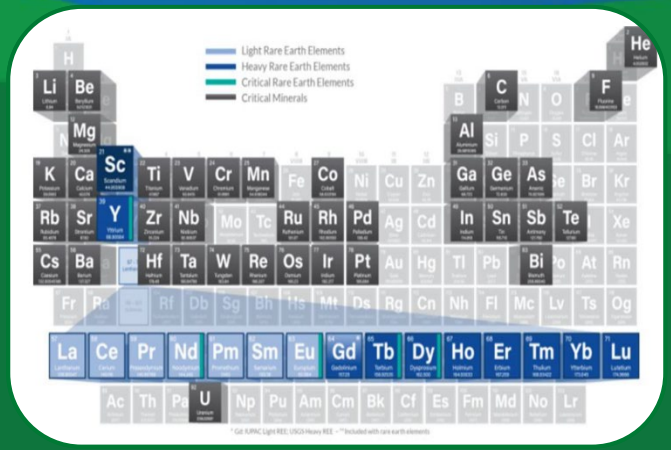
U.S. DEPARTMENT OF ENERGY
Fossil Energy and Carbon Management

Fossil Energy and Carbon Management Priorities in Carbon Management

Dr. Emily Grubert

DEPUTY ASSISTANT SECRETARY
OFFICE OF CARBON MANAGEMENT



Fossil Energy and Carbon Management (FECM)

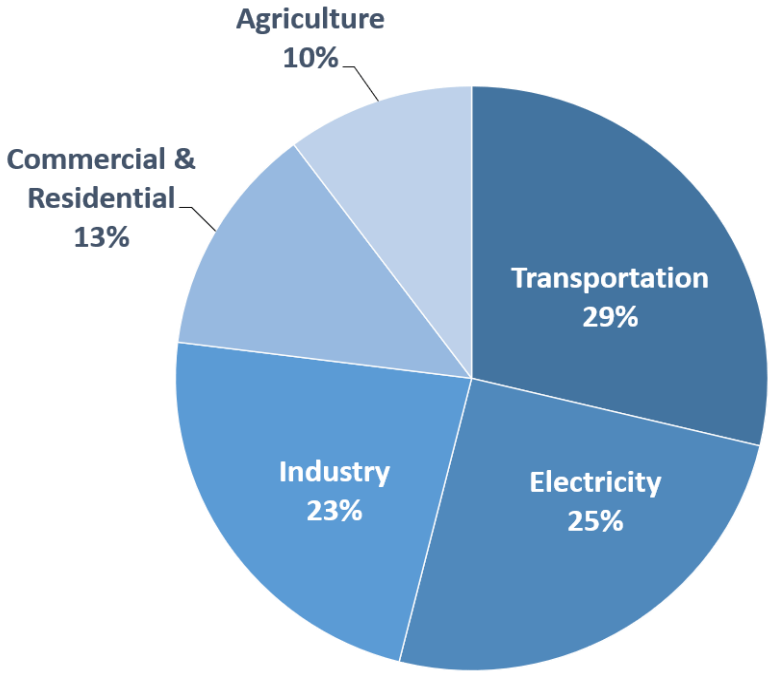
Office of Fossil Energy and Carbon Management

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

FECM Mission: Deep Decarbonization and Environmental Justice

Minimize environmental and climate impacts of fossil fuels from extraction to use

Priority Technology Areas

1. Point source carbon capture
2. Carbon dioxide (CO_2) removal
3. CO_2 conversion into products
4. Reliable CO_2 storage
5. Hydrogen production

Office of Carbon Management
(FECM-20)

