



Scaling Technology-based Carbon Dioxide Removal

A US FEDERAL POLICY ROADMAP



ABOUT CARBON180

Carbon180 is a climate NGO with a vision to remove legacy carbon emissions from the atmosphere and create a livable climate in which current and future generations can thrive. Based in Washington, DC, we design and champion equitable, science-based policies that bring carbon removal solutions to gigaton scale.

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CITATION

Holness, C., Thompson, J., Milko, J., & Yin, D. (2026). *Tech Policy Roadmap*. Carbon180.

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Section One:

Introduction & Overview

Introduction

Carbon dioxide removal (CDR) has the potential to become one of the defining industries of the 21st century, removing excess carbon pollution from the atmosphere while creating durable economic opportunities across the country.

The scientific community recognizes that, in addition to rapid emissions reductions, 5-10 gigatons of CDR will be required by 2050 to reach climate goals.¹ To set us on this path, the US should aim to remove 30 megatons of carbon dioxide per year by the year 2030. Technological carbon removal refers to engineered approaches that capture CO₂ from the air and store it for centuries to millennia and can deliver permanent, verifiable storage with a low risk of reversal.²

The opportunities of scaling technological carbon removal extend beyond its climate benefits. CDR facilities create economic opportunities, such as jobs in the industrial and construction sectors, and export opportunities in international compliance markets.³ The US has established early global leadership in technological carbon removal, accounting for a third of carbon removal companies and authorizing over \$3.65 billion in federal support.⁴ These investments have catalyzed private capital, driven innovation, and positioned US companies at the forefront of the emerging global industry.⁵

Technology development is advancing quickly, but the policy, infrastructure, and market systems required to scale are lagging. With coordinated federal action, the US can leverage early leadership to drive economic growth, with an industry estimated at between \$300 billion and \$1.2 trillion over the next 30 years.⁶

The US has built a unique global advantage here, with decades of experience in developing new technologies, utilizing the national lab system and research universities, and a long track record of industrial leadership. In 2022, the Carbon Dioxide Program was established at the Department of Energy (DOE) to advance a suite of CDR solutions that will help achieve the goal of a net-zero-emissions US economy by 2050. Federal policy is critical for de-risking investment, building enabling systems, and ensuring responsible deployment.

Overview

What Is This Roadmap?

This roadmap provides federal policymakers with practical policy solutions that utilize near-term opportunities to advance carbon removal. It is organized around four enabling conditions that must advance in parallel for the sector to scale responsibly:



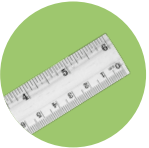
Boosting Research, Development, Demonstration, and Deployment (RDD&D)



Building Out Infrastructure



Creating Durable Markets



Strengthening Standards and Measurement, Monitoring, Reporting, and Verification (MMRV)

The scope of recommendations in this report spans authorizing legislation, appropriations, administrative action, and technology-neutral mechanisms that support the carbon removal sector as a whole. Where relevant, the recommendations identify existing statutory authority and unspent funds that can be deployed without new legislation. The roadmap covers durable carbon removal pathways, including direct air capture, biomass carbon removal and storage, and enhanced mineralization, as well as enabling storage and transport infrastructure.

For more information and pathway-specific recommendations on ocean and land-based carbon removal, visit our [Road to 2030 landing page](#).

The Challenges to Scaling Technological Carbon Removal

The decisions the US makes over the next two to three years will determine whether this country leads or follows in ensuring a safe climate scenario for decades to come.

Other nations, including Canada, the United Kingdom, and members of the European Union, are investing in carbon removal technologies. Meanwhile, over \$5 billion in Congressionally appropriated carbon management funding sits unspent. While public support for carbon removal has helped unlock initial private capital and driven early innovation, the existing incentives, funding, and regulations are far below what is needed for the sector to meet its growth goals and to reap the full economic benefits of the future carbon removal economy.⁷ The following challenges require policy interventions:

Public funding. The benefits of public goods are felt by everyone everywhere, such as clean air. The federal government has repeatedly stepped in to initially fund public goods that the private sector later scaled up, such as vaccines and basic scientific research. Carbon removal is a public good that removes excess pollution from the atmosphere, meaning the investments that make it possible, like early-stage R&D and large-scale infrastructure, have no natural private funders.⁸ Yet it lacks dedicated federal funding frameworks. Without purpose-built policies that treat carbon removal as a public good, the field will remain structurally underfunded across the value chain, regardless of private demand.

