U.S. Carbon Management Strategy

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1. Introduction

The title describes a DOE document I came across recently. Since I have presented other viewpoints on this subject, I decided that I needed to summarize the title document, which is referenced below.[1]

The U.S. Department of Energy's (DOE's) Carbon Management Strategy ("Strategy") provides a comprehensive roadmap for the remainder of the decade that outlines the diverse tools and approaches DOE will use to develop and deploy carbon management solutions in line with President Biden's climate, economic, and social priorities. Carbon management—an umbrella term that encompasses the suite of technologies used for capturing, transporting, converting, and storing carbon dioxide (CO_2), as well as removing it directly from the atmosphere—is a critical component of the DOE's climate change mitigation strategy.

The United States will need to rapidly deploy carbon management in the near-term to achieve net-zero greenhouse gas emissions in the power sector by 2035 and economy-wide by 2050. Concurrently, President Biden has directed agencies to implement carbon management policies responsibly so that they deliver clear benefits to communities and workers and provide robust environmental protections. DOE is focusing on implementing near-term programmatic activities that lay the groundwork for scaling carbon management in the future in alignment with these overarching policy goals.

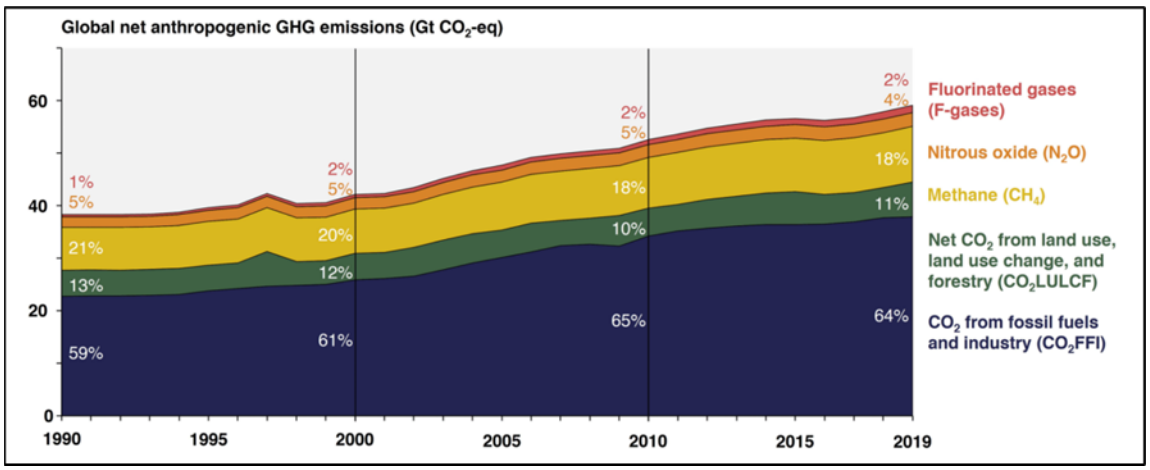
The Strategy is focused on near-term actions that can position carbon management to scale as needed in subsequent decades. DOE's near-term strategy through 2030 incorporates the following five components:

1. *Focusing research, development, demonstration, and deployment funding on priority use cases;*
2. *Building out CO_2 transportation and storage infrastructure where it likely will be needed most in the future;*
3. *Supporting the implementation of effective and evidence-driven policies and regulations related to carbon management at other federal agencies;*
4. *Engaging communities and workers to ensure projects deliver benefits and mitigate potential risks to public health and the environment; and*
5. *Supporting climate diplomacy efforts to accelerate the adoption of carbon management at scale globally in a way that aligns with the Paris Agreement.*

