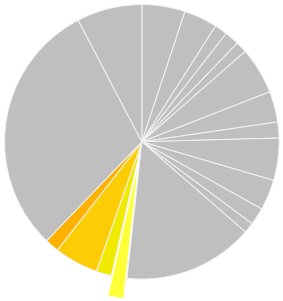
Federal Energy R&D: Carbon Capture

BY COLIN CUNLIFF AND BATT ODGEREL | MARCH 2020

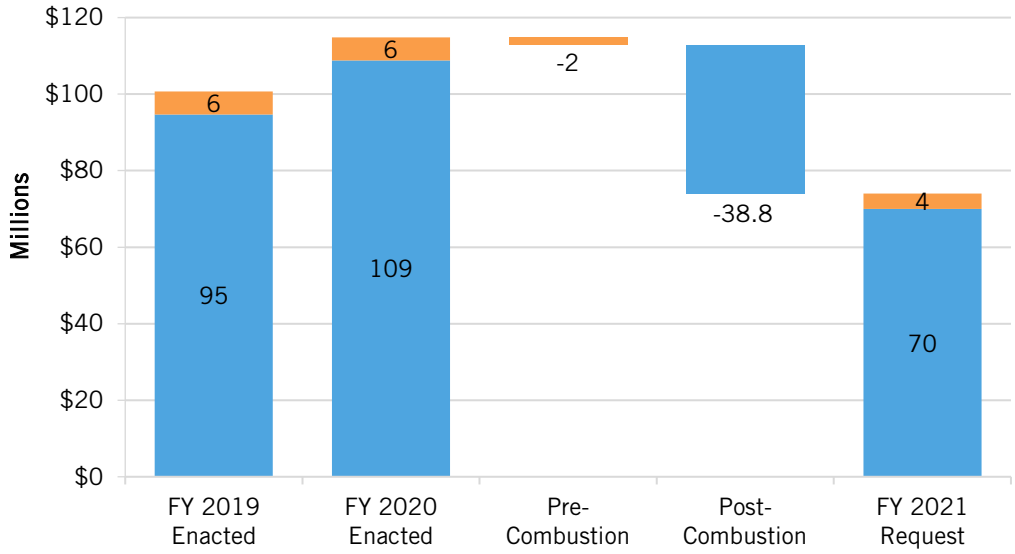
This briefing is part of a series on the U.S. energy budget. See: itif.org/energy-budget.



Carbon Capture (bright yellow)
Other Fossil (shades of yellow)
Energy R&D (gray)

Carbon capture, utilization, and storage (CCUS) technologies for fossil-fuel power plants have the potential to preserve important options—including coal- and natural-gas-fired electricity generation—in a carbon-constrained future. CCUS is also the only option for decarbonizing many industrial processes—such as the production of ethanol, fertilizers, plastics, cement, and steel—for which zero-carbon alternatives do not currently exist.[1] The 2018 Intergovernmental Panel on Climate Change (IPCC) special report on 1.5°C of warming found that CCUS plays an essential role in nearly all deep decarbonization pathways.[2] The Department of Energy's (DOE) carbon-capture research, development, and demonstration (RD&D) program focuses on two complementary technologies: pre-combustion systems, in which coal is gasified and the carbon dioxide (CO_2) removed prior to combustion or use in fuel cells; and post-combustion capture, which removes CO_2 from flue gas after combustion.

