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

Office of Carbon Management Technologies Overview

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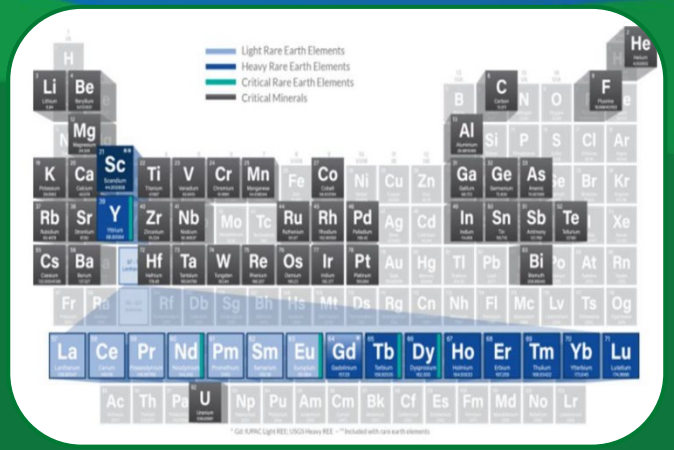
ACTING DIRECTOR, DIVISION OF OF CARBON DIOXIDE REMOVAL & CONVERSION
OFFICE OF FOSSIL ENERGY AND CARBON MANAGEMENT

February 27, 2023





Fossil Energy and Carbon Management (FECM)

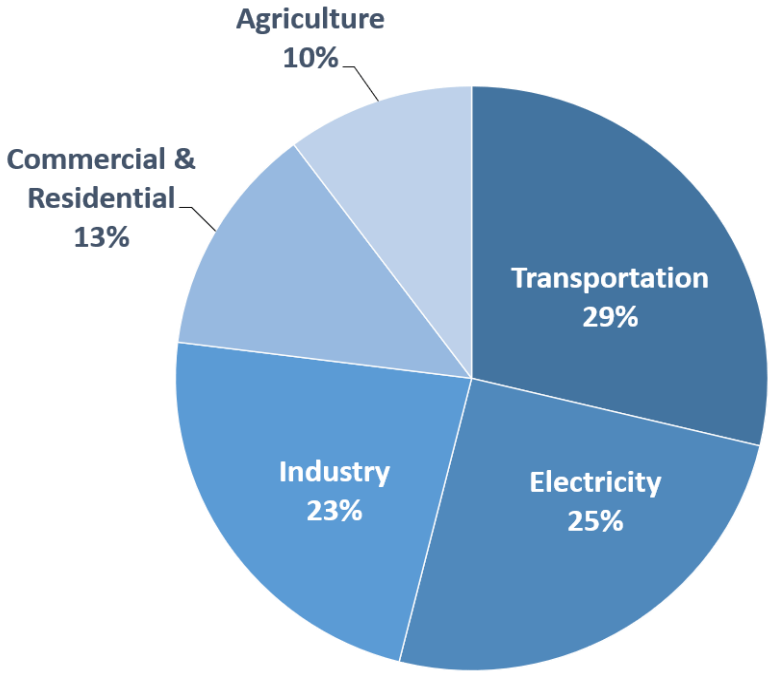
Office of Fossil Energy and Carbon Management