Countries around the world are integrating carbon removal into their compliance frameworks, creating an export opportunity for American	CDR producers. In 2026, Japan's Green Transformation Emissions Trading System will transition to compliance, and the European Union will draft	rules to integrate CDR into its Emissions Trading System.^{10,11} The United Kingdom has proposed to integrate CDR into its Emissions Trading System in 2029. ¹²
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Demand. Carbon removal projects can't reach final investment decisions without a credible buyer. The voluntary market of corporate purchasers has been essential in proving early demand, but remains concentrated. Microsoft alone accounted for over 90% of total carbon removal purchases in 2025, and in April 2026 announced plans to pause its purchasing.⁹ Such a pullback shows just how thin the demand floor really is.

Overview

Durable and diversified federal demand is essential to enable project financing and set the quality standards that allow responsible growth. A federal demand signal would also position the US to supply international compliance markets.

Standards. Standards are fundamental to ensuring that carbon removal projects deliver on their claims. At least 139 different MMRV protocols have been identified across carbon removal pathways, resulting in a patchwork system that undermines buyer confidence, limits competition, and creates accountability gaps.¹³ Standardization across MMRV protocols will ensure quality, boost competition, and strengthen credibility. Clear MMRV enables accountability and, in turn, public trust. Consistent, federally-recognized standards are necessary for a credible market.

Measurement, monitoring, reporting, and verification, or “MMRV”, is the process of accounting for all emissions, resource use, and environmental and public health outcomes associated with a project. MMRV is crucial to proving that investments drive real action.

Community engagement and public trust. Early carbon removal deployments will shape the sector’s reputation for decades. Community opposition and litigation can be significant cost drivers for large infrastructure projects. The loss of public trust is among the greatest risks to scaling carbon removal. Federal policy should set a consistent floor for community-group engagement that embeds transparency, shared decision-making, and accountability from the outset so that federally backed or permitted projects and standards are developed in partnership with the local communities most affected.¹⁴ Projects and standards developed with the people most affected are more durable and carry lower long-term financial and social risk.

Section Two:

Policy Recommendations



Boosting Research, Development, Demonstration, and Deployment

Carbon removal technologies span a range of maturity levels, from concepts still being validated in the lab to early commercial facilities beginning to operate at scale.

Federal research, development, demonstration, and deployment (RDD&D) funding is the most powerful lever in bringing these technologies down the cost curve, building the evidence base needed for responsible scale-up, and unlocking private investment. Now, the challenge is to prove that these technologies can be deployed economically and at the pace needed to meet climate goals.

The US is home to more than 200 carbon removal companies and leads the world in early deployment. Two bipartisan laws were foundational to this lead — the Energy Act of 2020 and the CHIPS and Science Act, which authorized DOE to perform RD&D for these technologies. Focused public investment to remove bottlenecks slowing commercial scale-up, such as costs, feedstock, and supply logistics can help the US maintain a competitive edge. Federal action to deploy unspent appropriations, refine program structures, and expand the scope of federally supported RDD&D activities will help advance the sector.

Reader note: For more information about the history of carbon removal funding and programs at DOE mentioned in this report, see [Appendix A](#).

Recommendation 1: Amend Section 40308 of the Infrastructure Investment and Jobs Act to ensure the Regional Direct Air Capture Hubs Program achieves maximum impact.

The Infrastructure Investment and Jobs Act (IIJA) provided \$3.5 billion to fund the development of four regional direct air capture hubs (DAC Hubs). The fiscal year (FY) 2026 Energy & Water spending agreement then reprogrammed \$1.05 billion from IIJA-appropriated funds for DAC Hubs and DAC Prizes, leaving roughly \$1.3 billion in

Boosting Research, Development, Demonstration, and Deployment

unobligated funding. Congress can amend the underlying authorization in Section 40308 of IIJA to ensure these funds are used most effectively by:

- A. Reducing the annual hub capture requirement** from 1 million tons of CO₂/year to 100,000 tons/year and increasing the number of hubs to at least 8, enabling technology and ownership diversity. The industry is not ready to launch four 1-million-ton/year hubs as the current law requires. DOE recognized this gap in its own 2024 [Request for Information](#) on mid-scale DAC facilities, which found that a sizable cohort of DAC companies were falling short of what commercial hub-scale deployment requires. Mid-scale size facilities are a necessary step in most companies' commercialization strategies. This proposal offers a more realistic, stepwise path to commercial scale that aligns the federal program design with the industry's current state.
- B. Allowing DAC Hub funds to support contracts for differences**, paying for each ton of CO₂ captured and stored by qualified DAC projects. Securing offtake through contracts for differences would help DAC companies secure financing and strengthen federal procurement capabilities needed for large-scale deployment.
- C. Expanding eligibility** to include biomass carbon removal and storage, enhanced mineralization, direct ocean capture, and other durable carbon removal pathways. These technologies face the same capital and infrastructure barriers that demonstration-scale federal support is designed to address. Broadening eligibility would diversify the technology portfolio and hedge against over-indexing in a single technology pathway.

Direct air capture (DAC) technologies remove carbon dioxide from the air using chemistry and mechanical or passive air-contacting processes.

