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

- Agriculture 10%
- Commercial & Residential 13%
- Transportation 29%
- Electricity 25%
- Industry 23%
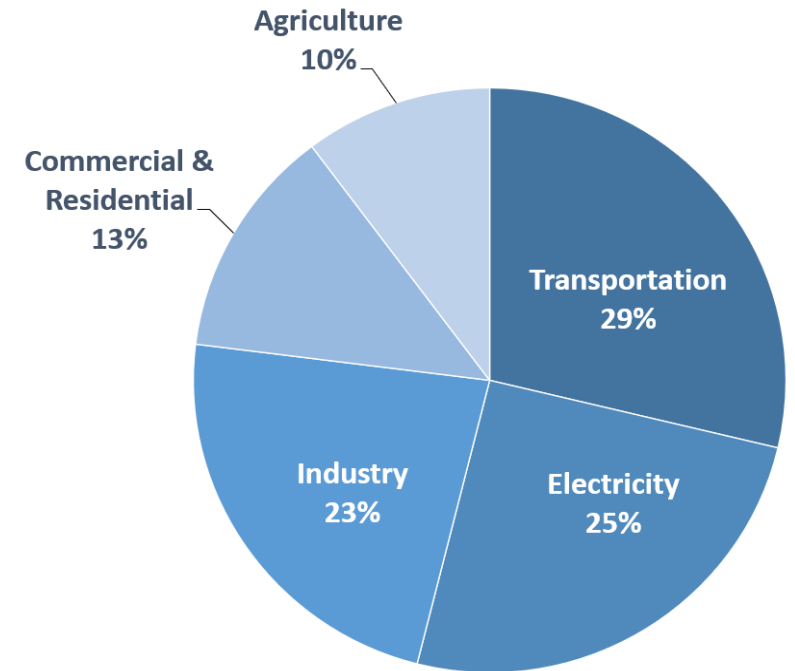
U.S. Environmental Protection Agency (2021). Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2019

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
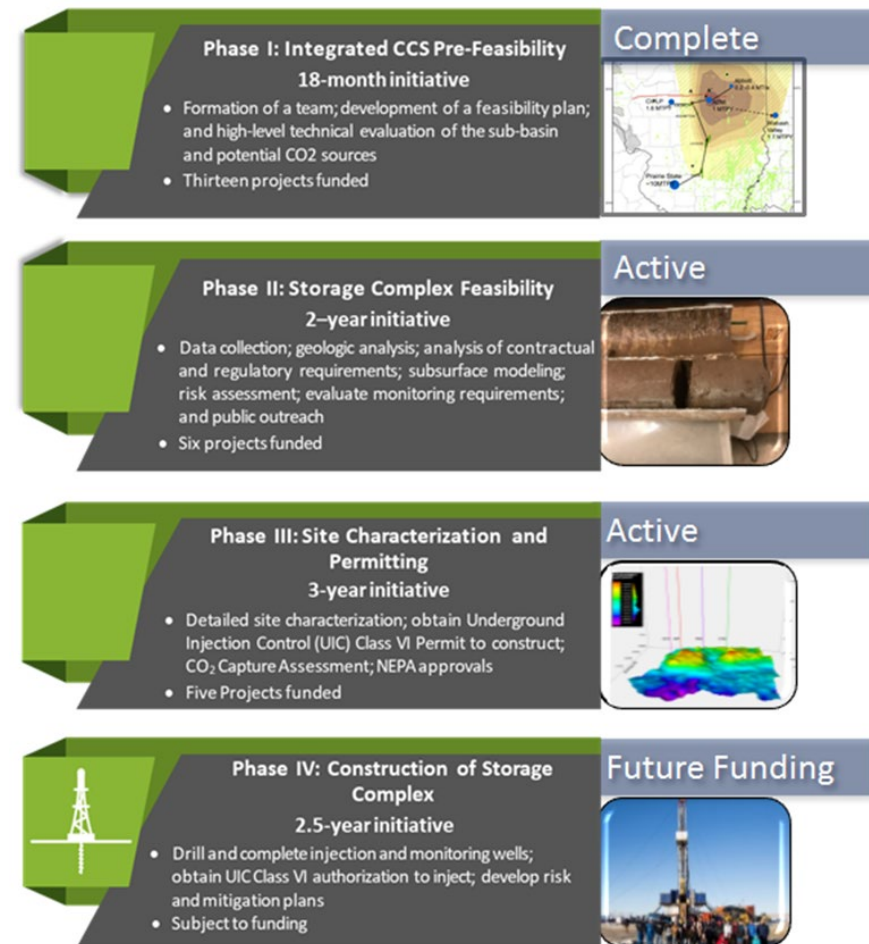- Design Studies and Demonstrations

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

Complete

Phase I: Integrated CCS Pre-Feasibility
18-month initiative
- Formation of a team; development of a feasibility plan; and high-level technical evaluation of the sub-basin and potential CO2 sources
- Thirteen projects funded