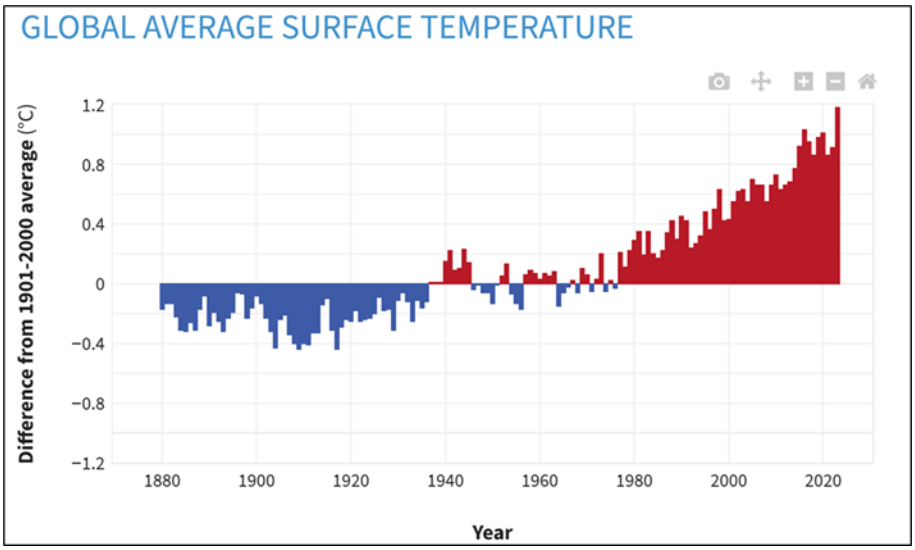
[1] The Author-Agencies that contributed to this document start on page 72, U.S. Department of Energy, "Carbon Management Strategy," October 2024, https://www.energy.gov/sites/default/files/2024-10/Carbon%20Management%20Strategy_10.10.24_0.pdf

Interwoven across all five of these components are a set of analysis and communications activities designed to provide insights into carbon management technologies that help inform investments in the field. Public/private partnerships, especially in the form of cost-share requirements for funding applicants, are central to this Strategy. DOE's analysis work is designed to catalyze private investment in the field and forms the foundation for partnerships with other governments and civil society organizations to ensure that carbon management projects can be effectively regulated and deliver benefits to communities and the workforce…

Author's comment: I have decided to include the two charts below (the first from an earlier post). Although I normally don't revisit figures in papers. I have recently encountered some climate change deniers, and Mr. Trump is now the President Elect, and he also denies that climate change is real. The two charts below, from reputable sources, disagree with all of the above.



Source: Data from IPCC (2022); Based on global emissions from 2019, details on the sectors and individual contributing sources can be found in the Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change, Mitigation of Climate Change, Chapter 2.



Above chart shows early surface temperature from 1880–2023 compared to the 20th-century average (1901-2000). Blue bars indicate cooler-than-average years; red bars show warmer-than-average years. NOAA Climate.gov graph.

1.1. History

Carbon management technologies initially emerged within the oil and gas sector, primarily for production purposes rather than as a climate solution. Early operations in the oil and gas sector proved that carbon capture, transport, and permanent storage could be deployed at scale. Since 1991, DOE has been investing in research and development activities to advance carbon management technologies primarily as a tool to reduce CO_2 emissions.

Successful demonstrations have confirmed that that carbon management can provide a valuable component in the broader climate solutions toolkit. Currently, 18 commercial-scale carbon capture, conversion, and storage projects across a range of industrial and power emissions sources are in operation in the United States, with approximately 50 million metric tons per year (Mt/y) of capture capacity online around the world.

However, the pace of development and deployment for carbon management technologies as a climate solution has lagged significantly behind other emission reduction technologies like renewable energy and electric vehicles, primarily due to a lack of policy support for large-scale deployment. According to the International Energy Agency 2023 "Tracking Clean Energy Progress Report,"[2] carbon management remains "not on track" to meet the Agency's net-zero emissions scenario by 2050.

In addition, some legacy industry infrastructure has led to cumulative pollution burdens with direct health impacts on communities, leading to a lack of trust for carbon management infrastructure as a climate tool in some communities. In response, DOE is prioritizing responsible deployment of carbon management projects with bilateral community engagement and transparency, environmental stewardship, and minimizing health and safety risks while maximizing benefits for communities.

Analyses of decarbonization scenarios are clear—carbon management technologies are essential to achieving net-zero greenhouse gas emissions by mid-century. These technologies contribute meaningfully to nearly all of the Intergovernmental Panel on Climate Change's 1.5°C aligned climate scenarios and are critical to the U.S. Long-Term Strategy, which aims to achieve net-zero emissions by 2050. In particular, most analyses show the necessary role carbon management has in removing historical emissions and addressing residual emissions from the hardest-to-abate emission sources.

