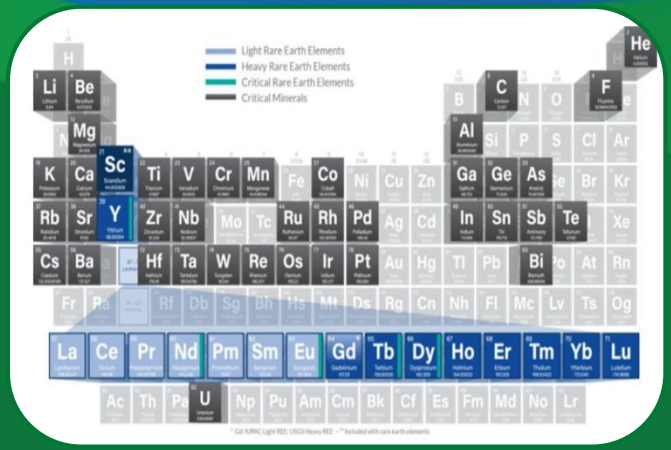
U.S. DEPARTMENT OF ENERGY
Fossil Energy and Carbon Management

FECM Perspectives on Carbon Management

Dr. Emily Grubert

DEPUTY ASSISTANT SECRETARY
OFFICE OF CARBON MANAGEMENT



Fossil Energy and Carbon Management (FECM)

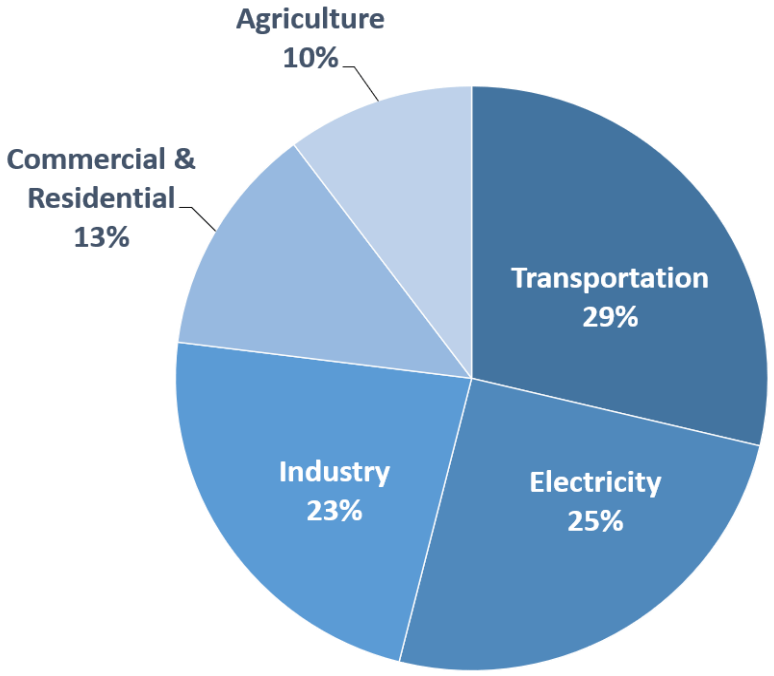
Office of Fossil Energy and Carbon Management

