U.S. DEPARTMENT OF ENERGY
Fossil Energy and Carbon Management

Direct Air Capture

Opportunities, Challenges, and Role of Policy

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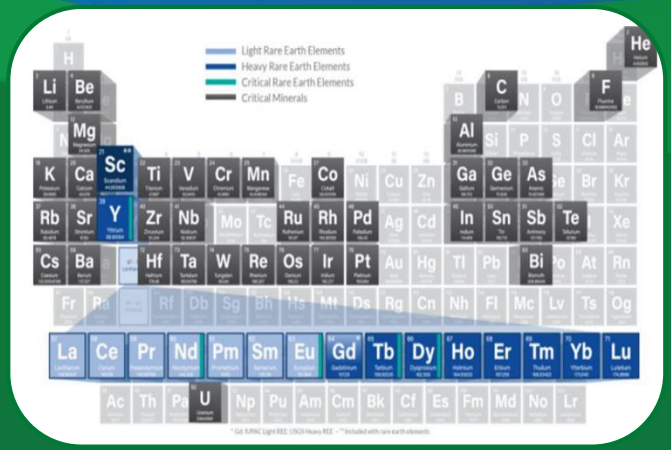


Office of Fossil Energy and Carbon Management

Advancing Carbon Management Approaches Toward Deep Decarbonization

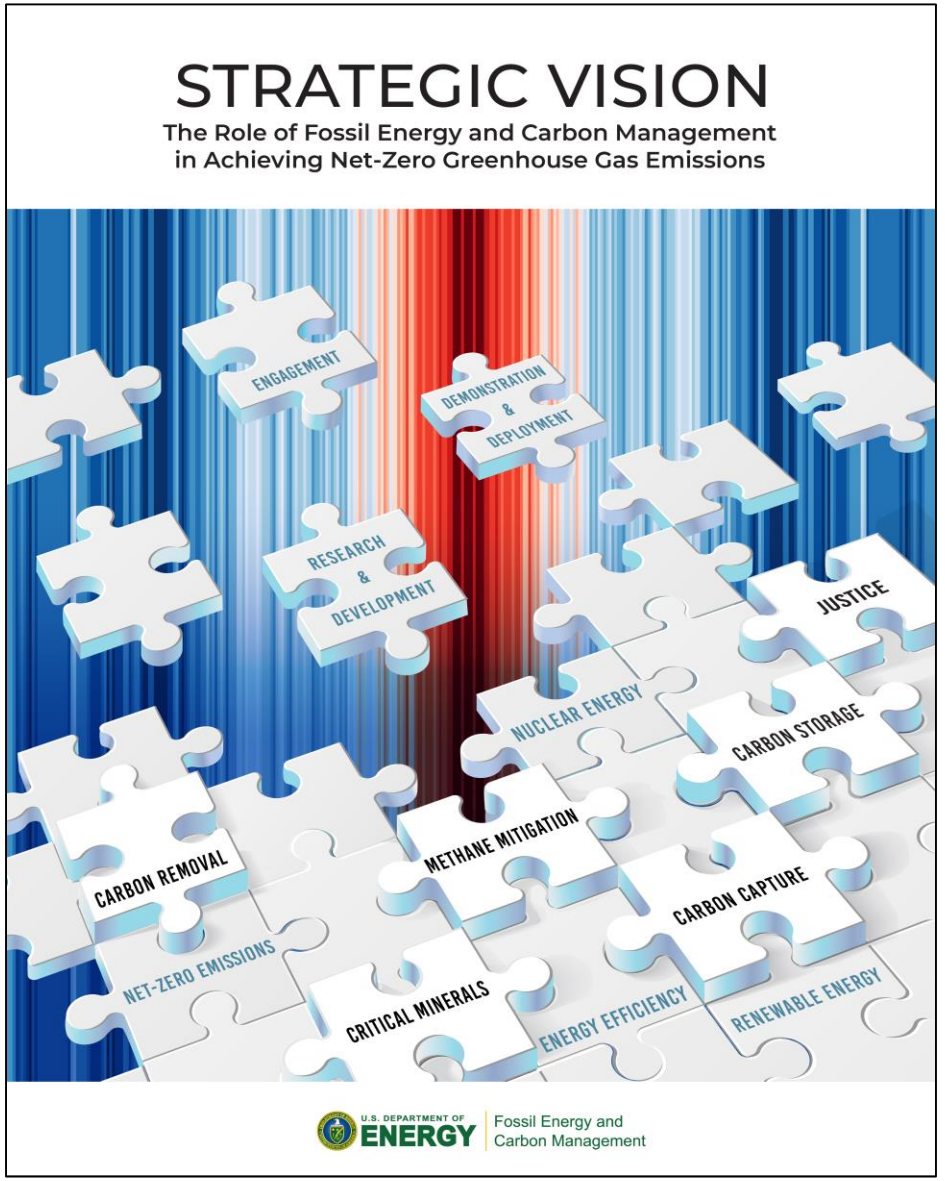
Priorities: *Point-source carbon capture, carbon dioxide conversion, carbon dioxide removal (CDR), and reliable carbon transport and storage*