6. Critical mineral production from industrial and mining waste
7. Methane mitigation

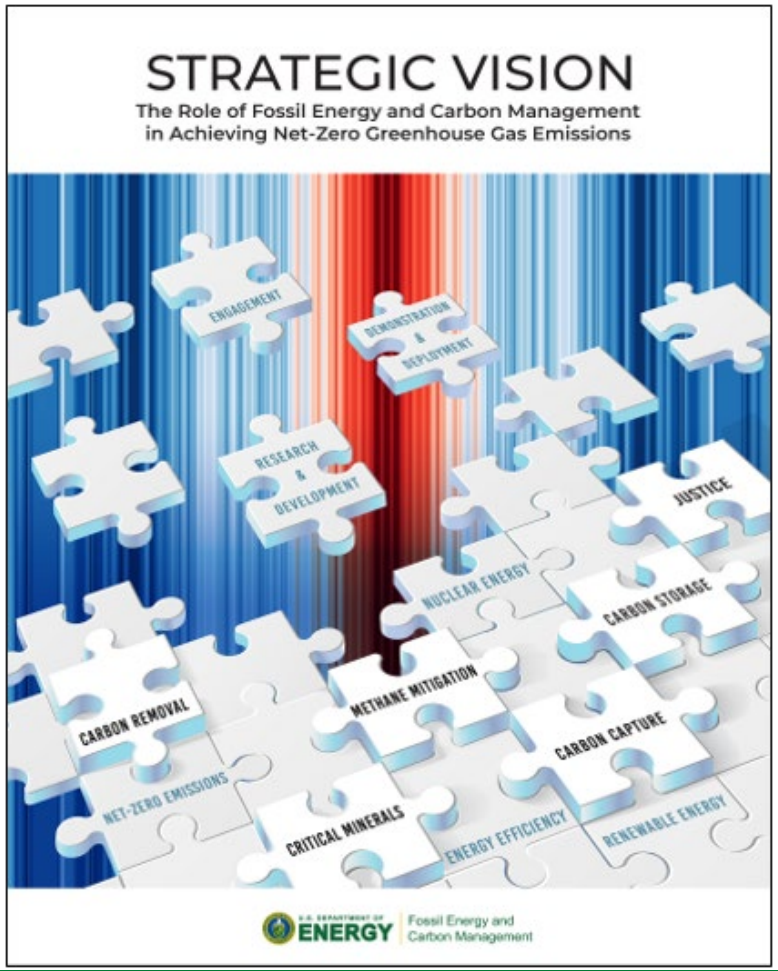
Office of Resource Sustainability
(FECM-30)

Enacting Justice and Supporting Legacy Communities

- Good-paying jobs
- Job growth acceleration
- Healthy economic transitions
- Improve community conditions

Address hardest-to-decarbonize applications in the electricity and industrial sectors

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*

Bipartisan Infrastructure Law (BIL)

FECM - **$6.5 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
Carbon Capture Technology Program: $100 million

Critical Minerals and Materials
Rare Earth Element Demonstration: $140 million
Rare Earth Mineral Security: $127 million

Office of Clean Energy Demonstrations (OCED)

OCED established December 2021
Principal Deputy Director, Kelly Cummins

- Builds on existing DOE investments in clean energy research and development
- Increases DOE's partnership with industry leaders

OCED Projects Areas:

- Clean hydrogen
- Carbon capture – thoughtful siting w/ focus on hard to avoid sectors (e.g., industry and committed emissions)
- Grid-scale energy storage
- Small modular reactors and more

FECM-OCED Project Coordination

Hydrogen Hubs

- $8 billion (for at least four projects, including at least one using fossil fuels with carbon management)

Carbon Capture Demonstrations and Large Pilots

- $3.5 billion

Carbon Dioxide Transportation Infrastructure Finance and Innovation Program Account

- Loan Programs Office: $2.1 billion

CCUS and CDR Facilitate Deep Decarbonization

Reduce the cost of capture/increase rates

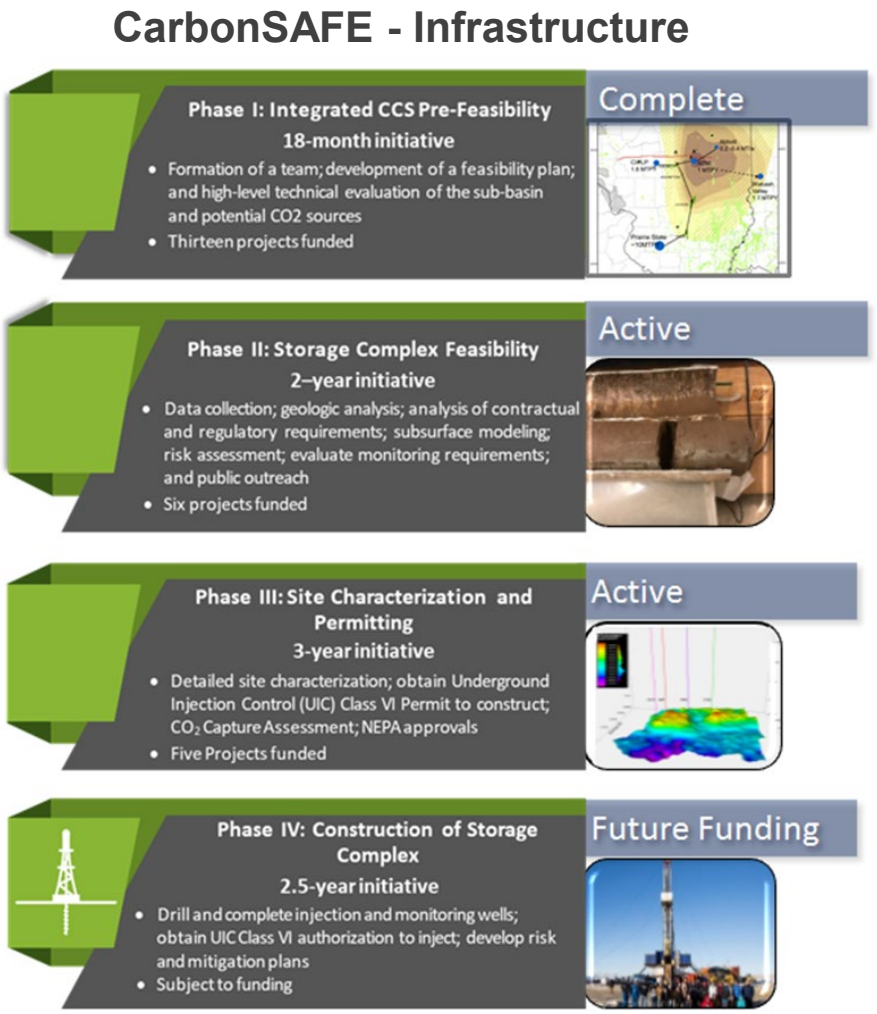
- Power Sector
- Industry
- Carbon Dioxide Removal
- Design Studies and Demonstrations