DAC has significant potential as a carbon removal solution, with estimates suggesting that it could remove between 0.5 and 5 gigatons of CO₂ per year by 2050.¹⁵

The first large-scale commercial DAC projects in the US are underway with plans to remove 500,000 tons of CO₂ annually in [Texas](#) and 1 million tons in [Louisiana](#).

Recommendation 2: Amend Section 41005 of IIJA to restructure the DAC Prizes program.

Roughly \$73 million remains unobligated for the DAC Prizes. DOE announced 24 semi-finalists under this program in May 2024, but has not proceeded with the planned Phase II, obligating only \$1.2 million of the \$35 million available. Congress appropriated an additional \$45 million for carbon removal purchases in FY2026. Congress should amend Section 41005 to allow a portion of the remaining funds to supplement annual funding for carbon removal purchasing. Rather than disburse funds via a formal prize competition, DOE can use its Other Transactional Authority (OTA) to enter offtake agreements with project developers, providing added flexibility, ensuring consistent applicant evaluation, and easing bureaucratic constraints.

Recommendation 3: Expend and expand existing funds for the Carbon Removal R&D Program.

More than \$71.5 million in FY2026 appropriations and significant unobligated balances from prior years remain available for DOE's Carbon Removal R&D Program. Congress should increase this investment to at least \$158 million in FY2027, which would restore the program above its FY2023 peak and maintain a credible, portfolio-wide R&D program. DOE should deploy these funds to remove technical barriers that would enable the growth of CDR technologies. Priorities should include:

- A. Direct air capture:** Reducing sorbent and solvent costs that constrain economics at scale; advanced bench-scale testing to accelerate commercialization timelines; and evaluating integration with building air-handling and heating, ventilation, and air conditioning (HVAC) systems.
- B. Biomass carbon removal and storage:** Improving the efficiency and net-removal economics of biomass conversion processes, with particular focus on reducing costs and carbon intensity of feedstock collection, transportation, and preprocessing for carbon removal applications.

<p>Biomass Carbon Removal and Storage (BiCRS) (pronounced “bikers”) uses photosynthesis to pull carbon from the atmosphere,</p>	<p>then processes it for long-term storage. The field has delivered 10,000 tons of carbon removal but has been contracted to remove</p>	<p>more than 20 million tons, underscoring the enormous scale-up potential of this pathway.¹⁶</p>
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C. Enhanced mineralization: Creating a national prospectivity map of carbon-absorbing minerals, including mineral wastes, conducting regional evaluations of enhanced rock weathering for removal capacity and cost, and establishing pilot test facilities.

D. Industrial integration: Assessing the carbon removal potential and demonstration readiness of existing industrial processes, including wastewater treatment, desalination, pulp and paper, concrete and cement production, and mining waste remediation.

<p>When carbon dioxide reacts with materials such as mine waste or certain rocks, solid minerals are created and stored in formations at the earth’s surface or underground.</p> <p>This process is called mineralization.</p>	<p>Enhanced mineralization is the process of scaling this approach through engineered methods and has the potential to sequester between 5 and 10 billion tons of CO₂ annually.¹⁷ Enhanced mineralization received minimal dedicated federal support to date, and more</p>	<p>funding will be essential to conduct R&D on the chemistry underlying these processes, as well as to assess the social and environmental impacts of integrating carbon removal with the mineral extraction industry and support key pilot studies.</p>
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Recommendation 4: Establish a carbon management authorization for the DOE Bioenergy Technologies Office.

DOE’s Bioenergy Technologies Office (BETO) is a critical asset for biomass carbon removal research. BETO is located within DOE’s Office of Energy Efficiency and Renewable Energy, alongside transportation and fuels programs, and has historically focused on liquid fuels and transportation applications. This framing limits how federal resources are deployed for biomass and understates its potential as a carbon removal feedstock. Unlike most of DOE’s other applied research offices, BETO did not get a

Boosting Research, Development, Demonstration, and Deployment

comprehensive authorization of its activities through the Energy Act of 2020. Congress should formalize BETO's role in carbon management through targeted authorization language that expands its mandate beyond transportation fuels and directs it to:

- Study the environmental, ecological, and public health and safety impacts of using biochar as a soil amendment.
- Expand research on algal systems as a durable carbon removal pathway.
- Fund pilots for biomass burial for purposes of carbon sequestration, carbon conversion processes using synthetic biology, small, modular conversion reactors capable of meeting material processing and air quality thresholds, and BiCRS facilities that demonstrate biomass capture and processing with geologic storage.
- Fund demonstration-scale conversion reactors capable of processing feedstocks from woody waste and cover crops.
- Synthesize existing research on the optimal use of sustainable biomass feedstocks across carbon removal applications and identify gaps requiring new analysis.

Recommendation 5: Initiate new research at DOE on strategies for removing short-lived climate pollutants.