Advancing Technologies that Lead to Sustainable Energy Resources

Priorities: *Hydrogen with carbon management, domestic critical minerals (CMs) production, and methane mitigation*

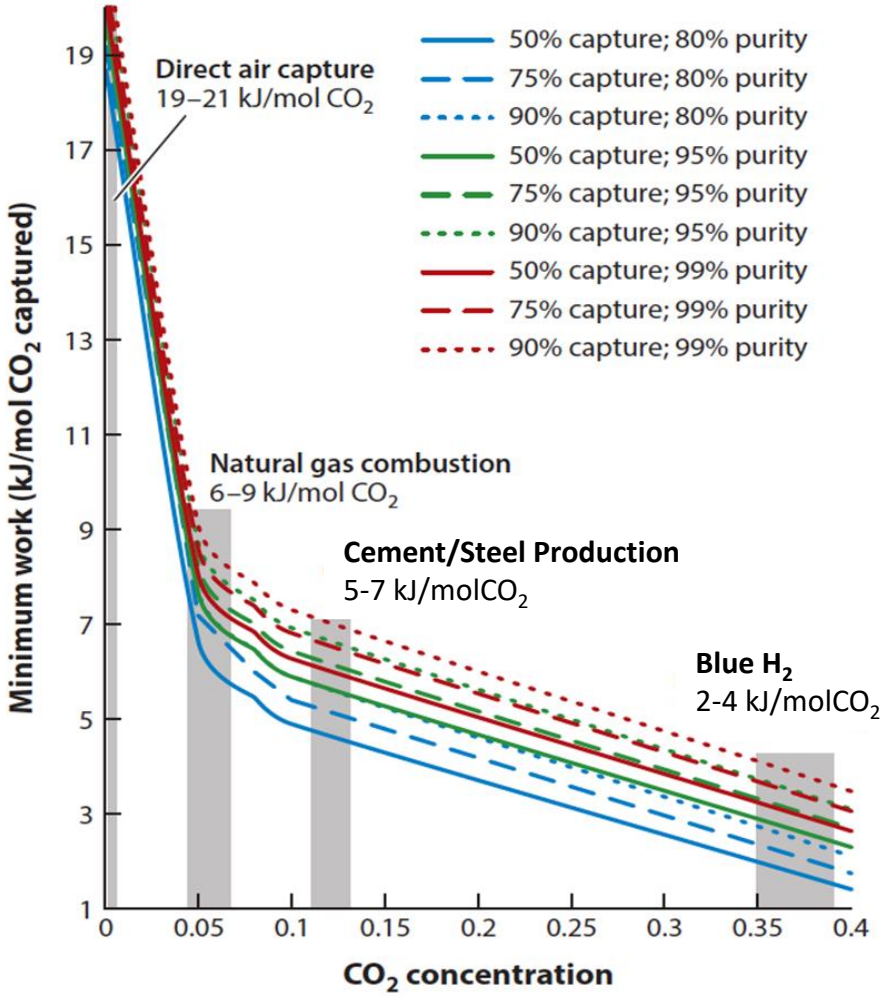
Advancing Justice, Labor, and Engagement

