Federal Energy R&D: Carbon Storage and Utilization

BY COLIN CUNLIFF AND BATT ODGEREL | MARCH 2020

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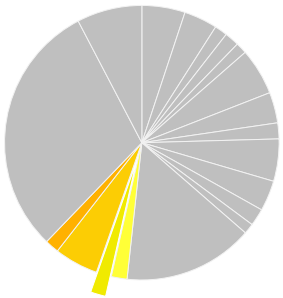
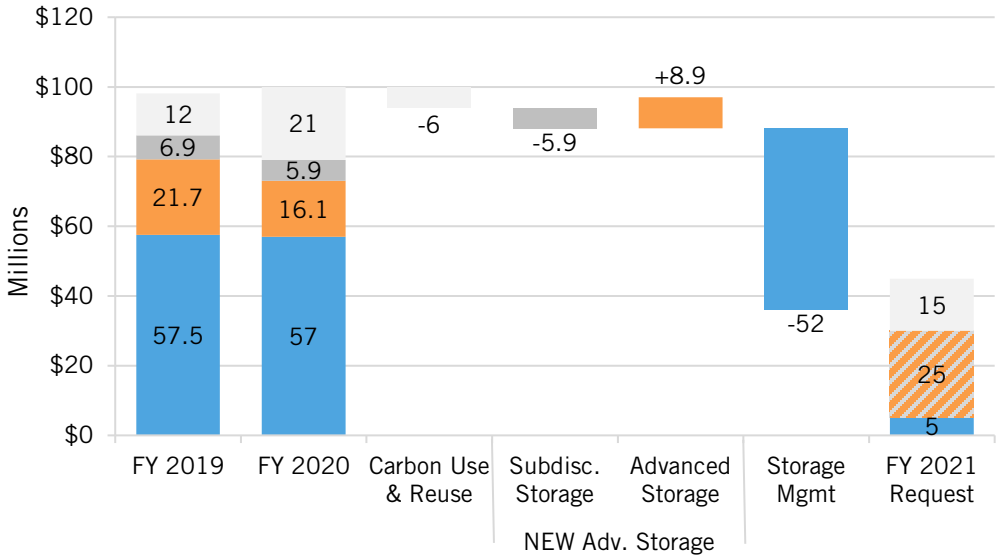


Carbon Storage (dark yellow)
Other Fossil (shades of yellow)
Energy R&D (gray)

The Carbon Storage and Utilization programs are focused on the development of technologies for the safe use and permanent storage of captured carbon dioxide (CO_2). The storage program focuses on developing the technologies and infrastructure necessary to store captured CO_2 safely in deep saline formations or oil and natural gas reservoirs.[1] The carbon use and reuse program focuses on recycling captured CO_2 into valuable products, such as chemicals, fuels, and building materials.

Figure 1: The FY 2021 budget request would cut carbon storage and utilization R&D by 55 percent[2]



What's at Risk

Preliminary research suggests the United States has enough subsurface capacity to permanently sequester 1.71 trillion metric tons of CO_2, which is the equivalent of 950 years of carbon emissions from power plants at 2016 levels.[3] However, additional cost reductions, validation, safety testing, and mitigation research are necessary to realize this capacity. While the size of many subsurface storage reservoirs has been initially characterized, detailed site-specific work is required to confirm their potential. Research and development (R&D) is also needed for tools to map and simulate below-ground fractures and faults with a high degree of resolution and fidelity, devise wellbore materials that can better resist corrosion by CO_2-saturated brine, and improve the ability to monitor and mitigate the risk of induced seismicity from the injection of CO_2

underground. And large-scale, long-term demonstration projects are necessary to ensure captured CO_2 is safely and permanently stored.

In April 2017, the Illinois Industrial Carbon Capture and Storage project—funded jointly by the Department of Energy (DOE) and private investors—began capturing CO_2 from an ethanol production facility and storing it underground in a saline reservoir at a rate of one million metric tons of CO_2 per year. This large, first-of-a-kind demonstration project is testing and validating technologies while concurrently endeavoring to reduce future costs.[4] In 2018, DOE selected three additional cost-shared R&D projects to identify sites that could store more than 50 million metric tons of CO_2 as part of its Carbon Storage Assurance Facility Enterprise (CarbonSAFE) initiative.[5] The proposed budget would substantially cut funding for these efforts.