Develop low-carbon supply chains through conversion

- Aggregates
- Fuels and Chemicals
- Solid Carbon Products

Optimize geologic storage operations

- CarbonSAFE Infrastructure, Partnerships
- Geomechanics (pressure and state of stress)
- Conversion of fossil assets
- Enabling real-time decision making through AI

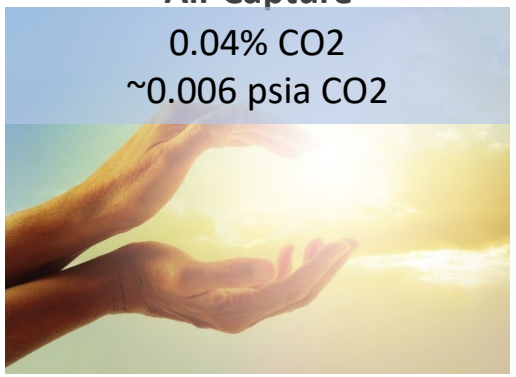


CO_2 Management Addresses Diverse Sources, and the CO_2 Concentration Affects Technical and Cost Challenges

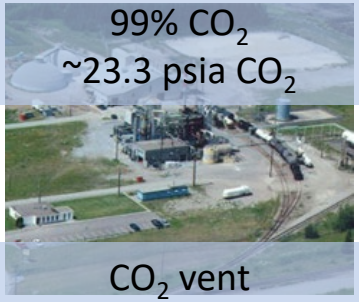
Coal Power Plant

Gas Power Plant

Air Capture

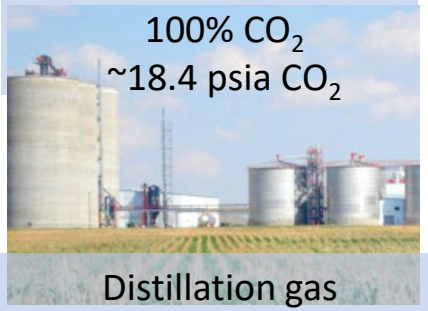


NG Processing Plant

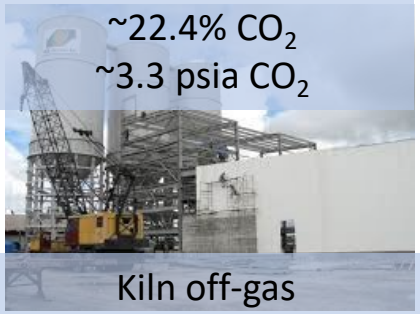


Ammonia Plant

Ethanol Plant



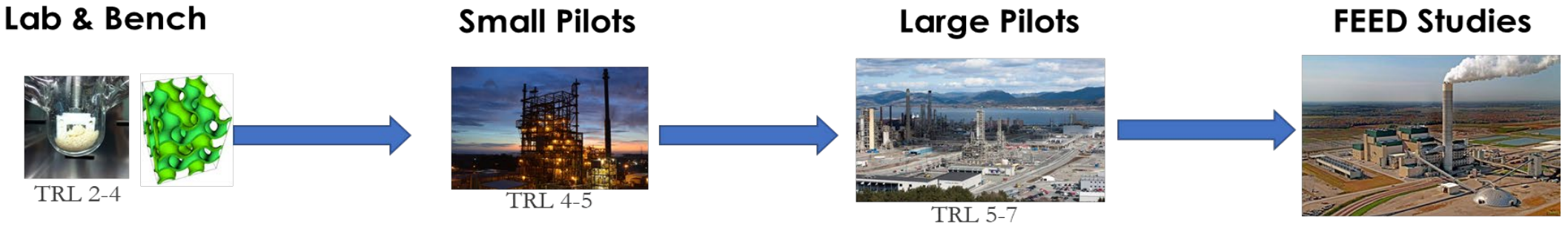
Cement Plant



Cost of Capturing CO_2 from Industrial Sources, January 10, 2014, DOE/NETL-2013/1602