DOE-FE is now DOE-FECM

New name for our office reflects our **new vision**

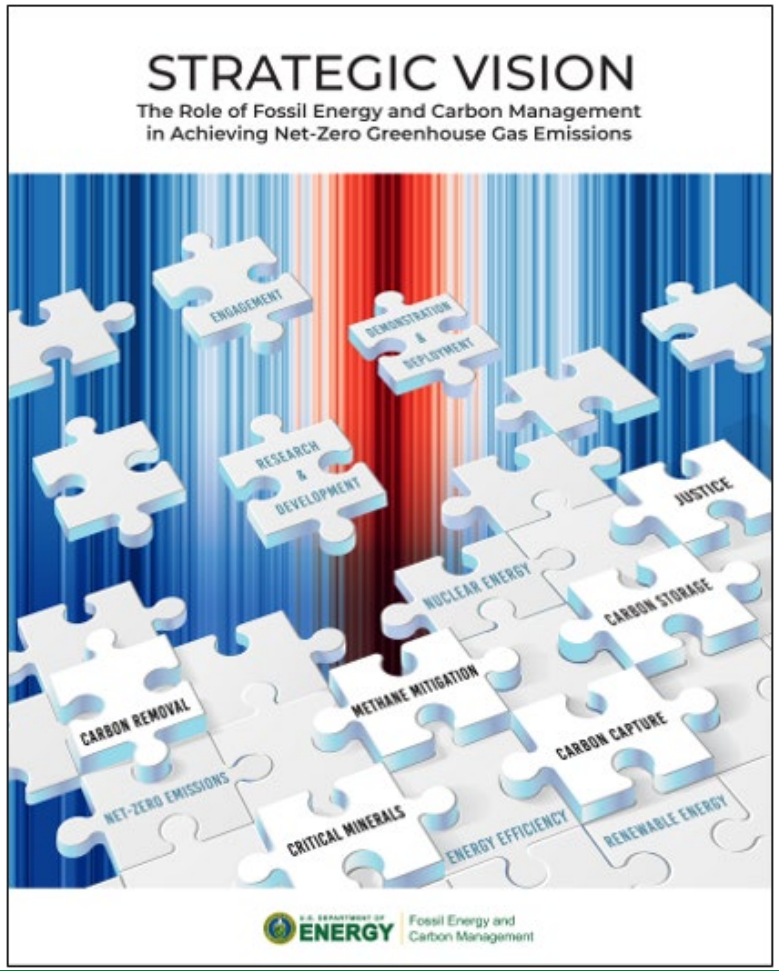
- President Biden's goals:
  - 50% emissions reduction by 2030
  - CO_2 emissions-free power sector by 2035
  - Net zero emissions economy by no later than 2050

Total U.S. Greenhouse Gas Emissions by Economic Sector in 2019



U.S. Environmental Protection Agency (2021). Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2019

A Vision for Carbon Management



A carbon management framework that will guide FECM's engagement with offices across the Department, Federal agencies, tribal and international governments, industry, non-governmental organizations, and communities

Advancing Justice, Labor, and Engagement

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

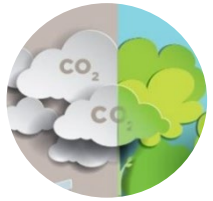
Advancing Carbon Management Approaches Toward Deep Decarbonization

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

Advancing Technologies that Lead to Sustainable Energy Resource

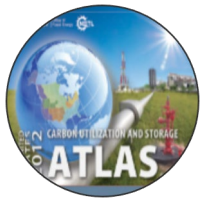
Priorities: *Hydrogen with carbon management, domestic critical minerals (CM) production, and methane mitigation*

H_2 with Carbon Management
Conversion of carbon-based feedstocks to H2 coupled with carbon management