Priorities: *Justice, labor, and international and domestic partnerships*

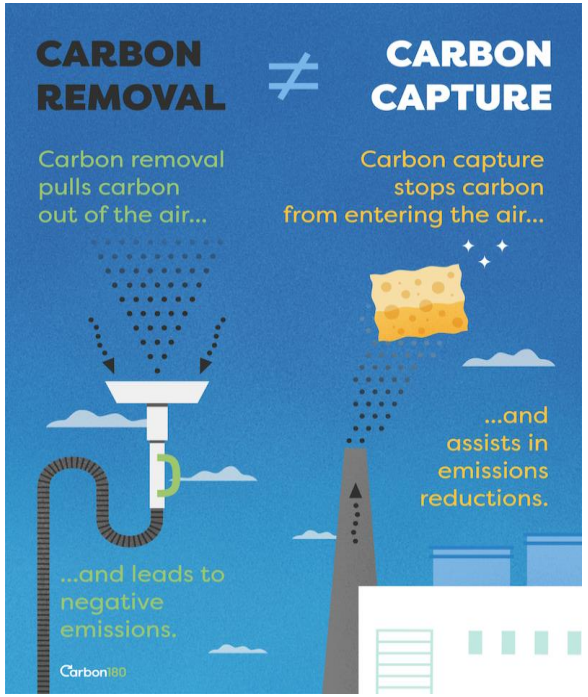


CCS and CDR Need to Be Done In Parallel

- Minimum work for separation may be derived from combined 1st and 2nd laws of thermodynamics
- Energy scales with dilution – > 3× more energy to do DAC vs exhaust streams
- 300× greater contactor area for CO_2 separation to do DAC vs exhaust
- High purity is desired for transport
- Direct air capture should not be seen as a replacement for avoiding carbon



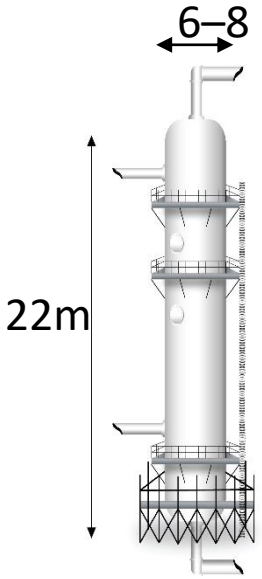
Distinction Between Point-Source Capture and Direct Air Capture



Source: https://grist.org/wp-content/uploads/2021/12/carbon180-carbon-removal-is-not-carbon-capture.png

Different designs and various technologies lead to different impacts, energy, land, and water requirements

Power Plant MEA Scrubber



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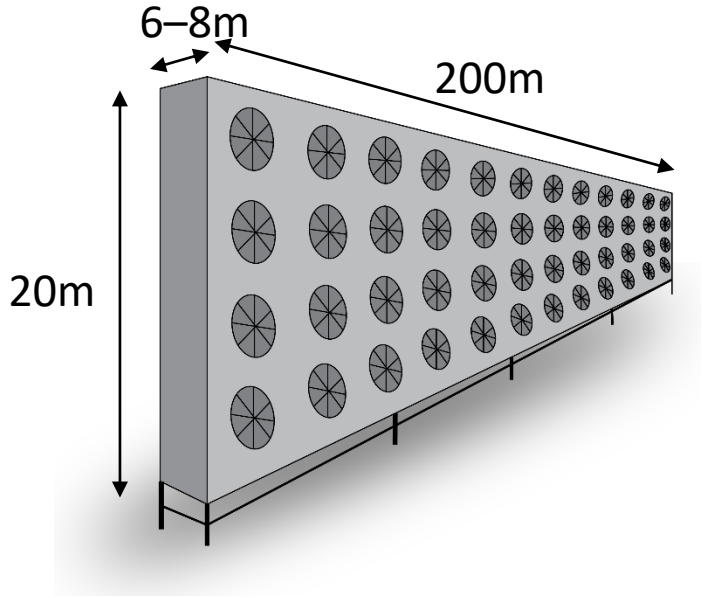
DAC Contactor