Point Source Capture Program

Integrated Approach to Accelerate Technology Development



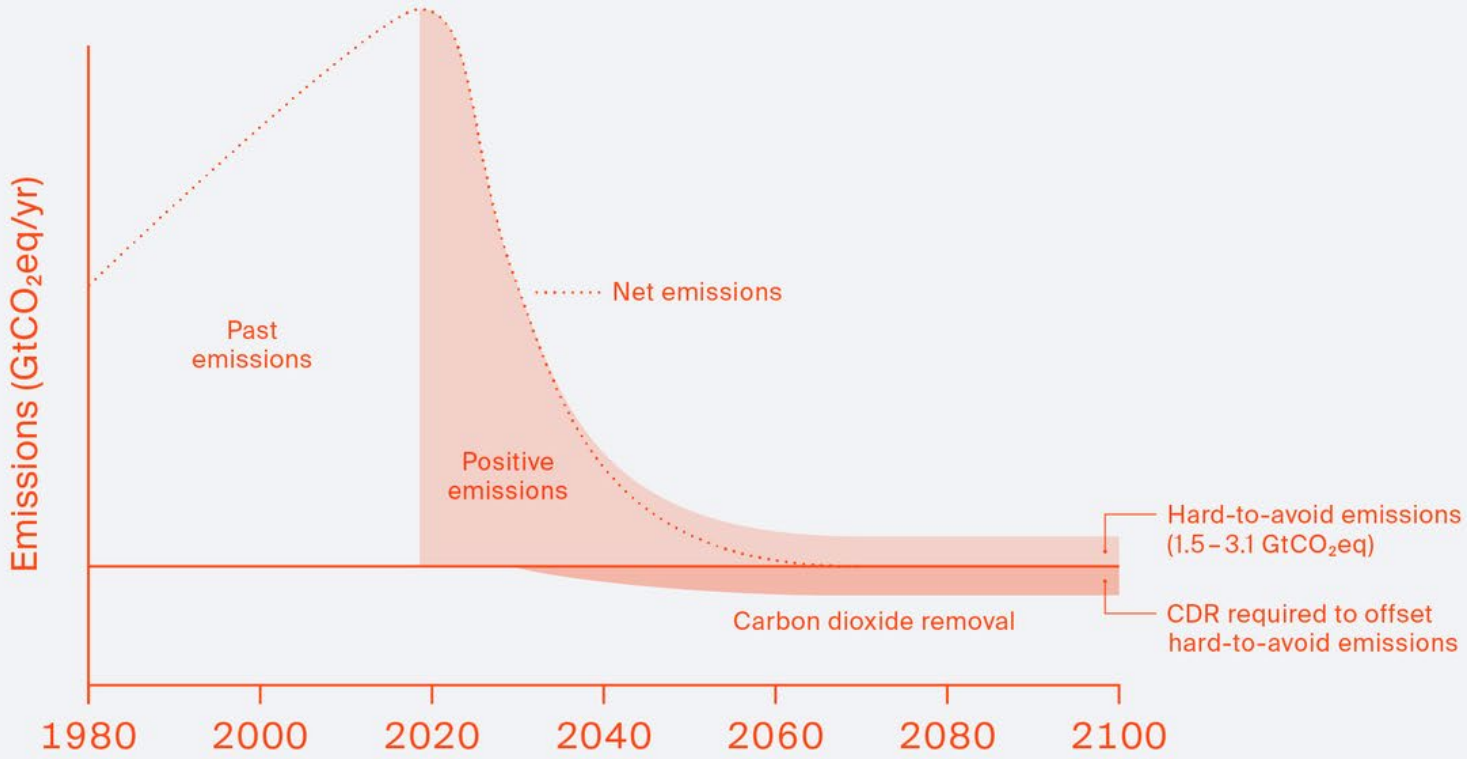
Point Source Capture Focus

- Develop capture technologies for the power and industrial sectors
- Reduce CAPEX/OPEX under a wide range of feed conditions
- Achieve high capture efficiencies (>95%)
- Maximize co-benefit pollutant removal
- Engineering-based Simulation ($CCSI^2$)
- Create low-carbon supply chains (i.e., cement, steel, hydrogen, etc.)