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

CCUS and CDR Facilitate Deep Decarbonization

Reduce the cost of capture/increase rates

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

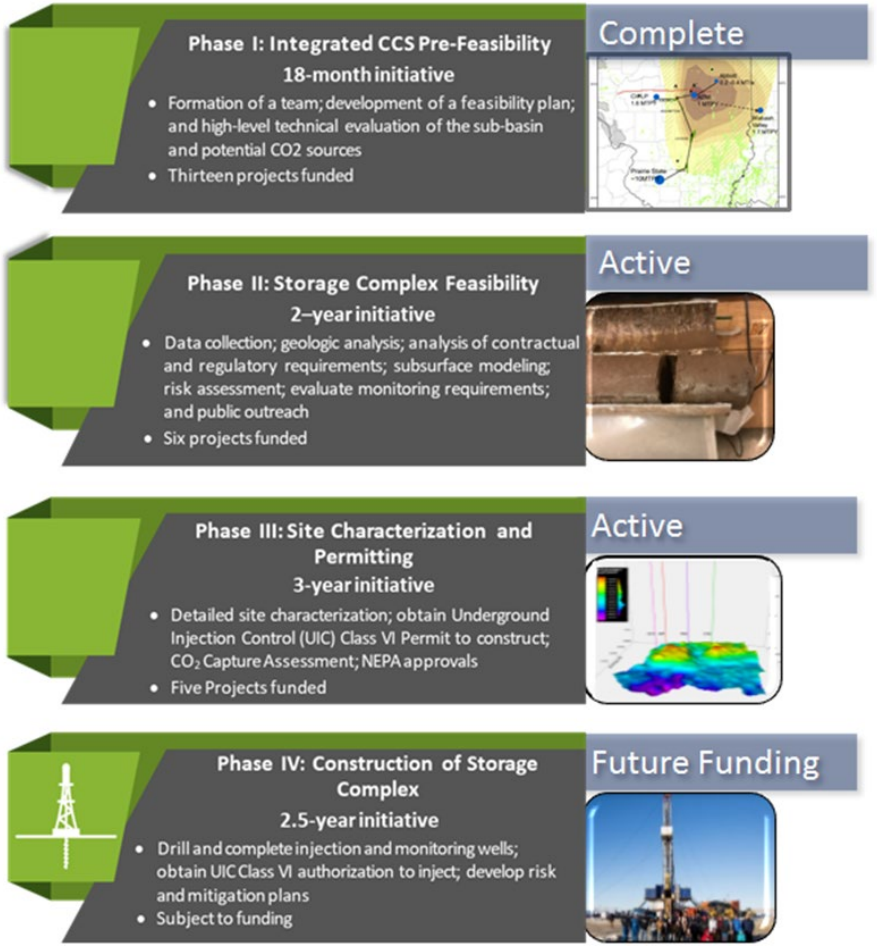
Develop low-carbon supply chains through conversion

- 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

CarbonSAFE - Infrastructure

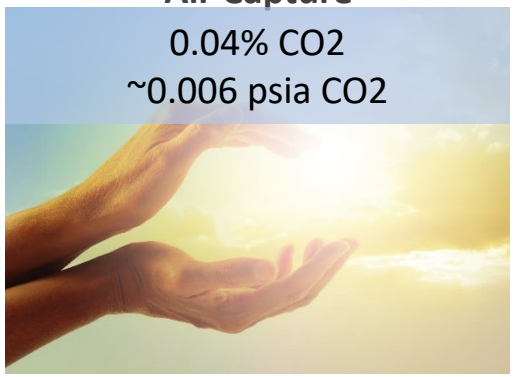


CO_2 Capture Addresses Diverse Sources, and the CO_2 Concentration Affects Technical and Cost Challenges