Carbon utilization—turning CO_2 from a waste product into a product of value—is key to expanding the market for CO_2 and incenting greater carbon capture. But many potential uses for captured carbon, such as carbon nanotubes and synthetic hydrocarbon fuels, are far from commercialized, and require further R&D in order to bring costs down. In 2019, the National Academies developed a broad innovation agenda for chemical and biological conversion of CO_2 into fuels and chemicals, but funding at DOE has been insufficient to address the full suite of research, development, and demonstration needs identified by the National Academies.[6]

Carbon Storage and Utilization R&D Activities

Funding for carbon storage and utilization R&D is spread across four activities:

- **Storage Infrastructure R&D** focuses on geologic resource characterization and small- and large-scale field projects to demonstrate permanent geologic storage; validation of injection, simulation/risk assessment, and monitoring strategies; and assessment of the probability, and subsequent mitigation, of potential seismic events. Program activities include the CarbonSAFE initiative, which funds industry cost-shared R&D projects to characterize and develop commercial-scale (more than 50 million metric tons of CO_2) storage complexes by 2025; the Brine Extraction Storage Test (BEST), which advances strategies for managing subsurface pressure and fluid flow; and the seven Regional Carbon Sequestration Partnerships (RCSPs), which are currently testing large-scale CO_2 injection and storage technologies.[7]

- **Advanced Storage R&D** is focused on validating storage monitoring, simulation, risk assessment, and advanced wellbore technologies to detect and mitigate wellbore issues. R&D activities include developing CO_2-resistant construction materials and well-integrity technologies, plus technologies to detect and mitigate potential CO_2 leakage pathways.

- **Sub-disciplinary Storage R&D** focuses on assessment and validation of subsurface models; support for the National Risk Assessment Partnership (NRAP), with a focus on storage risk tools; and development of the Energy Data

Exchange (EDX) system, which supports data management and technology transfer. The budget request proposes merging the subprogram with Advanced Storage R&D.[8]

- **Carbon Use & Reuse R&D** explores the beneficial reuse of CO_2, including conversion into higher-value products such as chemicals, plastics, and building materials, and accelerated curing for cement. The primary objective is to lower the near-term cost of carbon capture, utilization, and sequestration (CCUS) through the creation of value-added products via the conversion of CO_2.

Key Elements of the FY 2021 Budget Proposal

- **A 91 percent reduction in Storage Infrastructure R&D,** and no funding for activities other than "infrastructure network studies and cost and performance analyses." It is unclear whether the CarbonSAFE Initiative, BEST, or the RCSPs would continue to be supported. Long-term, ongoing evaluation and monitoring of storage test sites is necessary to provide confidence that captured CO_2 is safely and permanently stored.

- **A 14 percent increase in Advanced Storage R&D** (which would be merged with Sub-disciplinary Storage R&D), with the increased funding focused on efforts to advance machine learning/artificial intelligence (ML/AI) tools to support subsurface storage decision-making.

- **A 29 percent reduction in Carbon Use & Reuse R&D,** with reduced funding supporting laboratory- and bench-scale activities to convert CO_2 into chemicals, building materials, and solid carbon.

ENDNOTES

1. U.S. Department of Energy (DOE), "FY 2021 Congressional Budget Justification," Volume 3 Part 2, 233–234, (DOE Chief Financial Officer, DOE/CF-0164, February 2020), https://www.energy.gov/sites/prod/files/2020/02/f72/doe-fy2021-budget-volume-3-part-2_2.pdf.
2. DOE, "FY 2021 Congressional Budget Justification," Volume 3 Part 2, 237.
3. DOE, "Siting and Regulating Carbon Capture, Utilization, and Storage Infrastructure" (Washington, D.C.: DOE Office of Energy Policy and Systems Analysis and Office of Fossil Energy, January 2017), 14, https://www.energy.gov/sites/prod/files/2017/01/f34/Workshop%20Report--Siting%20and%20Regulating%20Carbon%20Capture%2C%20Utilization%20and%20Storage%20Infrastructure.pdf; EPA Draft, "Inventory of U.S. Greenhouse Gas Emissions and Sinks," Table ES-2 (Washington, D.C.: Environmental Protection Agency, February 2018), https://www.epa.gov/ghgemissions/inventory-us-greenhouse-gas-emissions-and-sinks.
4. DOE, "DOE Announces Major Milestone Reached for Illinois Industrial CCS Project," accessed March 29, 2019, https://www.energy.gov/fe/articles/doe-announces-major-milestone-reached-illinois-industrial-ccs-project.

5. DOE, "Energy Department Selects Additional Carbon Storage Feasibility Projects to Receive Nearly $30M in Federal Funding," accessed March 29, 2019, https://www.energy.gov/fe/articles/energy-department-selects-additional-carbon-storage-feasibility-projects-receive-nearly.
6. National Academies of Sciences, Engineering, and Medicine, *Gaseous Carbon Waste Streams Utilization: Status and Research Needs* (Washington, D.C.: The National Academies Press, 2019), https://doi.org/10.17226/25232.
7. DOE, "Storage Infrastructure," accessed March 29, 2019, https://www.energy.gov/fe/storage-infrastructure.
8. DOE, "FY 2018 Congressional Budget Justification," Volume 3, 369–372 (DOE/CF-0130, May 2017). The FY 2021 budget request proposes restructuring the carbon storage projects, so definitions from an earlier fiscal year are used here.

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