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)



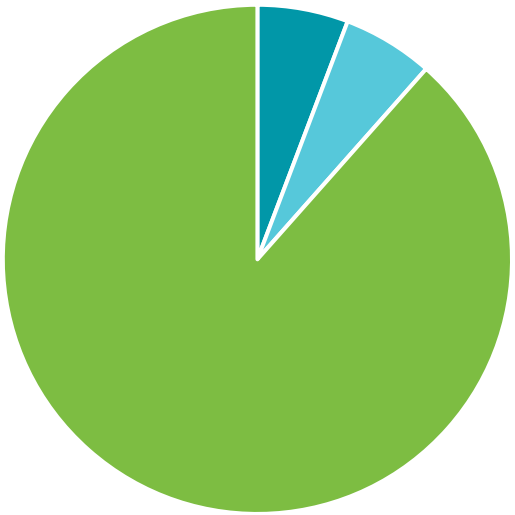
Reference: CDR Primer, 2021

Carbon Negative Shot: Key Performance Elements

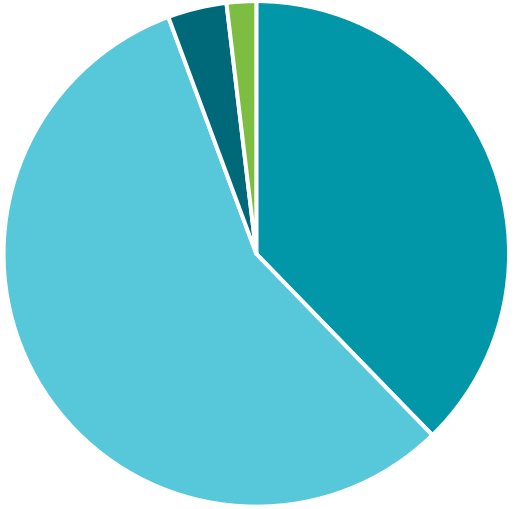
Carbon Negative Shot's key performance elements will guide a responsible industry that is responsive to the climate crisis, such that multiple true, durable removal pathways can be deployed at their most affordable cost at the scale required to address the climate crisis.

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

Soil Carbon Sequestration



Direct Air Capture and Storage



Blue are costs associated with ambient air capture
Green are costs associated with ensuring durable storage

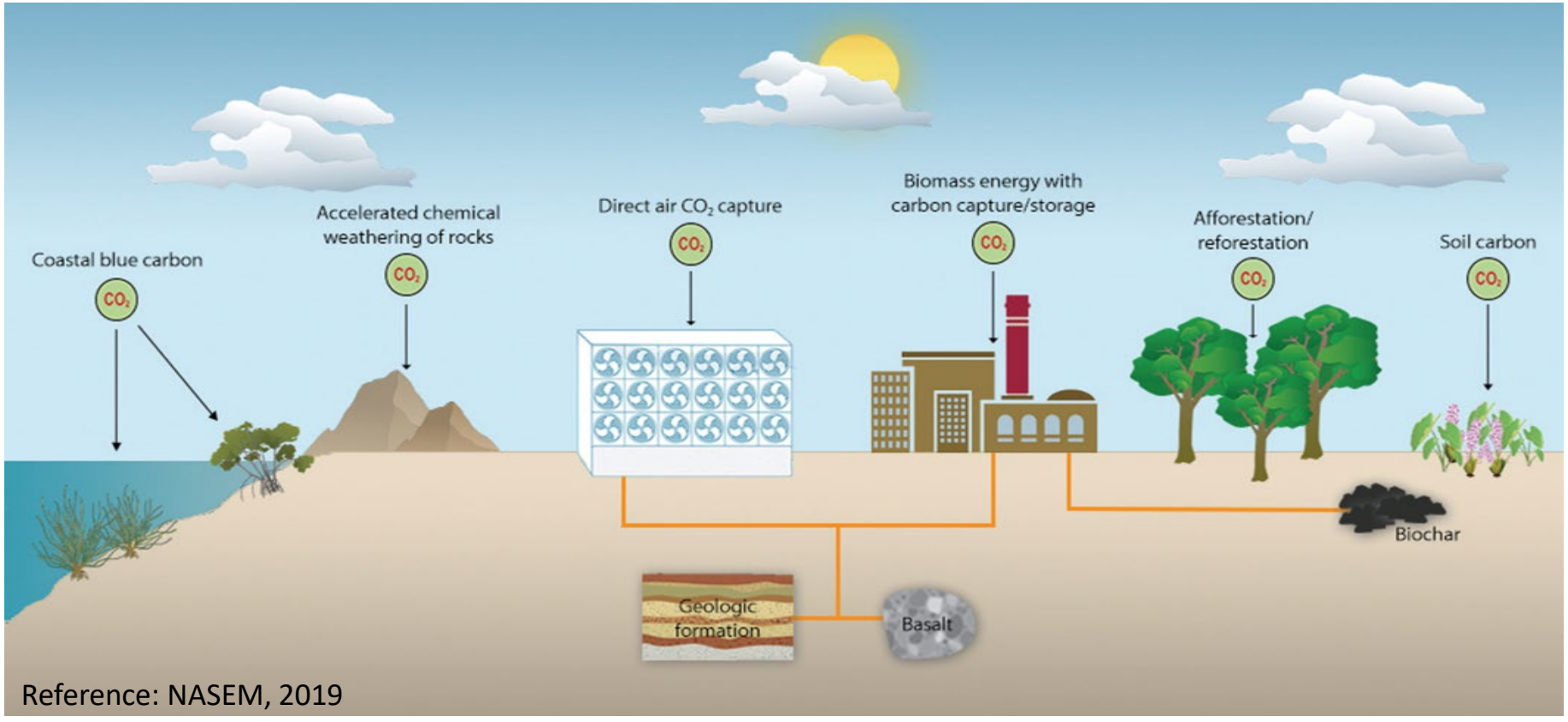
Ensure the first ton of removal is true, durable removal