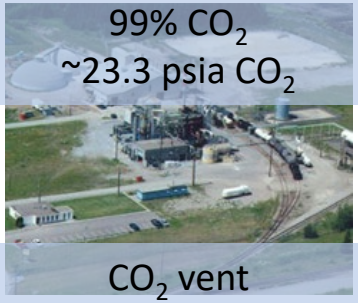
Coal Power Plant

Gas Power Plant

Air Capture

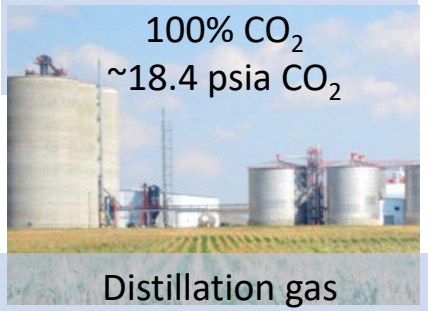


NG Processing Plant

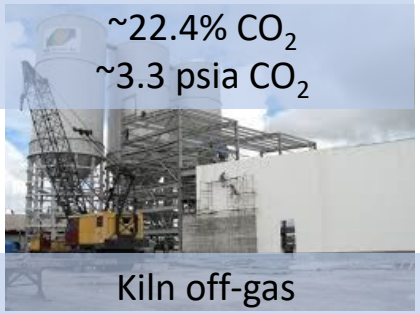


Ammonia Plant

Ethanol Plant



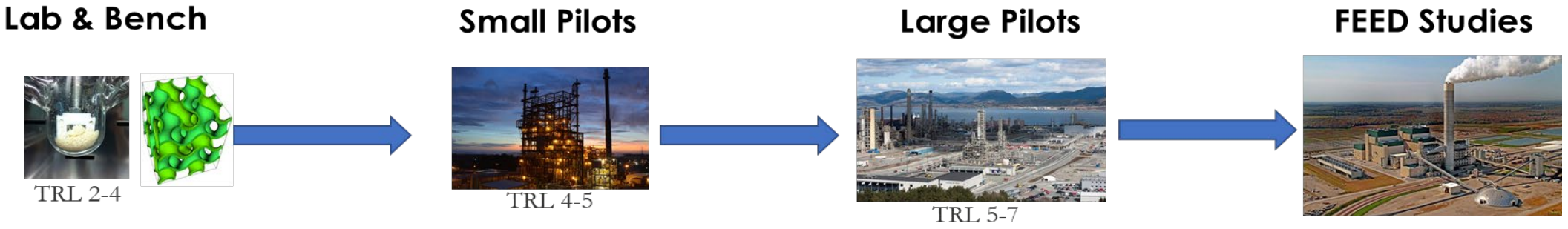
Cement Plant



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

Point Source Capture Program

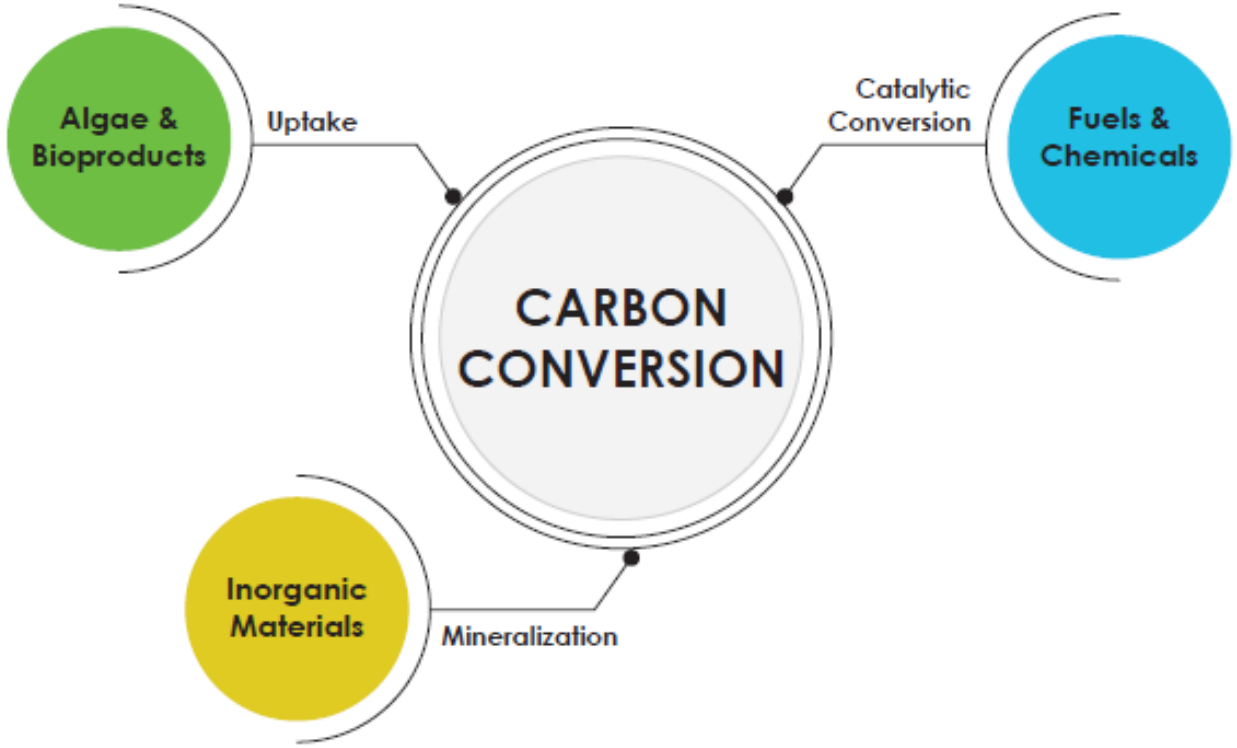
Integrated Approach to Accelerate Technology Development