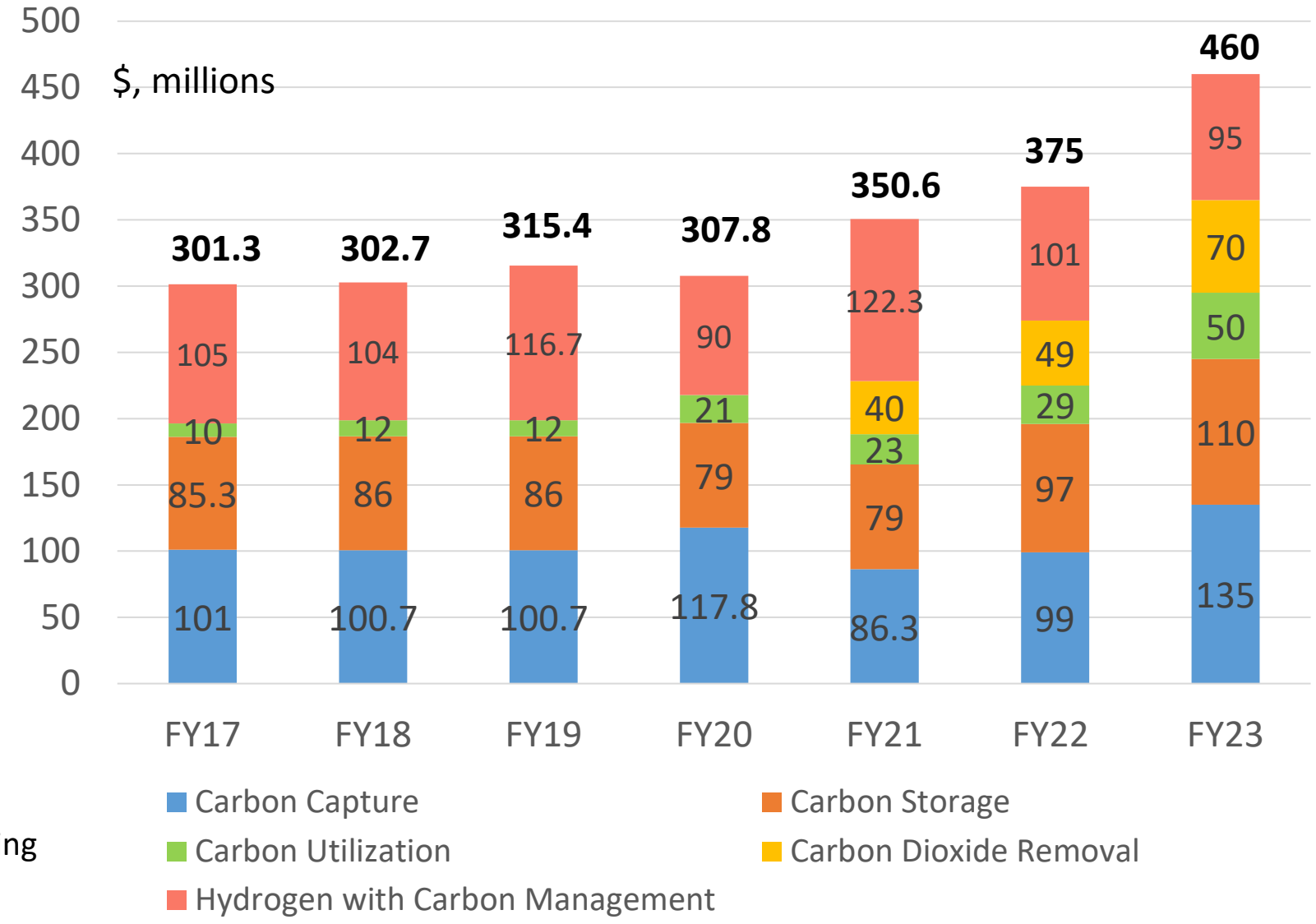
Carbon Dioxide Removal
Removal of atmospheric CO_2 and durable store

Carbon Conversion/Utilization
Conversion of CO_2 to value-added products



Carbon Storage and Transport
Safe, cost- effective, and permanent geologic storage of CO_2