Ensure the last ton of removal is as affordable as it can be

CDR Areas of Interest in FECM

- Biomass with Carbon Removal and Storage
- Direct Air Capture (DAC)
- Direct Ocean Capture (DOC)
- Accelerated Weathering and Mineralization

- Rigorous LCA and TEA (net-removed costs)
- Low-carbon energy, land, water resources required
- Leveraging transport and storage infrastructure
- Justice and work force considerations



Reference: NASEM, 2019

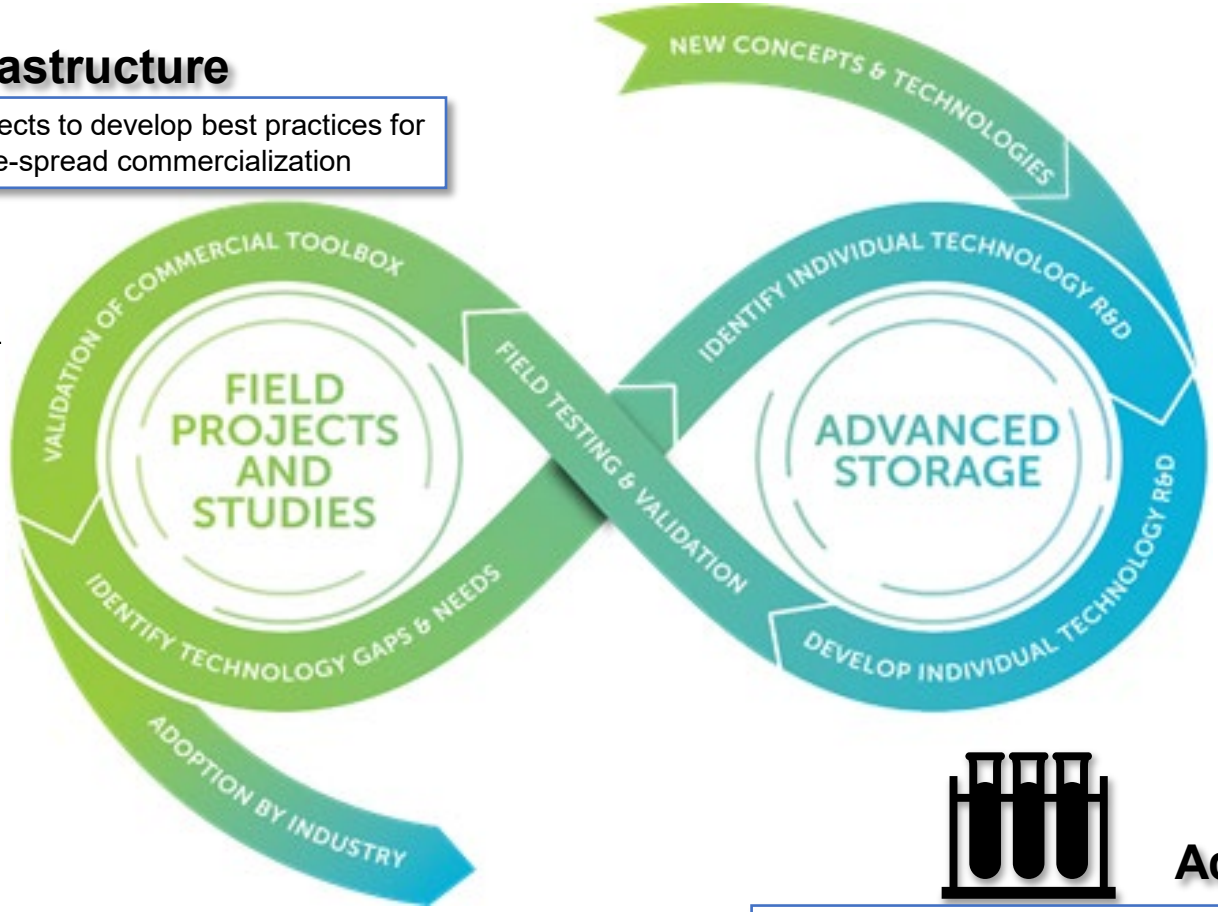
Carbon Transport and Storage RD&D: An Iterative Process towards Deployment

