air Capture Prize Competitions for two classes of DAC. The larger competition, for more mature technologies, is authorized at \$100 million (available until expended) and may award eligible facilities up to \$180 per ton of CO₂ captured and stored. The awards are to be smaller if the captured CO₂ is utilized, including for enhanced oil recovery. DOE's CDR R&D activities pursuant to Title V are authorized at \$175.0 million in FY2021 (of which \$115.0 million is for DAC prize competitions, to remain available until expended); \$63.5 million in FY2022; \$66.2 million in FY2023; \$69.5 million in FY2024; and \$72.9 million in FY2025 (all values rounded to the nearest tenth).

Infrastructure Investment and Jobs Act

The Infrastructure Investment and Jobs Act (IIJA; P.L. 117-58) made additional amendments to DOE's CCS and CDR programs, established several new programs, and provided supplemental appropriations for FY2022-FY2026 (**Table 1**) including funding for some programs authorized by the Energy Act of 2020.

In particular, IIJA established the Carbon Dioxide Transportation Infrastructure Finance and Innovation Program (CIFIA). CIFIA is to provide low-interest loans for eligible CO₂ pipeline projects and grants for initial excess capacity on eligible new pipelines. CIFIA aims to

realize economies of scale for CO₂ transportation infrastructure in the United States and address a “chicken and egg” problem identified for CCS development. IIJA provided \$2.1 billion for CIFIA for FY2022-FY2023, the bulk of which was provided for FY2023. CIFIA funds, like other IIJA funds for CCS, remain available until expended.

Another IIJA-established program focuses on the development of “commercial large-scale” carbon storage projects. IIJA provided \$2.5 billion for this program for FY2022-FY2026.

A third program aims to develop four Regional Direct Air Capture Hubs. Each hub is required to have the capacity to capture, store, and/or utilize at least 1 million tons of CO₂ annually. IIJA provided \$3.5 billion for DAC hubs for FY2022-FY2026. DOE has made funding announcements and selected projects for these IIJA-funded programs. For example, DOE is funding two DAC hubs—one in Louisiana and one in Texas.

CHIPS and Science Act

P.L. 117-167, commonly known as the CHIPS and Science Act, authorized additional activities. One such activity is the Carbon Sequestration Research and Geologic Computational Science Initiative “to expand the fundamental knowledge, data collection, data analysis, and modeling of subsurface geology for the purpose of

advancing carbon sequestration in geologic formations.” This initiative is authorized at \$50 million per year for each of FY2022 through FY2027. The law also authorizes \$1 billion for the period of FY2023-FY2026 for carbon removal research, demonstration, and development activities.

Regular Appropriations

Regular appropriations for DOE’s CCUS and CDR programs are provided by the Energy and Water Development and Related Agencies appropriations bills. Most of DOE’s CCUS research is funded through its Office of Fossil Energy and Carbon Management (FECM). DOE funds CDR activities through FECM and other offices, including the Office of Science and the Office of Energy Efficiency and Renewable Energy. According to the explanatory statement for the Consolidated Appropriations Act, 2023 (P.L. 117-328), Congress provided \$295 million to CCUS line items for FY2023, up from \$225 million in FY2022. For carbon removal, Congress provided \$140 million in FY2023, up from \$104 million in FY2022. **Table 1** shows a line-item breakdown of DOE CCS and CDR funding from regular appropriations and supplemental appropriations provided by IIJA for FY2022 through FY2024.

Table 1. Funding for Carbon Capture and Storage (CCS) and Carbon Removal R&D Activities at DOE

Budget authority in millions of dollars, rounded to the nearest tenth

Program Area	FY2022 Enacted (Regular)	FY2022 (Supplemental)	FY2023 Enacted (Regular)	FY2023 Enacted (Supplemental)	FY2024 Enacted (Regular)	FY2024 Enacted (Supplemental)
Carbon Capture	99.0	1,344.0	135.0	720.0	127.5	720.0
Carbon Utilization	29.0	41.0	50.0	65.3	52.5	66.6
Carbon Storage	97.0	500.0	110.0	500.0	93.0	500.0
CIFIA	n/a	3.0	n/a	2,097.0	n/a	n/a
<i>CCS Subtotal</i>	<i>225.0</i>	<i>1,888.0</i>	<i>295.0</i>	<i>3,382.3</i>	<i>273.0</i>	<i>1,286.6</i>
Carbon Dioxide Removal (FECM)	49.0	815.0	70.0	700.0	70.0	700.0
Carbon Dioxide Removal (other offices)	55.0	n/a	70.0	n/a	48.0	n/a
<i>CDR Subtotal</i>	<i>104.0</i>	<i>815.0</i>	<i>140.0</i>	<i>700.0</i>	<i>118.0</i>	<i>700.0</i>
Total	329.0	2,703.0	435.0	4,082.3	391.0	1,986.6

Sources: FY2022 enacted and FY2023 enacted from explanatory statements for P.L. 117-103 and P.L. 117-328. FY2024 enacted from explanatory statements for P.L. 118-42. Supplemental appropriations from P.L. 117-58, Division J.

Notes: FECM = Office of Fossil Energy and Carbon Management, the lead DOE office for CCS and carbon removal research activities. CIFIA = Carbon Dioxide Transportation Infrastructure Finance and Innovation program. Most of the supplemental appropriations for CCS are administered by DOE’s Office of Clean Energy Demonstrations. The explanatory statement for P.L. 117-103 additionally provided \$9 million in congressionally directed spending for an engineering study of a CCS project in Louisiana. The congressionally directed spending project is not included in the totals in the table. No congressionally directed spending projects in FY2023 or FY2024 related to CCS or carbon removal.

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