Carbon Capture
Capturing CO_2 from new and existing industrial and power plants



BIL Carbon Management Provisions

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

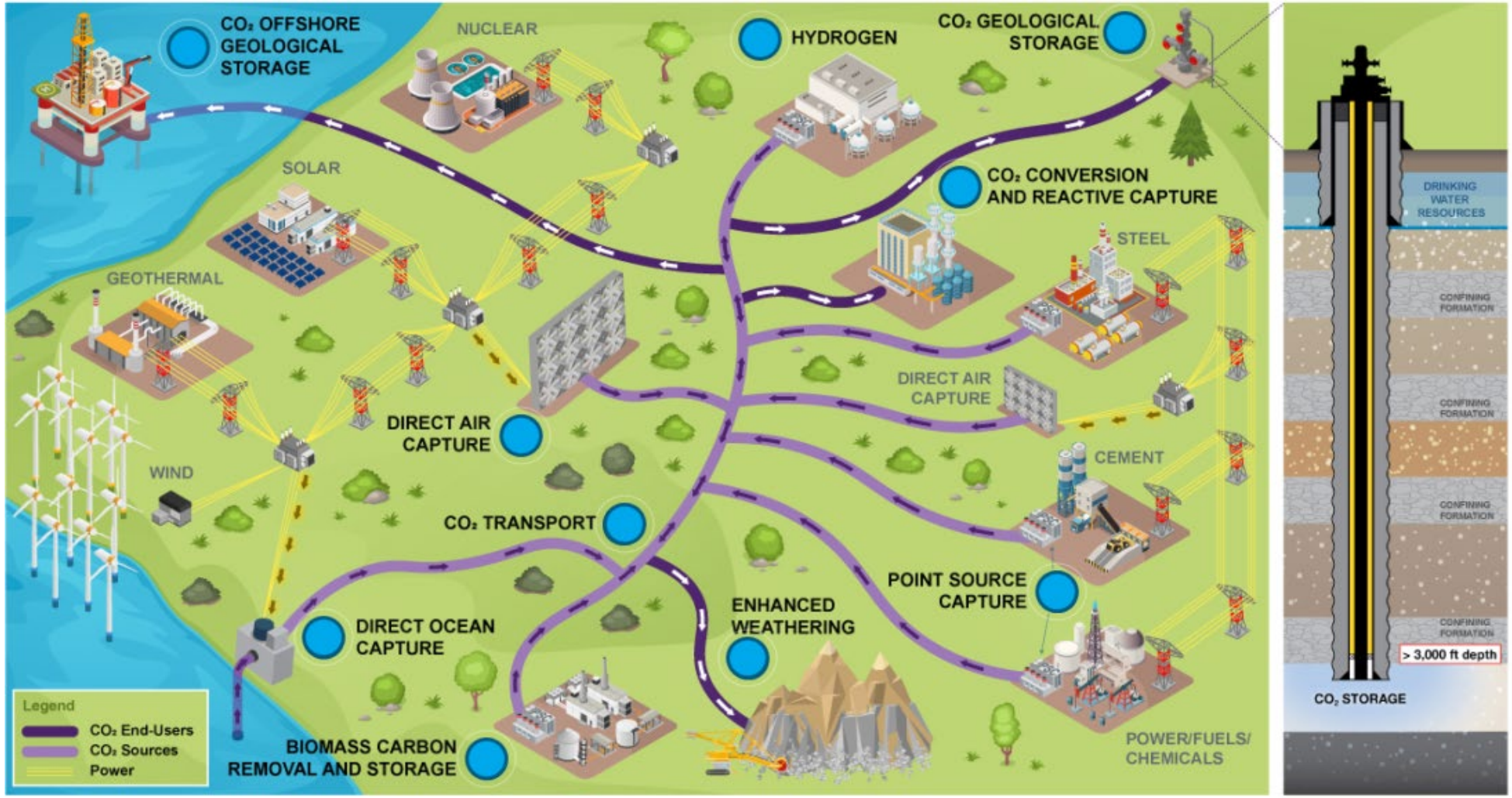
Carbon Capture, Utilization and Storage (CCUS)
Integrated CCUS Demos: $2.537 billion
Carbon Capture Large Pilots: $937 million

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

Carbon Dioxide Transportation Infrastructure Finance and Innovation Program Account (CIFIA)
Loan Programs and Future Growth Grants: $2.1 billion

Front-End Engineering Design Studies
Carbon Capture Technology Program (Transport Infrastructure): $100 million