While carbon dioxide is the largest driver of global climate change, several other gases emitted into the atmosphere as a result of human activity have a higher warming potential per unit volume: short-lived climate pollutants (SLCPs). SLCPs include methane, black carbon, hydrofluorocarbons, and tropospheric ozone. The highest volume of these is methane, also known as natural gas, which is currently the largest fuel source in the US electricity mix.

The Carbon Dioxide Removal Research and Development Act of 2023 (S. 2812/H.R. 5457) would direct federal agencies to support research on technology-based, land-based, and ocean-based approaches to remove carbon

dioxide from the atmosphere. This includes specific research provisions across solutions such as DAC, carbon mineralization, agroforestry, and perennial agriculture, forestry, and more.

The REMOVE Act of 2024 (H.R. 9212) would establish an interagency committee to develop a whole-of-government approach to CDR research, development, and deployment.

Boosting Research, Development, Demonstration, and Deployment

The US Department of Agriculture (USDA) has led decades of research and demonstration of methane capture in agricultural operations. The US Department of Energy, through investments in facilities like the Methane Emissions Technology Evaluation Center ([METEC](#)), has helped pioneer new technologies for monitoring and quantifying methane leaks. But there has been little dedicated research on the purposeful removal or conversion — outside of simple combustion — of methane and other SLCPs, whether directly from the atmosphere or from point sources where capture and reuse are technically or economically infeasible.



Building Out Infrastructure

Carbon removal cannot scale without the physical infrastructure to move and store CO₂, and infrastructure is the longest lead-time challenge.

The deployment of carbon removal technologies will require new infrastructure as well as the repurposing or rebuilding of legacy infrastructure. Yet key elements of this infrastructure remain underdeveloped or stalled. The US is uniquely positioned to be a global leader in CO₂ transport and storage, with abundant subsurface capacity, deep geologic expertise, and existing infrastructure. Developing robust and flexible carbon storage infrastructure can help ensure safe and permanent storage at the scale required to meet climate targets, while creating new economic opportunities across regions with geologic storage resources.

Recommendation 1: Increase funding and staffing at the Environmental Protection Agency (EPA) to improve the efficiency of Class VI permitting.

Geologic storage is a prerequisite for DAC and BiCRS projects to reach final investment decisions, and Class VI underground injection permits are necessary for storage. Yet, the EPA cannot keep up. As of May 2026, 200 Class VI wells are awaiting permit approval.¹⁸ Congress appropriated \$25 million between fiscal years 2022-2026 for the EPA to process Class VI applications.

While EPA targets a 24-month turnaround to process Class VI applications, actual timelines frequently stretch to three to five years, and EPA's Office of Inspector General found the agency is not on track to meet its 24-month goal portfolio-wide.¹⁹ Congress should increase annual appropriations for EPA's Class VI program above the current \$5 million per year baseline and fund the hiring and training of dedicated Class VI permit reviewers.

Class VI wells permanently store CO₂ in rocks deep underground and must adhere to stringent regulatory standards set for human and environmental health by the Environmental Protection Agency's Underground Injection Control Program. Paired with clear regulations that protect local resources, such as underground sources of drinking water, Class VI wells offer a viable opportunity for long-term carbon storage.

Recommendation 2: Reauthorize the Pipeline and Hazardous Materials Safety Administration (PHMSA) and finalize the CO₂ safety rulemaking announced in January 2025.

PHMSA's three-year authorization expired in September 2023. Congress should reauthorize PHMSA to ensure adequate staffing and resources are provided for its pipeline safety work. Furthermore, on January 15, 2025, PHMSA issued a Notice of Proposed Rulemaking to expand safety regulations to cover all phases of CO₂ transport. On January 20, 2025, the proposal was withdrawn by the current Administration before it could be published to the Federal Register. Congress, however, can establish standards and procedures for all phases of CO₂ transport, as proposed in the bipartisan PIPELINE Safety Act (S. 2975), which passed the Senate in April 2026 and now awaits a vote in the House. PHMSA should reissue the Notice of Proposed Rulemaking to expand safety regulations to all phases of CO₂ transport.

Recommendation 3: Expand CarbonSAFE to support additional storage characterization and validation for the development of carbon storage hubs.

DOE launched the Carbon Storage Assurance Facility Enterprise (CarbonSAFE) initiative in 2016 to perform site characterization, permitting, and construction of commercial-scale storage complexes.²⁰ To date, CarbonSAFE has favored regions where private industry is already active, and the economics of industrial-scale CO₂ are well understood. DOE should prioritize CarbonSAFE funding for conventional and basalt storage development in regions with high carbon removal potential but low industry engagement, where

Building Out Infrastructure

market incentives alone are unlikely to drive storage characterization in time to support projects in the 2030s.