Storage Infrastructure

Large-scale demonstration projects to develop best practices for industry and facilitate wide-spread commercialization

Storage Infrastructure Focus

- CarbonSAFE
- Regional Initiatives
- Offshore Storage
- Brine Extraction Strategy Test **(BEST)**
- Transition of O&G infrastructure



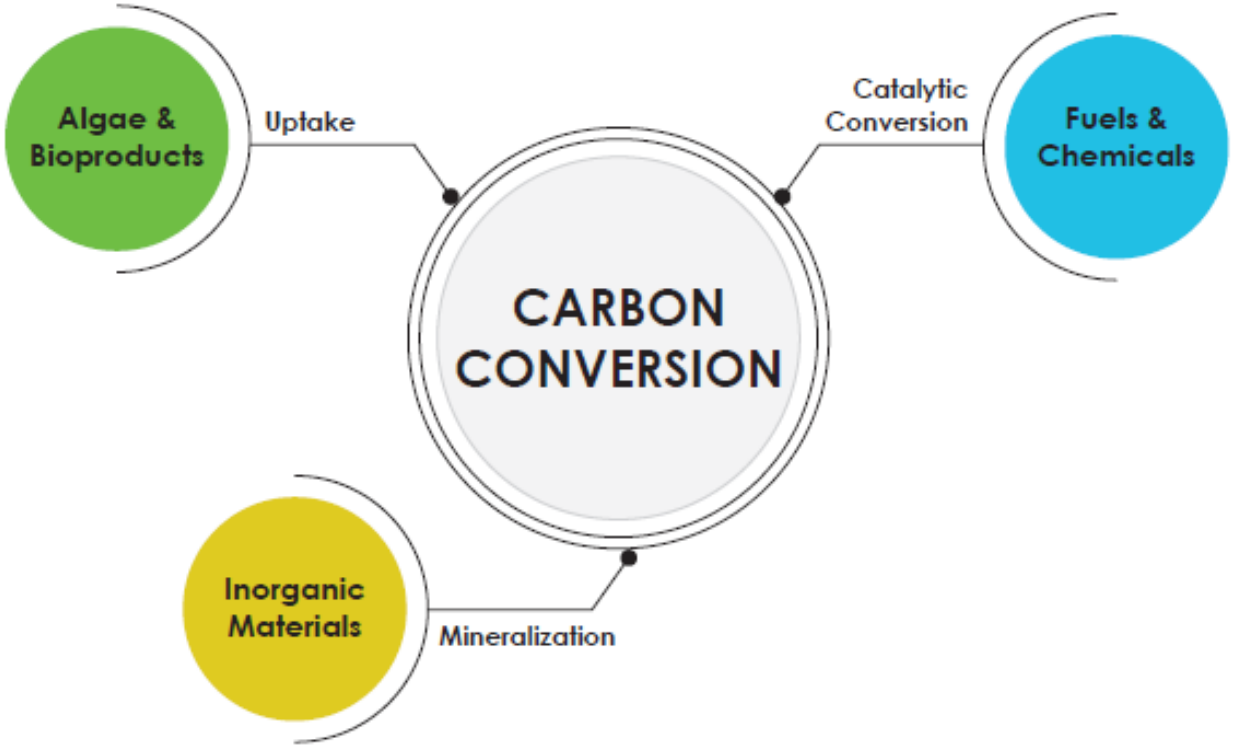
Advanced Storage Focus

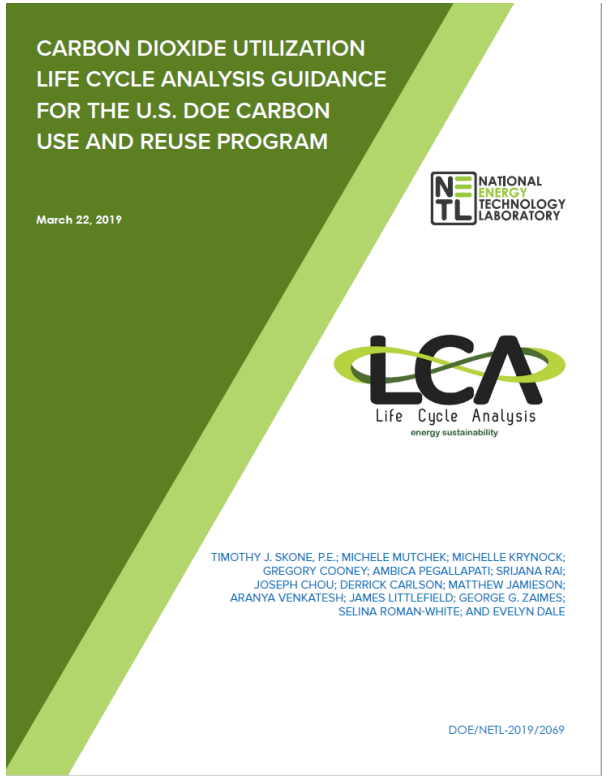
- Well Integrity and mitigation
- Monitoring, verification, and accounting