Decarbonization and the Industrial Ecosystem

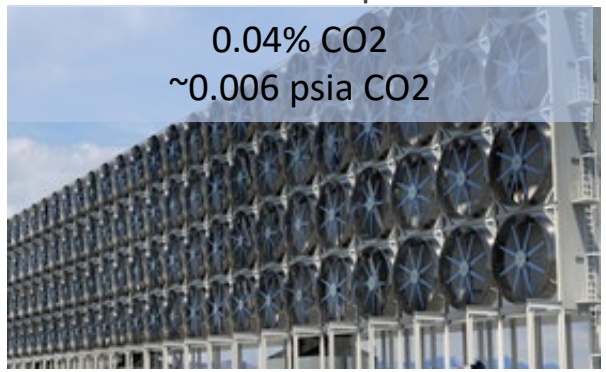


Capture Technologies — Diversity of CO_2 Streams

Coal Power Plant

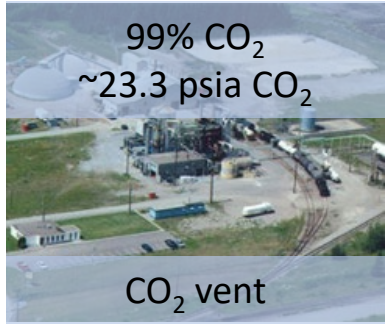
Gas Power Plant

Direct Air Capture



Hydrogen Plant

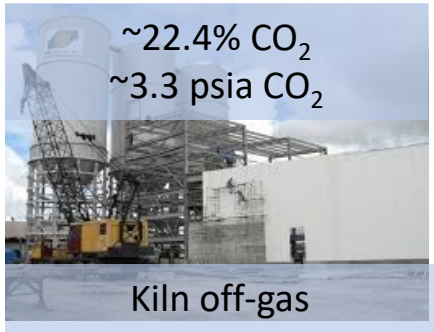
NG Processing Plant



Ammonia Plant

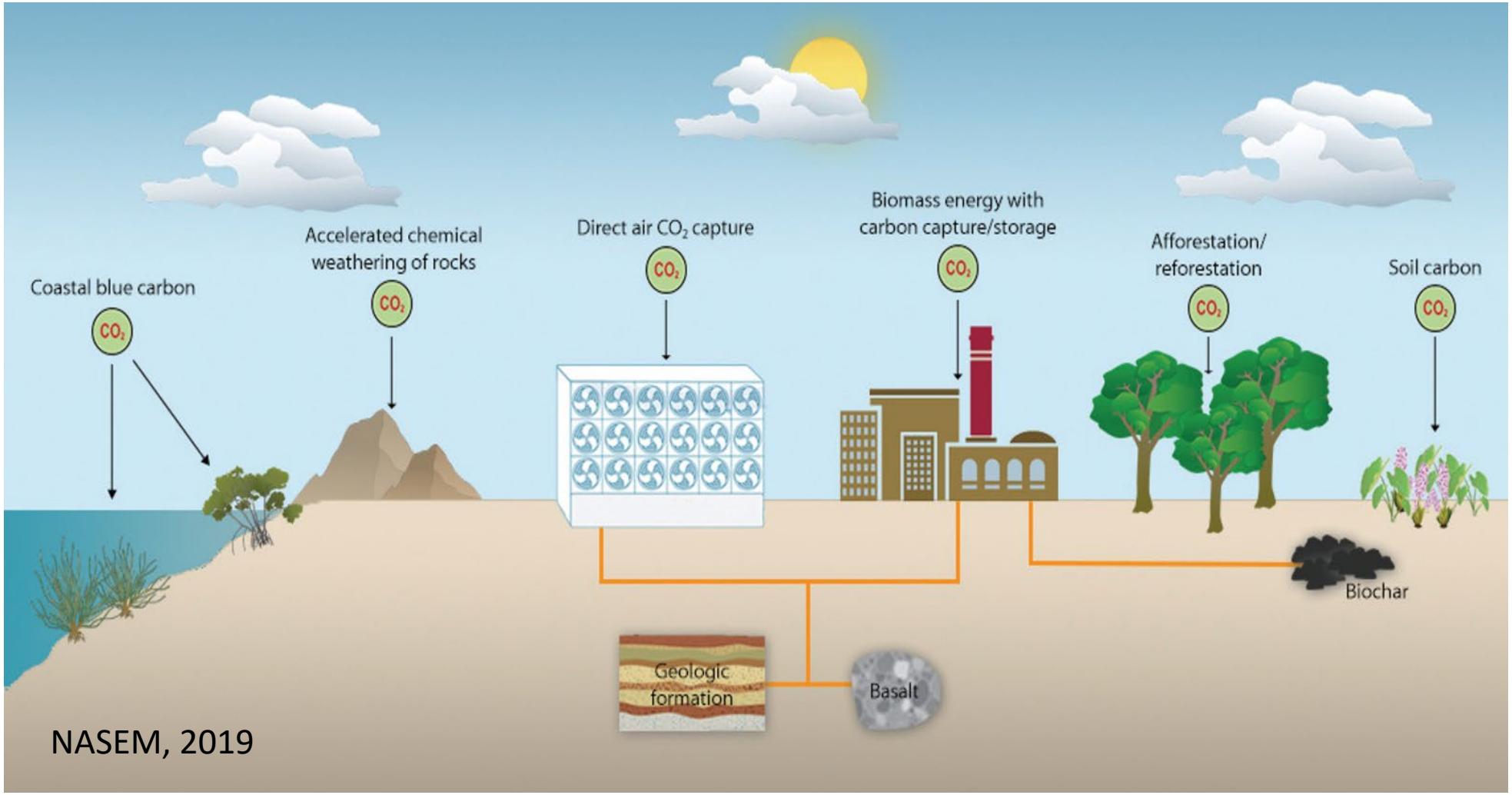
Ethanol Plant

Cement Plant