A. Direct DOE to continue spending the available funds in the Infrastructure Investment and Jobs Act (IIJA) for the CarbonSAFE program.

The IIJA of 2021, Section 40305, expanded CarbonSAFE’s mission to include large-scale commercialization activities and provided an additional \$2.5 billion in appropriations. This allowed DOE to make awards for several dozen new projects in 2023 and 2024, but DOE has not made any new funding selections since late 2024, leaving at least half of the funding unobligated in 2026. Congress urged DOE to continue competing for these funds for CarbonSAFE in the DOE Appropriations bill report for FY2026: “The Department is directed to issue funding opportunities with remaining Public Law 117-58 funding for CarbonSAFE projects and to continue advancing through all four phases of CarbonSAFE”. Congress should continue its oversight of CarbonSAFE to ensure DOE continues to extend financial assistance in a timely manner.

Recommendation 4: Continue to administer CO₂ Transport Front-End Engineering Design (FEED) Studies.

The IIJA of 2021, Section 40303, authorized and funded a new DOE program to support planning for and analysis of regional-scale anthropogenic CO₂ pipeline projects.²¹ As of early 2026, roughly \$80 million of these funds remain unobligated. DOE should continue making funding outlays to projects already awarded and offer new funding opportunities to release the remaining funds, enabling further project planning.

Geologic storage, although not a carbon removal approach in and of itself, is an essential component of carbon removal systems, including direct air capture

and biomass carbon removal with storage. It involves injecting CO₂ into deep underground rock formations, where it is stored permanently.

USGS estimates the national geologic storage potential of accessible subsurface CO₂ at 3,000 metric gigatons.²²



Creating Durable Markets

While the voluntary market has been crucial in signaling early demand for carbon removal, it will not be enough to sustain the sector alone.

The growth of the carbon removal industry will depend on supportive public policy that creates a durable market of buyers. Without sufficient and enduring demand, developers cannot finance their projects and ultimately expand operations to lower the marginal cost per ton of removal and reach the scale commensurate with scientific recommendations.

Recommendation 1: Enact a federal purchasing program.

Public procurement is essential to crowding in private-sector buyers, diversifying demand, and creating market certainty for developers to raise capital. The federal government has, on a bipartisan basis, appropriated funding for CDR purchases at DOE over the past several fiscal years, most recently \$45 million in FY2026. The Carbon Removal and Emissions Storage Act (S. 1576) and the Carbon Dioxide Removal Leadership Act (H.R. 7054/S. 3615) would authorize CDR purchasing programs with specific evaluation guidelines and more ambitious volume targets, creating a durable source of demand for carbon removal.

Federal purchases should be evaluated against clear standards that account for additionality, net negativity, environmental health and safety, and accountability, with expectations of early and authentic community engagement. While federal purchasing alone cannot build a gigaton-scale industry, it can establish the credibility and standards that enable other markets to grow. Learn more on federal procurement in our report [*The Procurement Toolbox*](#).

Reader note: Recommendations 2,3,4 in this section focus on emissions mitigation/enabling infrastructure rather than CDR directly.

Recommendation 2: Enact a Carbon Border Adjustment Mechanism (CBAM) that incorporates carbon removal.

A CBAM is a border tariff on imports based on their carbon intensity, protecting US

manufacturers from unfair competition by raising the price of goods from countries with weaker environmental standards and creating an incentive to buy cleaner, domestic goods. There is bipartisan support for rewarding cleaner manufacturing and holding foreign companies accountable for pollution.

In 2025, both parties introduced bills proposing to establish a CBAM in the US. The Clean Competition Act (S. 3523) and the Foreign Pollution Fee Act (S. 1325) include carbon removal provisions that allow manufacturers to reduce the carbon intensity of their products through verified purchases of carbon removal credits from US developers or the integration of carbon removal within their processes. These policies would drive demand for carbon removal, support global industrial decarbonization, and lay the groundwork for domestic carbon removal regulations.

Recommendation 3: Enact a regulatory policy that creates a pool of buyers from heavy industry.

Contingent on the enactment of a CBAM to insulate domestic manufacturers from unfair foreign competition, the US can expand and diversify the pool of carbon removal buyers by establishing a CDR purchase mandate. In its simplest form, such a policy would incentivize heavy industrial manufacturers to invest in decarbonizing their operations and to offset residual emissions above a set threshold through a combination of CDR purchases and fees to be reinvested in federal industrial decarbonization programs.

Narrowing the list of covered products to a subset of industrial goods keeps costs from showing up at gas stations or on home heating bills, limiting the potential for political blowback while providing a powerful and needed incentive for the industrial sector to decarbonize.²³

Recommendation 4: Expand the 45X Advanced Manufacturing Production Tax Credit to include carbon removal equipment.

