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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 analysis summarizes recent authorizations and appropriations for these activities, covering FY2021 and FY2022.

Background

CCS is a process that is envisioned to capture man-made carbon dioxide (CO₂) at its source and store it underground to prevent its release to the atmosphere. Captured carbon also can be used 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 also can 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 of the issue. CCS equipment can reduce CO₂ emissions from point sources that use fossil fuels (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.

FY2021 Appropriations

Among other provisions, the Energy and Water Development and Related Agencies Appropriations Act, 2021 (Division D of P.L. 116-260) provided regular appropriations for FY2021 for ongoing R&D activities within DOE. Most of DOE's CCUS research is funded through its Fossil Energy program (renamed Fossil Energy and Carbon Management in FY2022). According to the explanatory statement for the appropriations act, Congress provided \$188.3 million to CCUS line items for FY2021 (see **Table 1**). These appropriations are lower than the FY2021 authorized amounts in other divisions of the law (as discussed in the "Energy Act of 2020 Authorizations" section below.)

The explanatory statement directed at least \$72.5 million of DOE's appropriated funds for R&D on CDR (which it referred to as negative emissions technologies) in three DOE programs:

- within Fossil Energy, not less than \$40.0 million, including not less than \$15.0 million for DAC;
- within Energy Efficiency and Renewable Energy, not less than \$10.0 million for DAC; and
- within Science, not less than \$22.5 million, including not less than \$7.5 million for DAC.

Energy Act of 2020 Authorizations

DOE's carbon capture R&D activities date back to at least 1997 and historically centered on two aspects: carbon capture technology for coal-fired power plants and underground geologic storage reservoirs. In recent appropriations reports, 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. 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 technology maturity, and to continue funding carbon storage projects. Funded carbon capture projects must apply 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). The FY2021 appropriations reports did not address any DAC prize competition.

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.

One newly established program is 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 is provided in FY2023.

Another newly 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 newly established program aims to develop four Regional Direct Air Capture Hubs. Each hub should have the capacity to capture, store, and/or utilize at least one million tons of CO₂ annually. IIJA provided \$2.5 billion for DAC hubs for FY2022-FY2026.

FY2022 Appropriations

The Energy and Water Development and Related Agencies Act, 2022 (Division D of P.L. 117-103) provided regular appropriations for DOE's R&D activities, among other provisions.

For FY2022 regular appropriations, Congress directed \$225 million for CCS, according to the explanatory statement for the appropriations act. Additionally, Congress directed \$104 million for CDR, of which not less than \$75 million is for DAC. One funded congressionally directed spending project for DOE was for CCS: \$9 million for an engineering study of a CCS project in Louisiana.

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

Budget authority in millions of dollars

Program Area	FY2021 Enacted	FY2022 Enacted (Regular)	FY2022 Supplemental
Carbon Capture	86.3	99.0	1,344.0
Carbon Utilization	23.0	29.0	41.0
Carbon Storage	79.0	97.0	500.0
CIFIA	n/a	n/a	3.0
<i>CCS Subtotal</i>	<i>188.3</i>	<i>225.0</i>	<i>1,888.0</i>
Carbon Dioxide Removal (FECM)	40.0	49.0	815.0
Carbon Dioxide Removal (other offices)	32.5	55.0	n/a
<i>CDR Subtotal</i>	<i>72.5</i>	<i>104.0</i>	<i>815.0</i>
Total	260.8	329.0	2,703.0

Sources: FY2021 enacted and FY2022 enacted from explanatory statement for P.L. 117-103, Division D. FY2022 supplemental 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. Some of the FY2022 supplemental appropriations for CCS are to be administered by DOE's Office of Clean Energy Demonstrations.

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