Cost of Capturing CO_2 from Industrial Sources, 2022, DOE/NETL-2013/1602

Carbon Dioxide Removal



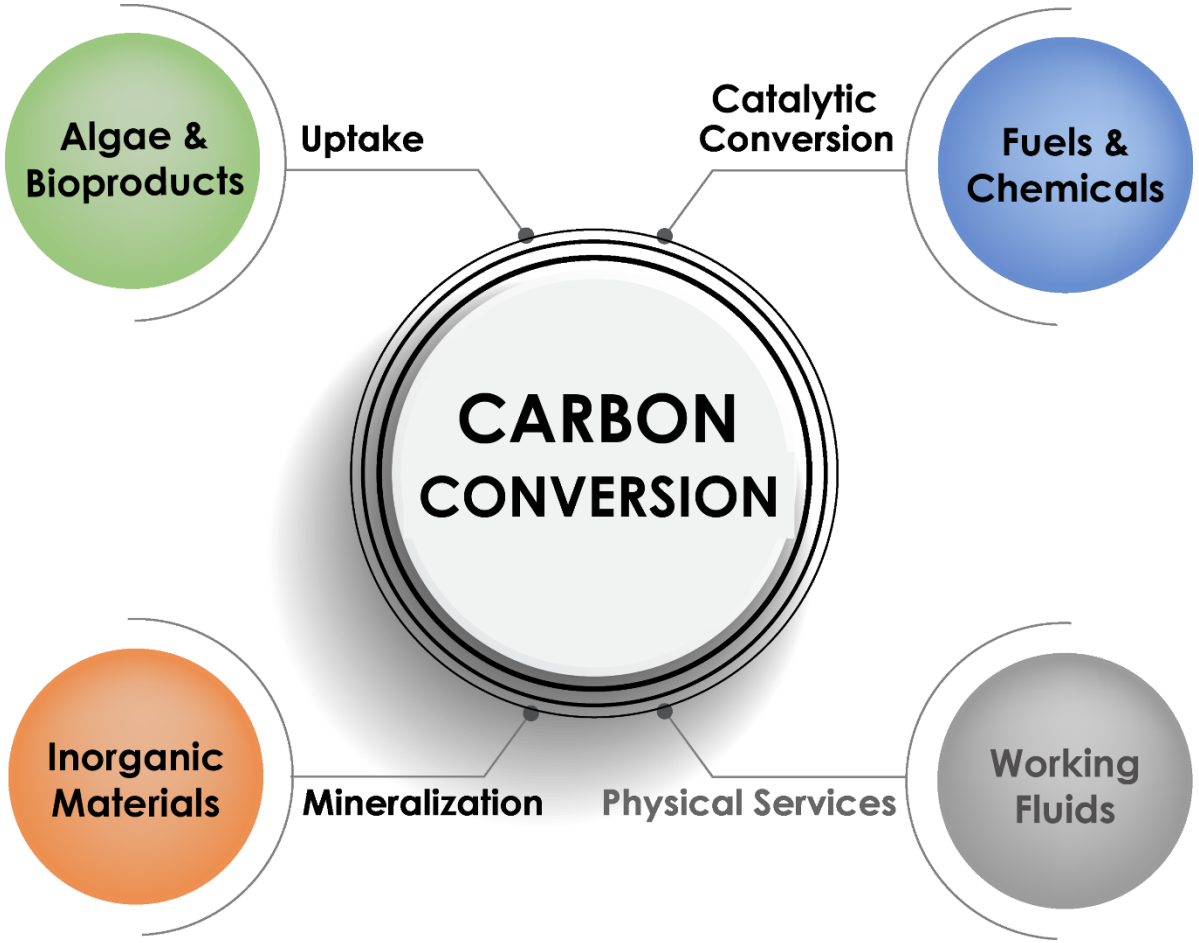
NASEM, 2019

Carbon Negative Shot: Key Performance Elements

Carbon Negative Shot's key performance elements will guide a responsible industry that is responsive to the climate crisis, such that multiple true, durable removal pathways can be deployed at their most affordable cost at the scale required to address the climate crisis.