Established in 2022, the 45X Advanced Manufacturing Production Credit reimburses up to 10% of project costs for domestic manufacturing and sale of specific energy technologies.²⁴ Congress could consider adding carbon capture equipment, such as modular units and sorbent systems suitable for DAC or BiCRS retrofits. Because the carbon removal sector

is still small, the cost of this expansion from 2026 to 2032 would be modest. Access to 45X would help commercialize US-designed technologies and enable more companies to enter the market.

Recommendation 5: Create an investment tax credit for carbon removal projects.

The 45Q tax credit, expanded by the Inflation Reduction Act of 2022 and the One Big Beautiful Bill Act (OBBBA) of 2025, has been among the most valuable drivers of US carbon removal growth.²⁵ Canada has already established an ITC for carbon capture projects, creating a competitive incentive that risks drawing investment away from the US.²⁶ Congress can build on 45Q by creating a 40% investment tax credit (ITC) for both non-enhanced oil recovery applications of DAC and ancillary CO₂ transport and storage infrastructure.

To qualify, projects must meet prevailing wages. Consistent with how several other energy-related tax credits are structured, an ITC for carbon removal credit should phase down over time as the industry scales. An ITC would reduce upfront capital requirements and improve project economics for project developers by lowering the financial barriers that prevent early-stage carbon removal projects from reaching a final investment decision.

Recommendation 6: Adopt federal clean procurement standards.

The federal government is the largest single purchaser of building construction materials in the US and can leverage its purchasing power to create demand for low-carbon cement, steel, and mass timber — materials that carbon removal pathways can help produce. The

The bipartisan **Carbon Dioxide Removal Investment Act (S.5369)** would establish a new production tax credit supportive of ready-to-

deploy carbon removal technologies. This credit is technology-neutral, allowing more technologies than just direct air capture to be

eligible and thus advancing a portfolio of technologies, balancing well-established technologies with those still in the development phase.

Creating Durable Markets

Inflation Reduction Act included roughly \$5 billion across several federal agencies to procure low-carbon building materials and improve embodied carbon calculations and labeling. Future policy can build on this work and require federally funded construction projects across all agencies to use materials that meet minimum greenhouse gas (GHG) standards, as well as incorporate versions of existing state-level procurement policies that can provide commercial pathways for carbon removal, such as the Low-Embodied Carbon Concrete Leadership Act in New York and New Jersey.

Read more about our recommendations related to procurement, CBAM, and CDR purchase mandate in our recent memo, [**The Demand Triangle: Policies to Grow Carbon Dioxide Removal.**](#)



Strengthening Standards and MMRV

Carbon removal projects and associated credits are rapidly moving from theory to practice, both in voluntary markets and limited federal procurement.

High-quality MMRV standards are essential to ensure projects deliver real benefits and maintain market credibility. Without strong MMRV, carbon removals and reductions become indistinguishable, and investments become risky. MMRV can support the credibility, climate impact, and safety of projects, enabling trust in these solutions.

As the evidence base for individual CDR pathways continues to evolve, it is equally important to establish a durable mechanism for ongoing public input to ensure responsible development of the carbon removal industry. The federal government is well-positioned to help bolster and enforce universal standards for the carbon removal field.

Recommendation 1: Invest in MMRV R&D.

In 2023, the DOE Office of Technology Transitions and the Office of Fossil Energy and Carbon Management distributed \$15 million across several national labs to advance carbon removal MMRV research and standardization.²⁷ Congress has directed DOE to continue these efforts, appropriating \$4 million in the fiscal year 2026 budget. Congress should increase this investment to at least \$10 million annually to improve the science underlying MMRV protocols and enable inter-pathway comparisons, unlocking potential growth across enhanced mineralization, biomass carbon removal, and certain marine carbon removal technologies.

Recommendation 2: Establish an interagency task force to evaluate and certify MMRV protocols.

The National Institute of Standards and Technology (NIST) established the Carbon Dioxide Removal Consortium in 2024 to convene CDR researchers, buyers, and practitioners to develop fit-for-purpose standards across carbon removal pathways.²⁸ While consortium efforts have advanced our scientific understanding of atmospheric measurement, the

government can play a more proactive role in commercial application by accrediting pathway-specific MMRV standards. CIUA proposes to codify a federal role in standards development by authorizing an interagency task force led by DOE, in coordination with NIST, national labs, and other relevant agencies. The task force, with input from civil society experts, would continually evaluate and certify pathway-specific MMRV protocols from third-party providers. The task force should integrate co-considerations into its evaluations, including environmental and public health considerations, enabling policymakers, purchasers, and the public to differentiate among pathways based on technical performance as well as on environmental, social, and community-level impacts. MMRV certifications should be publicly available in accessible, plain language formats.

Recommendation 3: Establish a federal advisory committee on responsible carbon removal deployment.