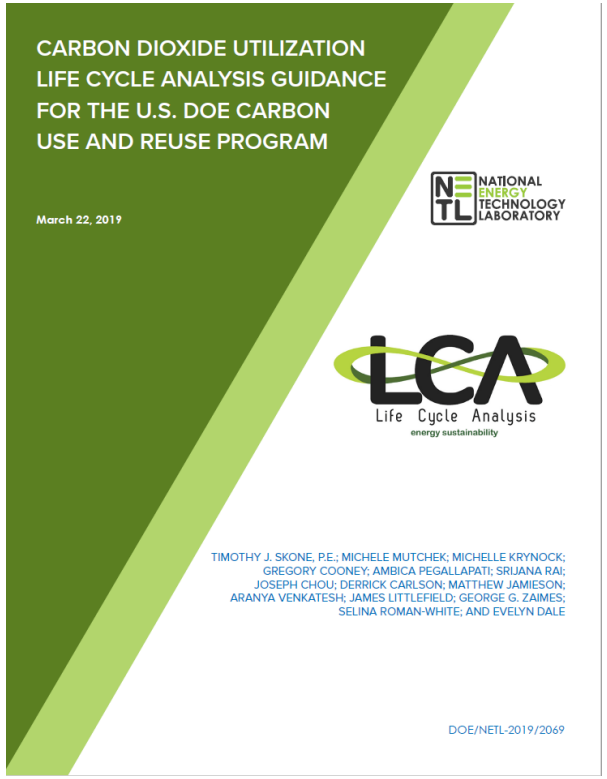


Point Source Capture Focus

- 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.)

CO_2 Conversion (the new "U")





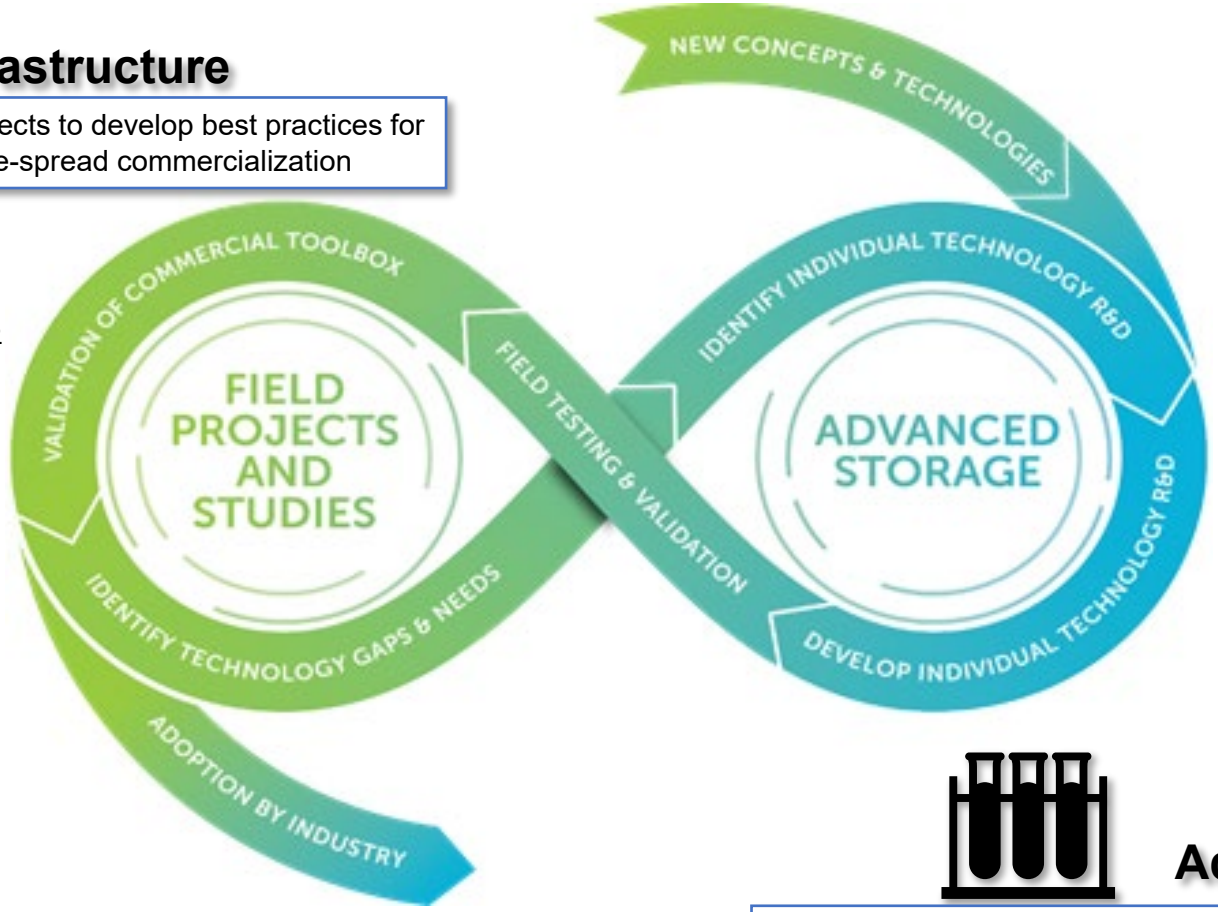
Carbon Transport and Storage RD&D: An Iterative Process towards Deployment