Over the past few years, the U.S. policy framework for carbon management has advanced significantly. The passage of the Infrastructure Investment and Jobs Act (IIJA), commonly referred to as the Bipartisan Infrastructure Law (BIL) in 2021 provided over $12 billion in funding for carbon management projects.

[2] The International Energy Agency (IEA). "Tracking Clean Energy Progress 2023," July 2023, https://www.iea.org/reports/tracking-clean-energy-progress-2023

Furthermore, in 2022, the Inflation Reduction Act (IRA) reformed the 45Q tax credit to include a significant increase in the value of the incentive for various carbon management activities in the United States. These incentives, alongside the established regulations for geologic storage of CO_2, make the United States one of the most attractive investment environments for carbon management projects globally.

In April 2023, DOE published its Carbon Management Liftoff Report to provide an initial perspective on how and when carbon management technologies could reach full commercial potential in the way they were first envisioned back in 1991—as interconnected industrial systems designed primarily to reduce CO_2 emissions from large emitters to residual levels and to enable large-scale removal of CO_2 from the atmosphere. This Strategy builds on the analysis as identified in the Carbon Management Liftoff Report to outline the approach and specific actions DOE is pursuing to accelerate the deployment of carbon management as a climate solution, including its deployment of over $12 billion in Bipartisan Infrastructure Law investments Congress provided for carbon management.

2. Scope

Carbon management is an umbrella term that encompasses carbon capture (from industry and power generation), transport, conversion, and storage, hydrogen with carbon management, and carbon dioxide removal, all aimed at climate mitigation. This document focuses on a subset of carbon management solutions including:

- *CO_2 capture, both from exhaust of stationary emissions sources (e.g., power plants and industrial facilities), and directly from the atmosphere using technologies such as direct air capture;*
- *CO_2 transportation, via pipelines and other transportation modes such as trucks, trains, barges, and ships;*
- *CO_2 conversion into value-added products such as building materials, fuels, and chemicals; and*
- *Geologic CO_2 storage in deep underground rock formations.*

While this Strategy discusses the intersection of biomass energy and point-source carbon capture, it does not provide a comprehensive strategy for biomass energy and products where those systems are not coupled to point-source carbon capture. In addition, this Strategy discusses some carbon dioxide removal strategies, such as direct air capture and storage and biomass carbon dioxide removal, but it does not present a comprehensive strategy for carbon dioxide removal. More comprehensive strategies for biomass and for carbon dioxide removal are available in other DOE documents. Additionally, DOE defines "carbon management" differently from the more colloquial use of the term to describe the exercise of calculating, tracking, and reducing an organization's "carbon footprint."

Author's comment: The table below is part of reference 1 document, but there was no introductory text. It seems useful, so I am including it.

Figure 2: Operational U.S. carbon capture capacity as of March 2024[26]

Project	Operational Date	State	Industry	Capture Rate (Mt/y)	Capture Type	Storage Type
Occidental Terrell	1972	Texas	Natural Gas Processing	0.5	Industrial Separation	Enhanced Oil Recovery
Enid Fertilizer	1982	Oklahoma	Hydrogen / Ammonia / Fertilizer	0.2	Pre-Combustion Capture (Natural Gas Processing)	Enhanced Oil Recovery
ExxonMobil Labarge Shute Creek Gas	1986	Wyoming	Natural Gas Processing	7	Industrial Separation	Enhanced Oil Recovery
Great Plains Synfuels Plant and Weyburn-Midale	2000	North Dakota	Hydrogen / Ammonia / Fertilizer	3	Pre-Combustion Capture (Gasification)	Enhanced Oil Recovery
Core Energy CO_2-Enhanced Oil Recovery South Chester Plant	2003	Michigan	Natural Gas Processing	0.35	Industrial Separation	Enhanced Oil Recovery
Arkalon CO_2 Compression Facility	2009	Kansas	Ethanol	0.5	Inherent Capture	Enhanced Oil Recovery
Longfellow WTO Century Plant	2010	Texas	Natural Gas Processing	5 (Design capacity exceeding 8 Mt/yr, but historical operations have been much lower (<1 Mt/yr))	Industrial Separation	Enhanced Oil Recovery
Gary Climate Solutions Bonanza BioEnergy	2012	Kansas	Ethanol	0.1	Inherent Capture	Enhanced Oil Recovery
PCS Nitrogen Geismar Plant	2013	Louisiana	Hydrogen / Ammonia / Fertilizer	0.3	Pre-Combustion Capture (Gasification)	Enhanced Oil Recovery
Contango Lost Cabin Gas Plant	2013	Wyoming	Natural Gas Processing	0.9	Industrial Separation	Enhanced Oil Recovery
Air Products and Chemicals Valero Port Arthur Refinery	2013	Texas	Hydrogen / Ammonia / Fertilizer	0.9	Pre-Combustion Capture (Natural Gas Processing)	Enhanced Oil Recovery
Coffeyville Gasification Plant	2013	Kansas	Hydrogen / Ammonia / Fertilizer	0.9	Pre-Combustion Capture (Gasification)	Enhanced Oil Recovery
Archer Daniels Midland Illinois Industrial	2017	Illinois	Ethanol	1	Inherent Capture	Deep Saline Formation

