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Carbon Management Overview at DOE Sarah M. Forbes

DEPUTY DIRECTOR FOR CARBON MANAGEMENT TECHNOLOGIES OFFICE OF FOSSIL ENERGY AND CARBON MANAGEMENT





Carbon management technology...





...works and is essential for meeting climate goals.

...is ready for commercial liftoff in the U.S. after recent policy advances.

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...requires more policy, private investment, and international collaboration to unlock its full potential.



Fossil Energy and Carbon Management Intro

EXECUTIVE SUMMARY

Figure 1 | Energy consumption and net exports (quadrillion B1U) and related GHG emissions (GHCO,e, GWP-100), associated with coal, eil and natural gas.

Major U.S. Consumption and Net Export Sources and Related Emissions (2020)



 Heat (commercial, residential) = Heat (industrial) = Industry (non-heat) = Transportation = Electric Power Supply Chain = Egentric Additional information supply chain emissione essociated with coal, natural gas and oil production. Both quantification and indistation of these appressions is and FECM product

VI L STRATEGIC VISION

EXECUTIVE SUMMARY

The Office of Fossil Energy and Carbon Management's (FECM) core mission is to address the climate crisis. Addressing climate change is more urgent than ever before. In 2020, global fossil CO, emissions were approximately 35 gigatonnes of CO₃ (GtCO₃), led by emissions from China (11 GtCO₂) and the United States (5 GtCO,) (Ritchie & Roser, 2020) (Union of Concerned Scientists, 2018). Historical emissions, at 420 GtCO2 for the United States and 240 GtCO, for China, tell a different story - as do emissions per capita (United States, 14 tonnes of CO,/person in 2020; China, 7 tonnes of CO,/person in 2020) (Global Carbon Budget, 2021). Emissions of all GHGs, including methane, are higher than ever before. Nations like the United States that have significant legacy and ongoing responsibility for emissions have a particular leadership obligation for addressing the climate crisis, which is expected to affect people who have often contributed very little to emissions but are highly vulnerable to climate change first and worst. For instance, 2020 per capita emissions for Kenya are approximately 0.3 tonnes of CO2 per person, and 2018 droughts

approximating to connex to Co₂ Le Jesion, interactive dougoist left more than a million people at the deglo of finanic Fillar, where per capita emissions in 2020 were also roughly 0.3 tourses of CO₄ per persone, its among the most elimiter-valurable countries in Latin America, subject to hurricates, storm surges and flooding made worse by elimate change. CHG emissions have then dramatically over the past several

decades, driven by fossil fied use and adding to the existing GHG pool in the atmosphere. In accordance with the Paris Agerement and climate data, it is critical to take aggressive action tody to limit global scarming to well below 27C and prefrashly below 15°C – a target that will hady require net-zeros, then net negative GHG emissions starting around mid-century (IPCC, 2021). Continued support for zero and low-carbon technologies that help the phaseous of foul field use and deployment of CDR methods must be prioritized demestically and globally to meet our net-zero goals.

Through Executive Order 14008, Tackling the Climate Crisis at Home and Abroad, President Biden set a goal to "lead a clean energy revolution that achieves a carbon pollutionfree power sector by 2035 and puts the United States on an intercentible path to a net-zero economy by 2030' (Federal Register, 2021). Further, President Biden set an interim target for the United States to au carbon emissions in half by 2030 compared to 2005 levels while addressing current and historical environmental injustice, including in commanities megatively impacted by fossil fact use and elimate change. At the same time, the United States will "accretice in the ladership internationality to promose a significant interease in global elimate ambition" in meeting the overarching elimate objectives of the Paris Agreement. Previsioner Bidden also set a goal to "vienimate fossil fact subsidies from the budget rouses for Fiscal Year 2022 and thereafter," financially aligning the federal budget toward low GHG emissions with a elimate-realitent