1. Less than **$100/net metric ton CO_2e** for both capture and storage
2. Robust accounting of full life cycle emissions
3. High-quality, durable storage with costs demonstrated for MRV **for at least 100 years**
4. Enables necessary **gigaton-scale** removal

Carbon Conversion/Utilization Program



Challenges

- Scale & Rate of CO_2 emissions relative to of CO_2 conversion
- Determining economic viability and environmental impact requires significant resources -> very place-based
  - Technical viability is relatively easy to qualify
- Sweet spot of low carbon & low-cost energy like electricity, CO_2 sources, markets, and transportation between it all

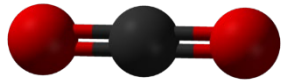
DOE/NETL CO2U LCA Guidance Toolkit

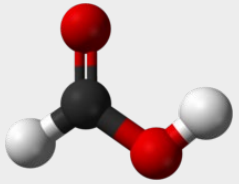
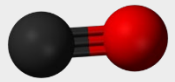
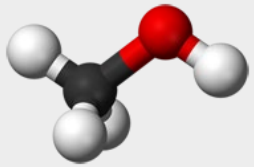
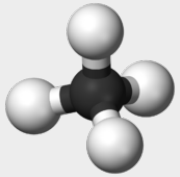
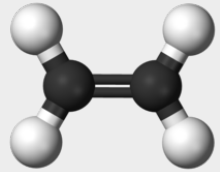
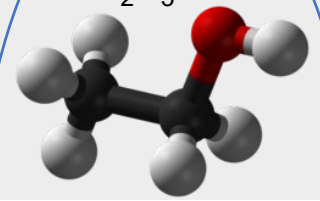
- CO2 utilization LCA guidance and tool package for Carbon Utilization Program primary research projects
- LCA guidance, open source LCA software (openLCA), NETL data, and results reporting tools
- An openLCA database has been populated with data and an example to help conduct LCA within the openLCA software
- An Excel tool has been created to take openLCA results and translate them into stacked bar charts for results communication

Toolkit available at netl.doe.gov/LCA/CO2U

CO_2: A Potential Reactant to Platform Chemicals

Carbon Dioxide
CO_2



Electrons Required:	+2e⁻	+2e⁻	+6e⁻	+8e⁻	+12e⁻	+12e⁻
Products	**Formic Acid** HCOOH	**Carbon Monoxide** CO	**Methanol** CH_3OH	**Methane** CH_4	**Ethylene** C_2H_4	**Ethanol** C_2H_5OH
						
Current Industrial Production Methods	Methyl Formate Hydrolysis $CH_3OH + CO \rightarrow HCOOCH_3$ $HCOOCH_3 + H_2O \rightarrow HCOOH + CH_3OH$	Coal Gasification $C + H_2O \rightarrow CO + H_2$ Steam Reforming $CH_4 + H_2O \rightarrow CO + 3H_2$	Syngas Conversion $CO + 2H_2 \rightarrow CH_3OH$	Major Component of Natural Gas	Steam Cracking $C_2H_6 \rightarrow C_2H_4 +$ other cracking products	Ethylene Hydration $C_2H_4 + H_2O \rightarrow C_2H_5OH$ Fermentation $C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2$ (using yeasts)

SEC. 40302 of BIL

Directs the Secretary to establish a program for **eligible entities …**to submit ….an application…. An eligible entity shall use a grant received to **procure and use commercial or industrial products** that

(i) use or are derived from *anthropogenic carbon oxides*; and

(ii) demonstrate significant net reductions in *lifecycle greenhouse gas emissions compared to incumbent technologies, processes, and products.*

https://uscode.house.gov/view.xhtml?hl=false&edition=prelim&req=granuleid%3AUSC-prelim-title42-section16298a&f=treesort&num=0

Thank You

Learn More About Us

The Office of Fossil Energy and Carbon Management
https://www.energy.gov/fecm

Justice & Engagement
https://www.energy.gov/fecm/justice-engagement-planning-societal-considerations-impacts-fecm-projects

Our Strategic Vision
https://www.energy.gov/sites/default/files/2022-04/2022-Strategic-Vision-The-Role-of-Fossil-Energy-and-Carbon-Management-in-Achieving-Net-Zero-Greenhouse-Gas-Emissions_Updated-4.28.22.pdf