Project	Operational Date	State	Industry	Capture Rate (Mt/y)	Capture Type	Storage Type
Petra Nova Carbon Capture	2017 (closed in 2020 and reopened 2023)	Texas	Power Generation and Heat	1.4	Post-Combustion Capture	Enhanced Oil Recovery
Red Trail Energy Richardton Ethanol	2022	North Dakota	Ethanol	0.18	Inherent Capture	Dedicated Geological Storage (Under Evaluation)
Harvestone Blue Flint Ethanol	2023	North Dakota	Ethanol	0.2	Inherent Capture	Deep Saline Formation
Heirloom DAC Facility	2023	California	Direct Air Capture	0.001	Ambient Air Capture	Utilization (Concrete)
Celanese Utilization Project	2024	Texas	Chemicals	0.18	Inherent Capture	Utilization

3. Near-Term Strategy

DOE has designed a near-term carbon management strategy comprised of the following five intertwined objectives to achieve the 2030 vision outlined above.

1. *Focus new innovation investments on priority use cases: Advance the development of carbon management use cases with the fewest decarbonization alternatives, such that each priority use case: a) has been demonstrated safely and effectively at commercial-scale, and b) is approaching economic viability based on existing U.S. policy incentives.*
2. *Fund regional clusters of transportation and storage infrastructure: Support the buildout of CO_2 transportation and storage infrastructure in the regions where it is likely needed most–including through support for CO_2 capture projects that can anchor clusters as well as regional specific analysis, engagement, and regulatory support in a way that leads to the greatest economies of scale for future carbon management build-out across key regions.*
3. *Support the implementation of effective policy and regulatory frameworks: Provide technical assistance and detailed analysis to interagency partners working to implement carbon management regulations and incentives.*
4. *Engage and protect communities, workers, and their environments: Support stakeholder engagement and CBPs[3] so that all investments in carbon management protect communities and their environments and provide high-quality jobs across the United States, especially in disadvantaged communities.*
5. *Build a foundation for global cooperation: Collaborate toward scaling carbon management internationally, especially to enable developing economies that have a much younger fossil power and industrial base that will be more challenging to fully retool with renewable and electric alternatives on the timeframe needed to achieve net-zero emissions globally.*

[3] DOE's Community Benefits Plan Framework aims to ensure that projects that receive federal funding, particularly from the Bipartisan Infrastructure Law and Inflation Reduction Act, generate economic, environmental, and societal benefits for the communities and workers where the projects are located.

All five of these pillars are supported with robust analysis and communications. DOE investments provide a wealth of information about the economics, engineering, and environmental impacts of carbon management technologies. Leveraging this information by conducting detailed analysis on techno-economics, life cycle accounting, and energy systems modeling enables stakeholders across industry, civil society, and other governments to have valuable insights into the state of the field. These insights provide a foundation for outside stakeholders to have a clear understanding of where further public and private investments are most useful for advancing carbon management in line with climate and broader social, economic, and environmental goals…