U.S. dependence on fossil fuels and other sources of GHG emissions spans sectors like power generation, industry, heat and transportation fuels. Figure 1 shows the breakdown of U.S. energy dependence on coal, oil and natural gas (quadrillion British thermal units (BTU)) alongside the breakdown of GHG emission per sector (COze), assuming a global warming potential over 100 years (GWP-100) of 100 for methane). In 2020, approximately 40 percent and 19 percent of the U.S. power generation was sourced from natural gas and coal, respectively (EIA, 2021a). In the same year, petroleum provided for approximately 90 percent of the transportation sector's energy consumption (EIA, 2021b). The largest share of the U.S.' CO, emissions footprint is associated with transportation. Industrial heat from natural gas also contributes significantly to emissions. When combined with industrial process emissions in some sectors (e.g., cement), these streams become more concentrated in CO,, making emissions easier and less expensive to capture compared to more dilute sources. Natural gas, oil and coal supply chains also include emissions of methane, a powerful GHG that is the primary component of natural gas. Although the U.S. Environmental Protection Agency (EPA) has estimates of these methane emissions, as shown in Figure 1, official estimates are widely understood to be too low, in some cases substantially (Alvarez et al., 2018).

STRATEGIC VISION | V

- Two areas of focus:
 - Carbon management
 - Resource sustainability
- Office of Carbon Management:
 - ~\$450M annual budget
 - TRL 3-5 grant funding:
 - Engineering studies
 - Benchtop research
 - Small pilots and demos

Source: FECM 2022 Strategic Vision



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Fossil Energy and Carbon Management







Scaling carbon management is a Biden Administration climate priority.

User Clip: POTUS on CMC POTUS on CMC





Carbon management is a key component for meeting net-zero economy-wide climate goals.





...a bridge for industrial decarbonization:





...a more reliable, low-cost power grid:





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…negative emissions for offsets and legacy carbon emissions cleanup:





DOE is confident carbon management is technically feasible.



Industry has decades of experience with capture.



Global Status of CCS 2022 - Global CCS Institute



Some capture applications are already low-cost.



Fossil Energy and

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CO₂ storage in dedicated storage wells is proven at the Mt/year scale.





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Fossil Energy and Carbon Management

The U.S. is poised for commercial liftoff.



Pathways to Commercial Liftoff: Carbon Management

Pathways to Commercial Liftoff: Carbon Management (energy.gov)



U.S. policy enables full range of projects.

Policy Lever

Expected

Project

Impacts

Updated 45Q tax credits (Inflation Reduction Act)

High concentration

point sources near

pipelines and/or storage

Pilot and demo funding (*Bipartisan Infrastructure Law* + *Inflation Reduction Act*)

Lower concentration point sources, especially early-of-a-kind projects Carbon credits + Buy Clean (voluntary corporate + state/ local governments)

Early demonstrations for carbon dioxide removal and conversion techniques



300M+ tons of CO₂ storage is economic by 2035.



Optimized CO₂ transport and storage network deployment modeling from the Great Plains Institute finds that, under 45Q, a shared, interconnected CO₂ transport and storage system could capture, transport and store 300 million metric tons of CO₂ per year by 2035 from industrial facilities and power plants.



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Numerous projects announced, but few online



U.S. DEPARTMENT OF

100M+ t/y capacity by 2030 announced

U.S. point source CCUS capture capacity by year, MTPA



1 Includes those expected to have commissioning in 2022 Source: Bloomberg New Energy Finance, "2022 CCUS Market Outlook"

Figure 5: The U.S. has over 20 MTPA of operational point source CCUS capacity, with an announced project pipeline of ~140 MTPA as of Dec 2022



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DOE supporting liftoff across offices



Carbon Negative Shot sets innovation grand challenge



Carbon Negative Shot activities across DOE





FECM FEEDs and Pre-FEEDs... Overall Portfolio



CarbonSAFE Project Locations



All-of-Government Support for Carbon Management







Regulations Applicable to Carbon Capture, Transport, and Storage Projects



Carbon Capture

 Clean Air Act
 Prevention of Significant Deterioration New Source Review



Carbon Transport

Hazardous Liquid Pipeline Act - Rights of Way

Carbon Storage

Clean Water Act
 Federal Land Policy and Management Act
 Marine Protection Research Sanctuaries

 Mineral Leasing Act
 National Forest Management Act
 Outer Continental Shelf Lands Act

Underground Injection Control Program

Regulations that Apply Across Carbon Capture, Transport, and Storage

- Coastal Zone Management Act Comprehensive Environmental Response Compensation and Liability Act

Endangered Species Act

 Emergency Planning and Community Right-to-Know Act
 Magnuson-Stevens Fishery Conservation and Management Act

- National Environmental Policy Act
- National Historic Preservation Act
- National Pollutant Discharge Elimination System
 - Rivers and Harbors Act of 1899

Social and environmental impacts essential for project success



Includes community, workforce, and environmental criteria in funding opportunities (up to 20% on major demos)



Community and stakeholder engagement activities



Require monitoring and data collection including non-CO $_2$ emissions and water usage impacts



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What is included in successful Community Benefits Plans?