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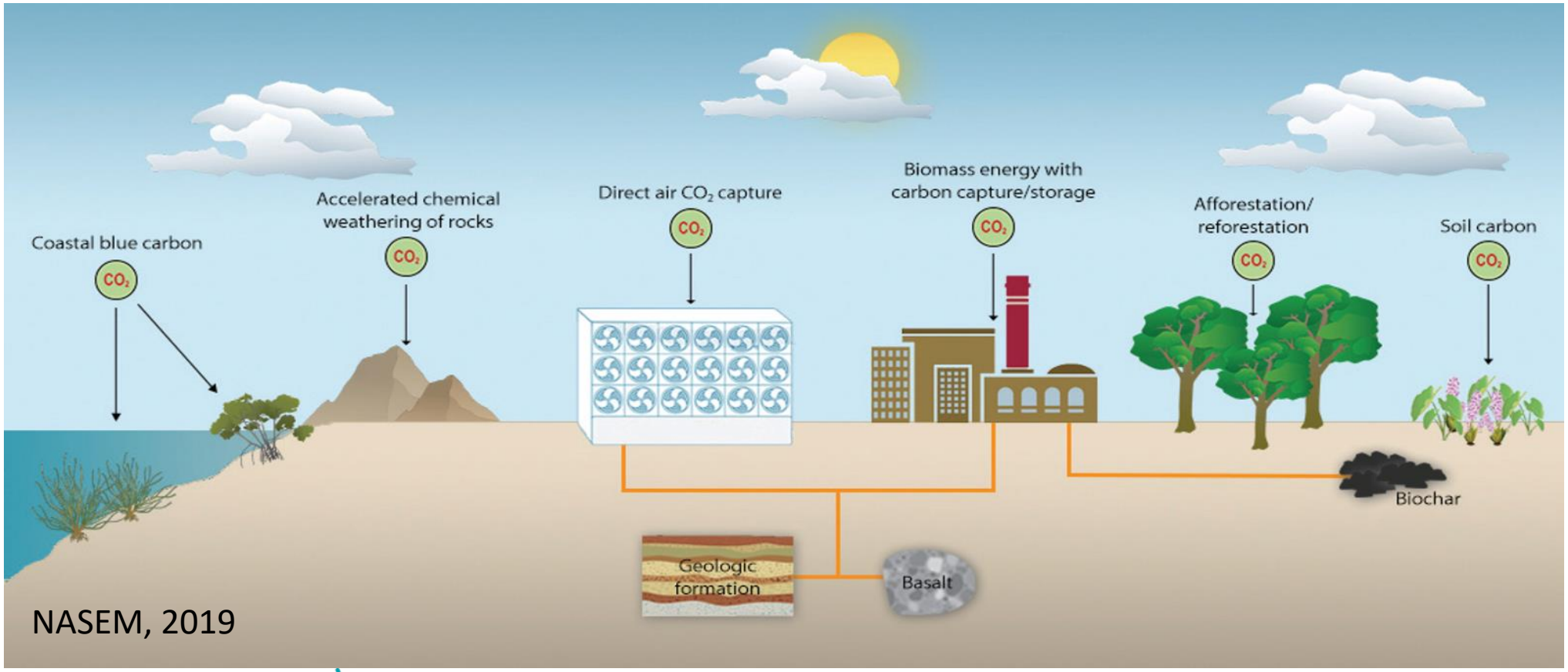
Carbon Dioxide Removal and Importance of MRV



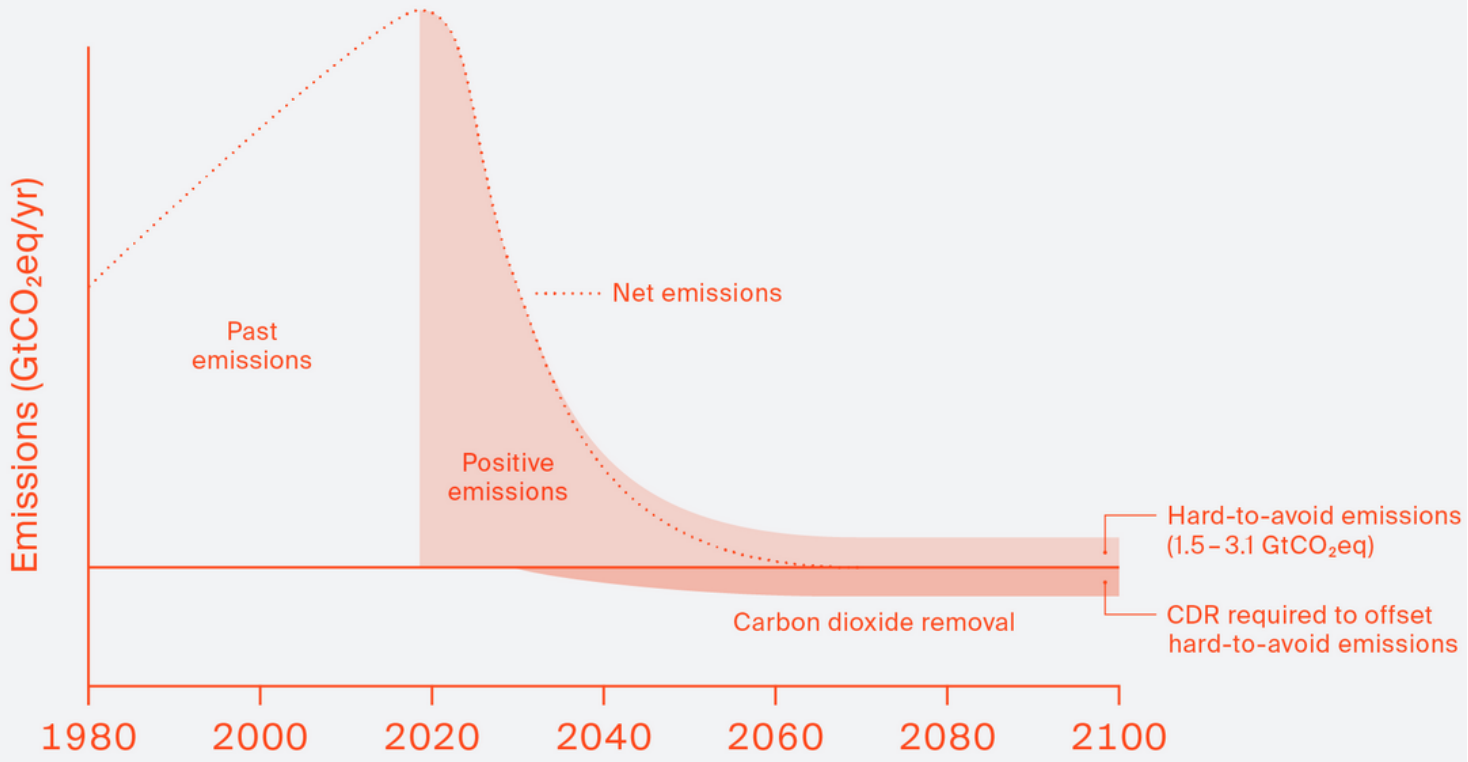
ENERGY earthshots U.S. DEPARTMENT OF ENERGY | Carbon Negative