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



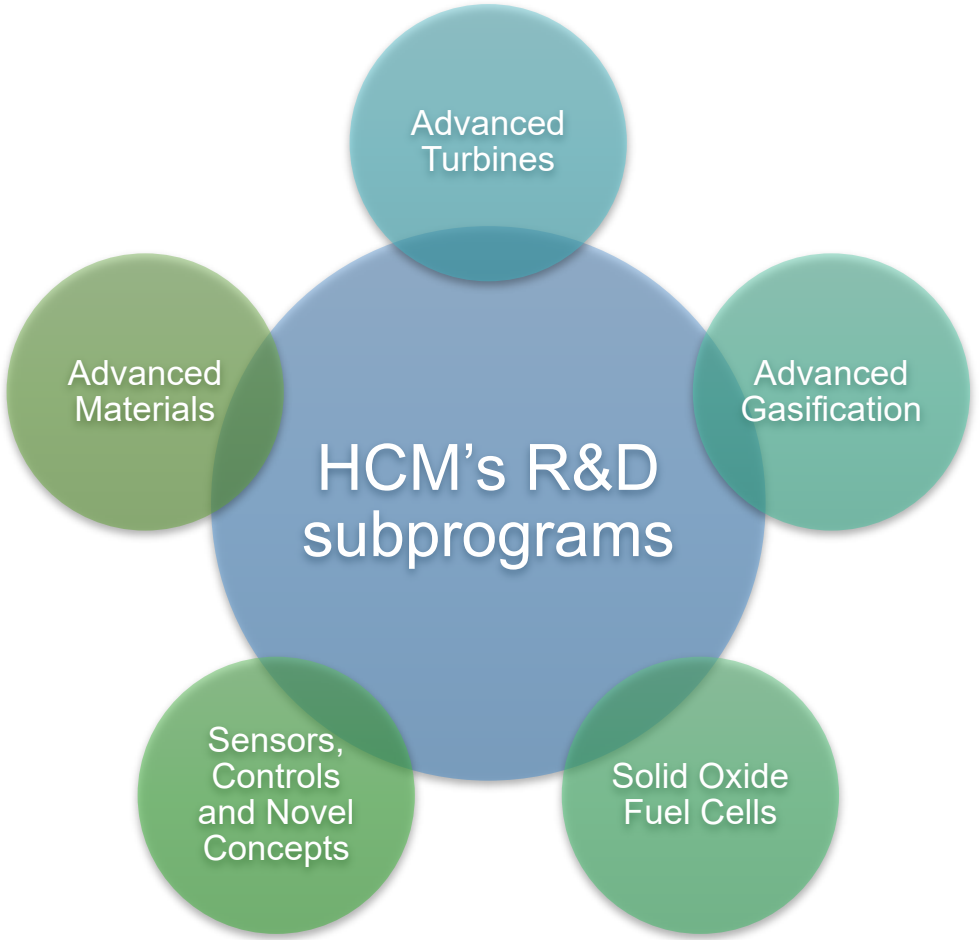
Advanced Storage Focus

- 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