As federal carbon removal investment expands, the standards governing project development and procurement must incorporate the perspectives of communities most affected. Large infrastructure projects that exclude affected communities from early decisions face more litigation, longer timelines, and greater opposition. The costs of late engagement are paid in dollars and in public trust.

DOE should charter a Federal Advisory Committee Act (FACA) committee to develop guidelines for responsible carbon removal deployment, including topics such as public safety, environmental stewardship, accountability, workforce development, cumulative impact analyses, and the use of community agreements in carbon removal project development. USDA, Department of Commerce (DOC), Department of Interior (DOI), and the EPA should participate through memorandums of understanding with defined roles. The committee's recommendations should be published in publicly accessible, plain language formats and the committee should include representatives from affected communities, community-based organizations, Tribes, state and local governments, project developers, scientists, and civil society. To ensure meaningful participation and effective implementation, Congress should appropriate at least \$3 million annually to fund dedicated DOE staff, technical assistance, and other relevant activities.

Recommendation 4: Condition federal CDR procurement on adherence to the standards certified by the interagency MMRV task force and federal advisory committee.

DOE should condition its carbon removal purchases on the guidance developed or approved by the interagency MMRV task force and federal advisory committee described above. Requirements could begin with the DOE CDR Purchase Prize and extend to broader federal purchasing authority as it develops. This approach would harness federal purchasing power to drive meaningful deployment, ensuring that publicly funded CDR reduces carbon pollution and delivers tangible opportunities.

Section Three:

Conclusion

Conclusion

The US leads on technology-based carbon removal today, and it must retain that lead. The most urgent priority is the execution and implementation of the carbon removal programs at DOE.

But DOE cannot do this alone. USDA, DOC, DOI, EPA, and other agencies will each play critical roles in the enabling conditions addressed by this roadmap, requiring coordinated action across agencies. More than \$5 billion in previously appropriated carbon removal funding remains unobligated or unspent, and the policy, infrastructure, and market systems needed for scale are still catching up to the pace of technology development.

The recommendations in this roadmap draw on existing authority, unspent appropriations, and targeted legislative reforms to advance the four enabling conditions that must move together: robust RDD&D, enabling infrastructure, durable demand, and high-accountability standards. No single technology or policy lever will be sufficient; progress will require a coordinated portfolio approach to reach our interim goal of 30 megatons per year by 2030 and beyond. The choices we make in the next few years will shape the trajectory of the carbon removal sector and the climate at large.

Carbon180 is committed to supporting policymakers in this work by offering durable coalition-building, direct congressional engagement, assistance to agencies, and public education.

Contact us at tech@carbon180.org to learn more and join this work.

Appendix A

History of Carbon Removal Funding and Programs at DOE

The Energy Act of 2020 established the first-ever program for carbon removal at the Department of Energy and authorized the following activities through 2025:

1. RD&D for various carbon removal pathways
2. A DAC prize competition
3. One or more Direct Air Capture Test Center(s)
4. Pilot and Demonstration Projects
5. Direction to coordinate with the Environmental Protection Agency on accounting frameworks and monitoring, reporting, and verification for carbon removal and sequestration

Below are brief summaries of what is included in the current law and the associated funding.

The Carbon Removal RD&D Program

Authorized by the Energy Act of 2020 and established in 2022, the Carbon Dioxide Removal Program was formally established to test, validate, or improve technologies and strategies to remove carbon dioxide from the atmosphere on a large scale. The program's scope covers direct air capture, bioenergy with carbon capture and storage, enhanced weathering, agricultural practices, forest management and afforestation, and planned or managed carbon sinks, including natural and artificial. The program has received annual appropriations from Congress since its creation.

Table 1: Energy & Water Appropriations for the Carbon Removal RD&D Program

Program Area	FY2022	FY2023	FY2024	FY2025	FY2026
Carbon Removal R&D at DOE	\$104M	\$140M	\$118M	\$118M	\$71.5M

Appendix A

The Precommercial & Commercial DAC Technology Prize Competitions

Through the bipartisan IIJA, Congress provided DOE with \$115 million for a suite of DAC Prizes to accelerate carbon removal. Split into pre-commercial (\$15 million) and commercial tracks (\$100 million). In 2023 and 2024, DOE made selections totaling approximately \$40 million of the combined \$115 million allocated to DAC Prizes. The FY2026 Energy & Water spending agreement reprograms \$1.04 billion from IIJA Section 40308 (Regional DAC Hubs) and 41005 (DAC Prize Competitions). Assuming that DOE draws those reprogrammed dollars from the Regional DAC Hubs program, roughly \$73,331,100 remain for both the pre-commercial and commercial prizes.