- Storage complex efficiency and security
- **SMART**: **S**cience-Informed **M**achine Learning for **A**ccelerating **R**eal **T**ime Decisions
- **NRAP:** National Risk Assessment Partnership

Advanced Storage

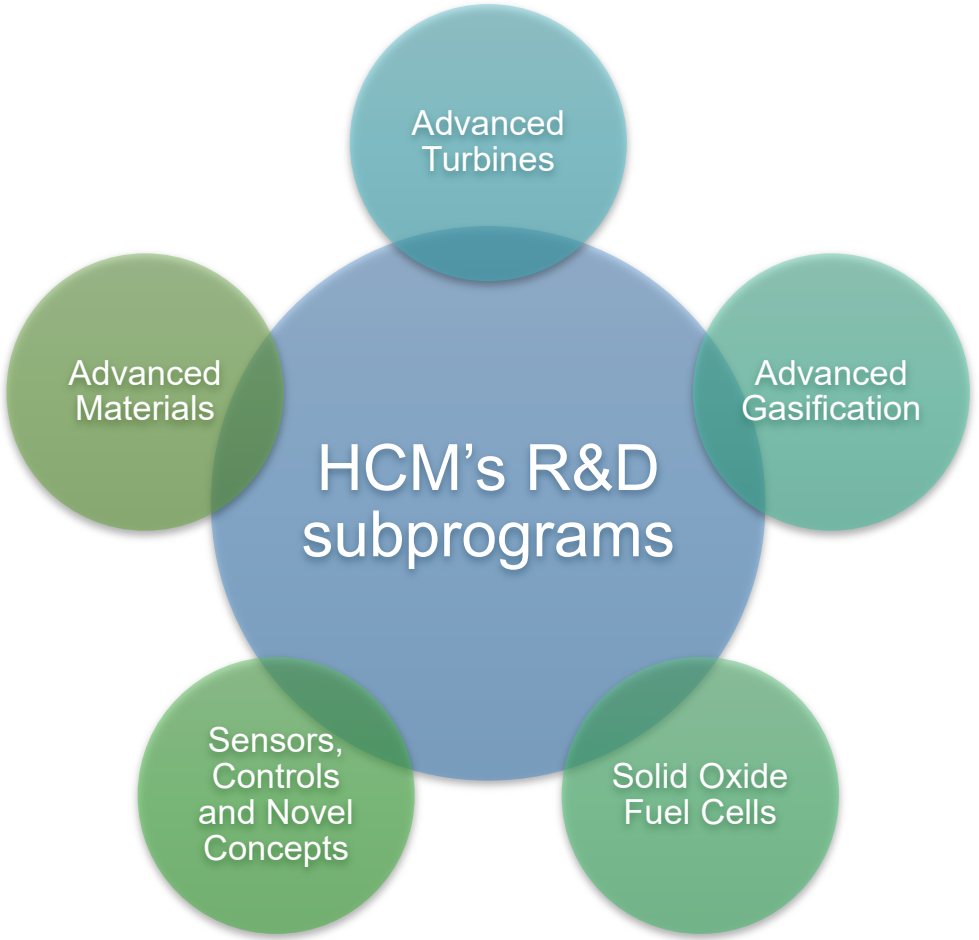
Harness early-stage storage concepts to technology demonstration

CO_2 Conversion (the new "U")





Hydrogen with Carbon Management Division



U.S. DEPARTMENT OF ENERGY

Fossil Energy and Carbon Management

Questions?