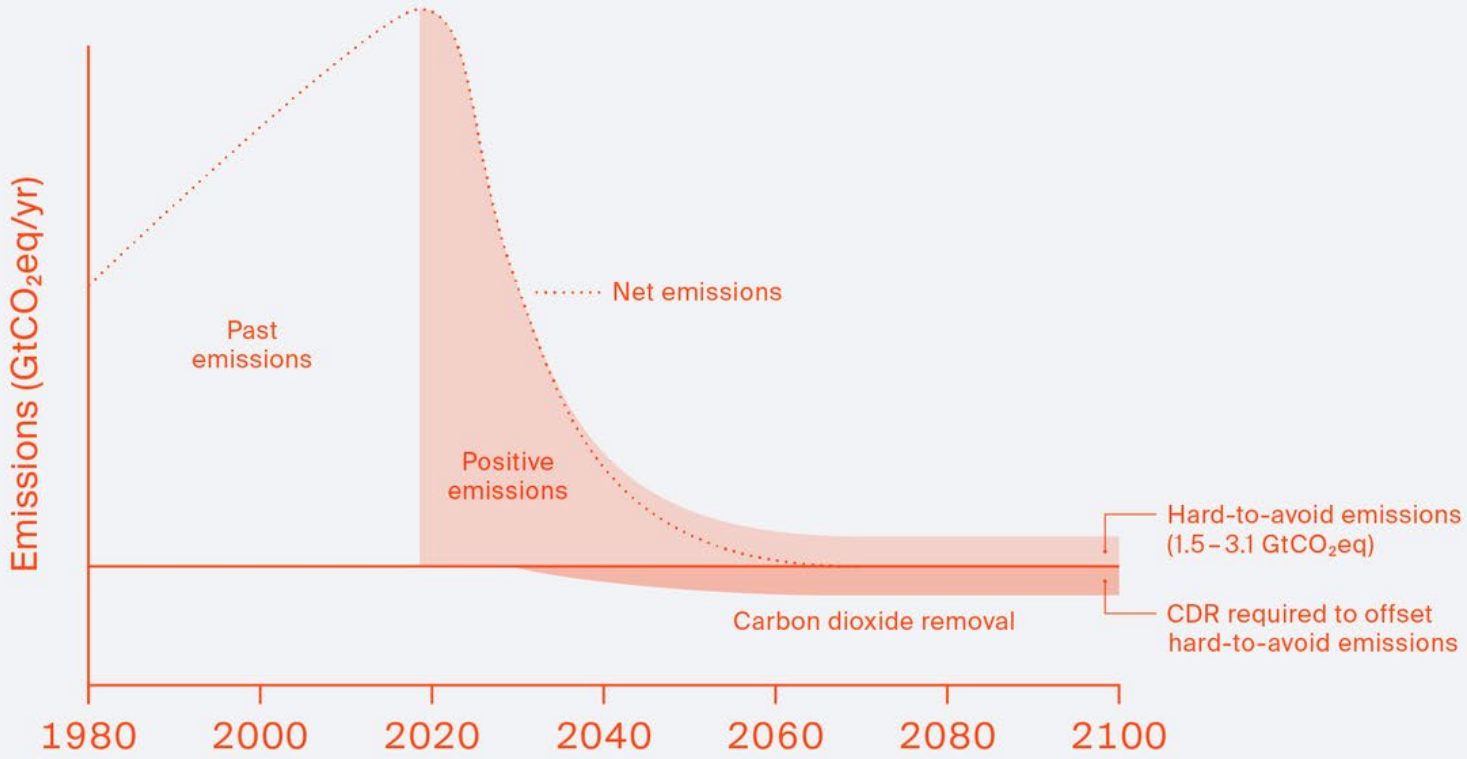
Hydrogen with Carbon Management Division



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)