The National Direct Air Capture Test Center

The Energy Act of 2020 authorized DOE to make grants to operate one or more test centers for innovative DAC and storage technologies. In FY2022, Congress appropriated \$25 million for this purpose, and in early 2023, DOE funded the National Energy Technology Laboratory to establish its Direct Air Capture Test Center. The NETL DAC Center, housed at the Lab's Pittsburgh campus, supports technology maturation by testing technologies that have achieved proof of concept but have not reached pilot scale to expedite development and de-risk scale-up.

The Regional Direct Air Capture Hubs Program

Through the bipartisan IIJA, Congress provided DOE with \$3.5 billion over five years (2022-2026) to finance the development of four DAC Hubs across the US. To be eligible, a hub must have the capacity to capture at least 1 million metric tons of CO₂ annually upon completion, and must be able to store CO₂ permanently in geologic formations and/or convert the CO₂ into products or commodities. In August 2023, DOE awarded two commercial-scale DAC Hubs under this program, for \$550 million and \$500 million, respectively, and 19 FEED and design studies, totaling \$99 million. As of January 2025, about \$2.3 billion of funds remained available for obligation for the DAC Hubs. In the FY2026 Budget Agreement, \$1.05 billion of the DAC Hubs funding was reprogrammed to fund other Departmental priorities. Accordingly, an additional \$1.3 billion remains uncommitted and available for expenditure under the DAC Hubs program.

Appendix A

Table 2: DOE Carbon Management Programs in IIJA¹

Program	Total Funding	Funding Committed to Financial Assistance ²	Reprogrammed (FY2026)	Estimated Remaining Funding ³
Carbon Utilization Procurement + Research	\$310.14M	Unknown	\$0	\$290M
CO ₂ Transport FEED Studies	\$100M	\$17M	\$0	\$80M
CO ₂ Transportation Infrastructure Finance and Innovation (CIFIA)	\$2.1B ⁴	\$0	\$1.5B	\$590M ⁵
Carbon Storage Validation and Testing (CarbonSAFE)	\$2.5B	\$1.044B	\$0	\$1.35B
Regional Direct Air Capture Hubs	\$3.5B	\$1.15B	\$1.04B	~\$1.4B (combined)
Precommercial DAC Technology Prize Competition	\$15M	\$1.2M		
Commercial DAC Technology Prize Competitions	\$100M	~\$40M		
Carbon Capture Large-Scale Pilots	\$937M	\$300M	\$950M	~\$1.3B (combined)
Carbon Capture Demonstrations	\$2.537B	\$890M		
Total, Carbon Management	\$12.099B	~\$3.7B	\$3.49B	~\$5B

¹ This table reflects the carbon management programs in IIJA representing a portfolio of technologies that include carbon removal, not exclusively carbon removal.

² This table reflects funding commitments from the Department to grantees. The figures for dollars obligated would be significantly lower, because for certain large awards, including the DAC Hubs, the Office of Clean Energy Demonstrations (OCED) chose to obligate funds in stages, even after the awards had been definitized. These figures also ignore the grant cancellations DOE announced in 2025, as none of these funds for Carbon Management have been deobligated, as of March 19, 2026.

³ This column reflects simply the total appropriation, minus any financial assistance selections announced and any rescission of funding Congress. Actual totals will vary as program costs include DOE administration expenses.

⁴ CIFIA is a loan program. Funds will revolve back into the program as offsetting collections if DOE issues a successful loan.

⁵ DOE has not yet issued any loans under CIFIA.

Appendix B

Acronyms

BiCRS: Biomass Carbon Removal and Storage

BETO: Bioenergy Technologies Office, Department of Energy

CarbonSAFE: Carbon Storage Assurance Facility Enterprise

CBAM: Carbon Border Adjustment Mechanism

CDR: Carbon Dioxide Removal

CIUA: Carbon Innovation and Utilization Act

CO₂: Carbon Dioxide

DAC: Direct Air Capture

DAC Hubs: Direct Air Capture Hubs

DOE: Department of Energy

DOI: Department of Interior

DOT: Department of Transportation

EPA: Environmental Protection Agency

FACA: Federal Advisory Committee Act

FEED Study: Front-End Engineering Design Study

FY: Fiscal Year

GHG: Greenhouse Gas

HVAC: Heating, Ventilation, and Air Conditioning

IIJA: Infrastructure Investment and Jobs Act

ITC: Investment Tax Credit

METEC: Methane Emissions Technology Evaluation Center

mCDR: Marine Carbon Dioxide Removal

MMRV: Measurement, Monitoring, Reporting, and Verification

NIST: National Institute of Standards and Technology

OBBBA: One Big Beautiful Bill Act

OTA: Other Transactional Authority

Appendix B

Acronyms

PHMSA: Pipeline and Hazardous Materials Safety Administration

RDD&D: Research, Development, Deployment, and Demonstration

R&D: Research and Development

SLCPs: Short-Lived Climate Pollutants

USDA: US Department of Agriculture

USGS: US Geological Survey, Department of the Interior

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