Durable and scalable carbon dioxide removal under $100/net metric ton within a decade

Net-Zero and Role of Carbon Dioxide Removal

Figure 1.1 →

Schematic of hard-to-avoid emissions and the CDR needed to offset them. Adapted from a figure produced by Glen Peters (2020)



CDR Primer, 2021

Recent FECM awards focus on coupling DAC to Existing Utilities

- As a leader in advancing carbon management technologies, FECM is researching and investing in DAC technologies to help scale them up for the commercial market
- DAC coupled to durable storage for carbon dioxide removal is energy intensive, relying on both heat and electricity inputs
- FECM recently awarded $11 million (federal) for 4 FEED studies leveraging existing sources of clean heat for DAC – nuclear, geothermal, and industrial waste heat

DAC coupled to nuclear heat: $3.4m ($2.5m federal) FEED study led by Battelle with AirCapture, Carbonvert, Sargent & Lundy, Southern Company, and the University of Alabama to be located at Southern Company's Joseph M. Farley nuclear power plant in Columbia, AL. Image: NRC

DAC coupled to nuclear heat and power: $3.1m ($2.5m federal) FEED study led by Exelon with Carbon Engineering, Worley Group, 1PointFive, Univ. of Illinois, and PNNL to be located at Exelon's Byron Generating Station for 250k net tons CO_2/year captured with permanent storage. Image: CE

DAC coupled to geothermal energy: $3.1m ($2.5 federal) FEED study led by UIUC with Climeworks, Ormat, Sentinel Peak, Visage Energy, LLNL, and Kiewit to be located at an Ormat geothermal facility in California. Image: Ormat

DAC coupled to steel plant waste heat: $4.3m ($3.5m federal) FEED study led by Univ. Illinois to be integrated with US Steel's Gary Works in Indiana, with CO_2 to be trucked to a ready-mix concrete plant to be mineralized into calcium carbonate.Photo: Adobe 296734139

Bipartisan Infrastructure Law

> $10 billion in new carbon management funding over 5 years through the Infrastructure Investment and Jobs Act (Bipartisan Infrastructure Law).

Carbon Dioxide Removal - Direct Air Capture
Regional Direct Air Capture Hubs: $3.5 billion
DAC Technology Prize Competition: $115 million

Carbon Dioxide Utilization and Storage
Carbon Storage Validation and Testing: $2.5 billion
Carbon Utilization Program: $310 million

Front-End Engineering Design Studies
Pipeline Infrastructure: $100 million

Carbon Dioxide Transportation Infrastructure
Loan Programs Office: $2.1 billion

Carbon Capture Demonstrations and Large Pilots
Integrated Systems: $3.5 billion

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Questions?