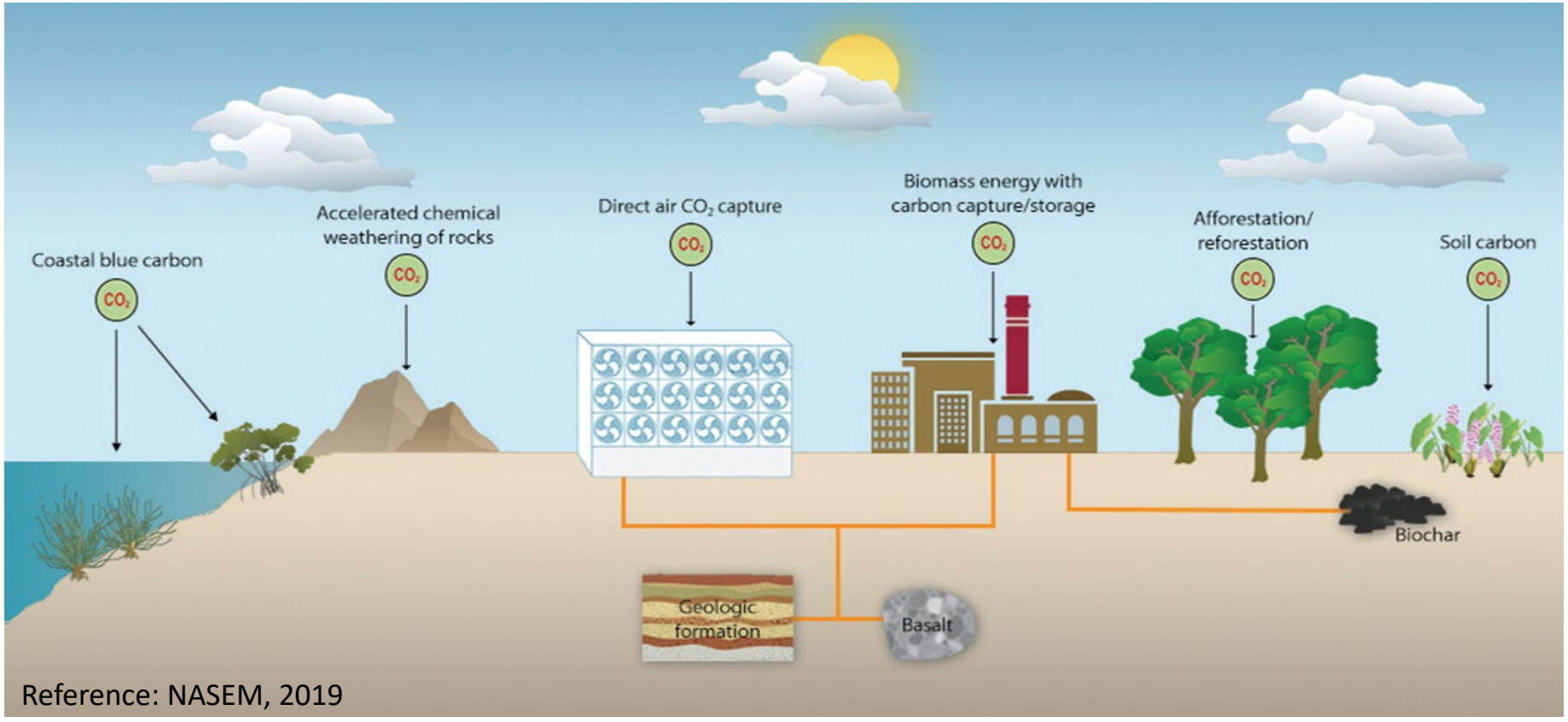


Reference: CDR Primer, 2021

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



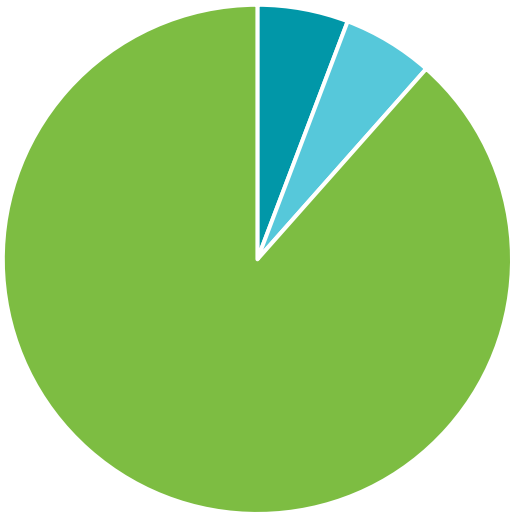
Reference: NASEM, 2019

Carbon Negative Shot: Key Performance Elements

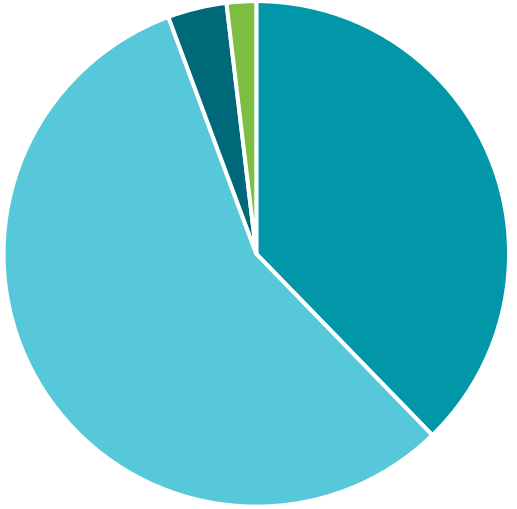
Carbon Negative Shot's key performance elements will guide a responsible industry that is responsive to the climate crisis, such that multiple true, durable removal pathways can be deployed at their most affordable cost at the scale required to address the climate crisis.

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

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

Questions?