Figure 1: The FY 2021 budget request would cut carbon capture R&D by 36 percent[3]



What's at Risk

CCUS may be on the cusp of significant new buildouts and cost reductions. DOE's Industrial Carbon Capture and Storage (ICCS) program culminated in the successful launch of CCUS demonstration projects at the Port Arthur fertilizer facility in 2013, and the Archer Daniels Midland ethanol plant in 2017.[4] The world's largest successful post-combustion carbon-capture facility came online at the Petra Nova coal power plant in

Texas in 2017.[5] A new pilot-scale natural gas oxy-fuel demonstration began operating at the NET Power facility in Texas in May 2018, and the company is targeting 2020 to commercially deploy a 300-megawatt project using a supercritical CO_2 cycle.[6] The National Carbon Capture Center in Wilsonville, Alabama, is now installing a natural-gas-fired system to test technologies under natural-gas-fired and coal-fired flue gas conditions.[7] And in February 2018, Congress expanded and extended the 45Q tax credit to incentivize greater utilization and storage of captured CO_2.[8]

However, continued improvement and cost reductions must occur before CCUS will be viable for full-scale deployment. Even with the 45Q tax credit, current state-of-the-art technologies for capturing and storing carbon emissions are still too expensive to spur widespread deployment in the largest-emitting sectors, particularly power plants and cement and steel production.[9]

DOE's carbon capture program has primarily focused on coal-fired power plants, to the exclusion of natural gas power plants and industrial sources. The ICCS program, which explored both power plant and industrial applications of carbon capture, received a one-time appropriation through the American Recovery and Reinvestment Act of 2009 (ARRA), but has received no further funds.[10] This focus leaves the unique challenges of integrating and optimizing carbon capture with other sources of emissions unsolved. ITIF recommends DOE establish new carbon capture programs for natural gas power plants and industrial facilities.[11] ITIF has also called for the federal government to invest in a robust portfolio of demonstration projects, which would include major investments in CCUS.[12] In FY 2020, Congress for the first time directed DOE to reserve $4 million "for research and optimization of carbon capture technologies for use at industrial facilities," and $7 million for carbon capture at natural gas power plants.[13]

DOE has set the ambitious target of reducing the cost of carbon capture to less than $40 per metric ton of CO_2 by 2025—and under $30 per metric ton by 2035.[14] Additionally, DOE has sought to establish international leadership in CCUS technologies through its participation in the Clean Energy Ministerial and Mission Innovation.[15] Reductions in R&D funding, and a shift away from demonstration projects, threaten to delay or even derail current DOE progress toward these targets, and cede U.S. leadership in the emerging global CCUS industry.

Carbon Capture R&D Activities

R&D in carbon capture is spread across two activities:

- **Post-Combustion Capture Systems** focuses on separating and capturing CO_2 from flue gas after the fuel has been combusted. These systems can be used to retrofit existing fossil-fuel power plants. Because CO_2 makes up only 3–4 percent of flue gas from natural gas plants and 12–15 percent of flue gas from coal plants, separation is challenging—and once separated, the pure CO_2 must then be compressed for sequestration.[16]

- **Pre-Combustion Capture Systems** focuses on removing CO_2 from fossil fuels before combustion is complete. Coal can be gasified under high pressure to produce a mixture of hydrogen and highly concentrated CO_2, with the former used for energy storage and fuel, and the latter captured and sequestered.

Activities within the carbon capture program are tightly coupled with research and development (R&D) in advanced energy systems. Solid oxide fuel cells (SOFCs), gasification systems, oxy-combustion and chemical looping combustion, and direct-fired supercritical CO_2 cycles (i.e., Allam cycles), are all designed and optimized to integrate with carbon capture technologies.[17]

Key Elements of the FY 2021 Budget Proposal

- **A 36 percent reduction in Post-Combustion Capture Systems**, including a shift away from later-stage R&D and demonstration projects. The budget proposes focusing on early-stage research on novel CO_2 separation technologies, including non-aqueous solvents, membranes, advanced sorbents, and cryogenic processes. This subprogram would also support early-stage testing of negative emissions technologies, including direct air capture (DAC) and bioenergy with carbon capture and storage (BECCS).

- **A 33 percent reduction in Pre-Combustion Capture Systems,** including a shift away from later-stage R&D. No funding is requested for activities to scale up pre-combustion technologies beyond bench-scale demonstrations.

ENDNOTES

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