Setting engagement goals

Set internal goals for stakeholder and community engagement, as well as discuss what goals stakeholders and communities have for the engagement process.

Choosing methods of engagement and building a timeline

Identify when engagement is expected to occur in the project timeline and what type of engagement is planned.

Defining resources required to implement plan

Define the scope, schedule, personnel, and budget to enact the plan, as well as key community partners.

Crafting SMART milestones

Include Specific, Measurable, Achievable, Relevant, and Time-bound (SMART) milestones.





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\$100Bs in finance required





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Further policy required to unlock investment

2023 Policy Blueprint Recommendations



Source: Carbon Capture Coalition, 2023 US Federal Policy Blueprint



US International Engagement Priorities

Bilateral:

- R&D complementarities: Canada, Norway, Japan, U.K., Australia, UAE, KSA, and more
- *Enabling activities:* Kenya, Nigeria, Mozambique, Brazil, India, Malaysia, and more

Multilateral:

- Information sharing and catalyzing actions: Clean Energy Ministerial CCUS Initiative, Mission Innovation CDR mission, CDR Launchpad, G7, G20, IEA GHG Programme, and more
- R&D collaborations: Accelerating CCUS Technologies (ACT) and Clean Energy Transition Partnership (CETP)
- Finance: Development banks



Demonstrations and Large- Scale Pilots

Carbon Capture



Demonstration Projects: Develop six carbon capture facilities to improve costs, emissions reductions, and environmental effects from coal and natural gas

Carbon Capture Large-

Scale Pilot Projects: Establish and
test innovative carbon capture pilot
projects large enough to support
new processes and technology improv
ements at scale

This summer, Office of Clean Energy Demonstrations will review applications for large-scale carbon capture pilots and demos.

- •Demos selection notifications expected August 2023
- •Pilots selection notifications expected September 2023
- •Award negotiations expected fall 2023
- •Learn more: <u>www.energy.gov/oced/carbon-management-0</u>



Regional Direct Air Capture Hubs Program

\$1.2 billion in funding available to begin to conceptualize, design, plan, construct, and operate direct air capture hubs

Part of larger \$3.5 billion effort to develop four domestic regional direct air capture hubs with potential to capture and permanently store or use 1 million+ metric tons of CO2 annually

Email: <u>OCED@hq.doe.gov</u> Website: <u>energy.gov/oced/DACHubs</u>

Funding Opportunity Announcement issued	December 13, 2022
Full applications submitted	March 13, 2023
Pre-selection interviews	Summer 2023
Expected date for DOE selection notifications	June 30, 2023
Expected timeframe for award negotiations	November 30, 2023



Open Funding Opportunity Announcements

Announcement Title	Est. Total Federal Funding	Close Date
Direct Air Capture Pre-Commercial Technology Prize	\$3.2M	9/26/23
Carbon Management	\$45.5M	7/18/23
Carbon Storage Validation and Testing	\$2.25B	7/6/23
Direct Air Capture Pre-Commercial EPIC Prize	\$3.7M	6/22/23
Carbon Capture Large-Scale Pilot Projects	\$820M	6/21/23







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Thank You!

Questions?

Contact Sarah Forbes, Deputy Director for Carbon Management Technologies: Sarah.Forbes@hq.doe.gov

FECM's Office of Carbon Management

Focused on minimizing the environmental and climate impacts of fossil fuels and industrial processes, while working to achieve net-zero GHG across our economy

The Office of Carbon Management Technologies

Leads and invests in research, development, demonstration, and deployment across five divisions...

The Office of Strategic Planning, Analysis, and Engagement

Leads in strategic activities and international, domestic, and intergovernmental coordination across two divisions...

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Systems, Economic, and Environmental Analysis

Strategic Engagement

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