Active

Phase II: Storage Complex Feasibility
2–year initiative
- Data collection; geologic analysis; analysis of contractual and regulatory requirements; subsurface modeling; risk assessment; evaluate monitoring requirements; and public outreach
- Six projects funded

Active

Phase III: Site Characterization and Permitting
3-year initiative
- Detailed site characterization; obtain Underground Injection Control (UIC) Class VI Permit to construct; CO₂ Capture Assessment; NEPA approvals
- Five Projects funded

Future Funding

Phase IV: Construction of Storage Complex
2.5-year initiative
- Drill and complete injection and monitoring wells; obtain UIC Class VI authorization to inject; develop risk and mitigation plans
- Subject to funding

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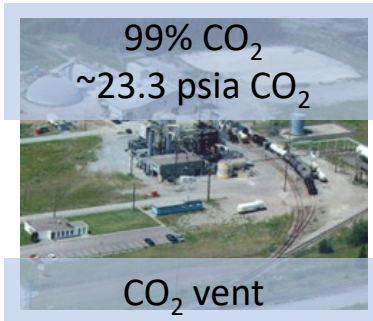
Coal Power Plant

11-14% CO_2
~2 psia CO_2

Gas Power Plant

4-6% CO_2
~0.7 psia CO_2

Air Capture

0.04% CO2
~0.006 psia CO2

NG Processing Plant

99% CO_2
~23.3 psia CO_2

CO_2 vent

Ammonia Plant

99% CO_2
~22.8 psia CO_2

Stripping vent

Ethanol Plant

100% CO_2
~18.4 psia CO_2

Distillation gas

Cement Plant

~22.4% CO_2
~3.3 psia CO_2

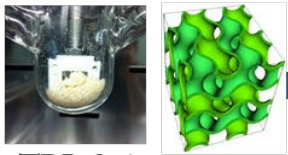Kiln off-gas
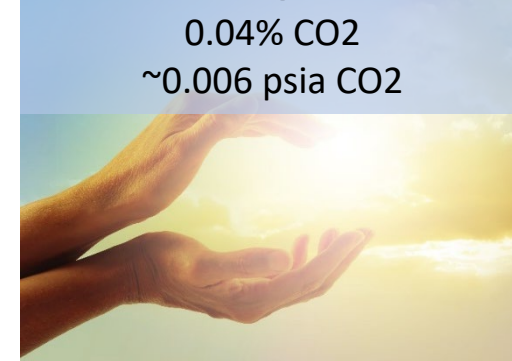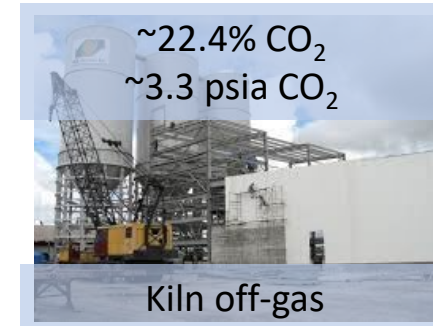
Cost of Capturing CO_2 from Industrial Sources, January 10, 2014, DOE/NETL-2013/1602

Point Source Capture Program

Integrated Approach to Accelerate Technology Development

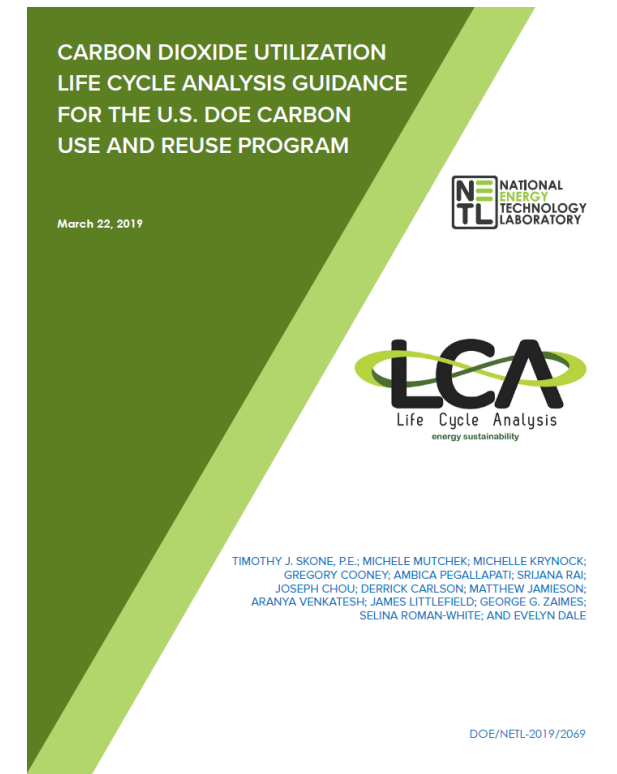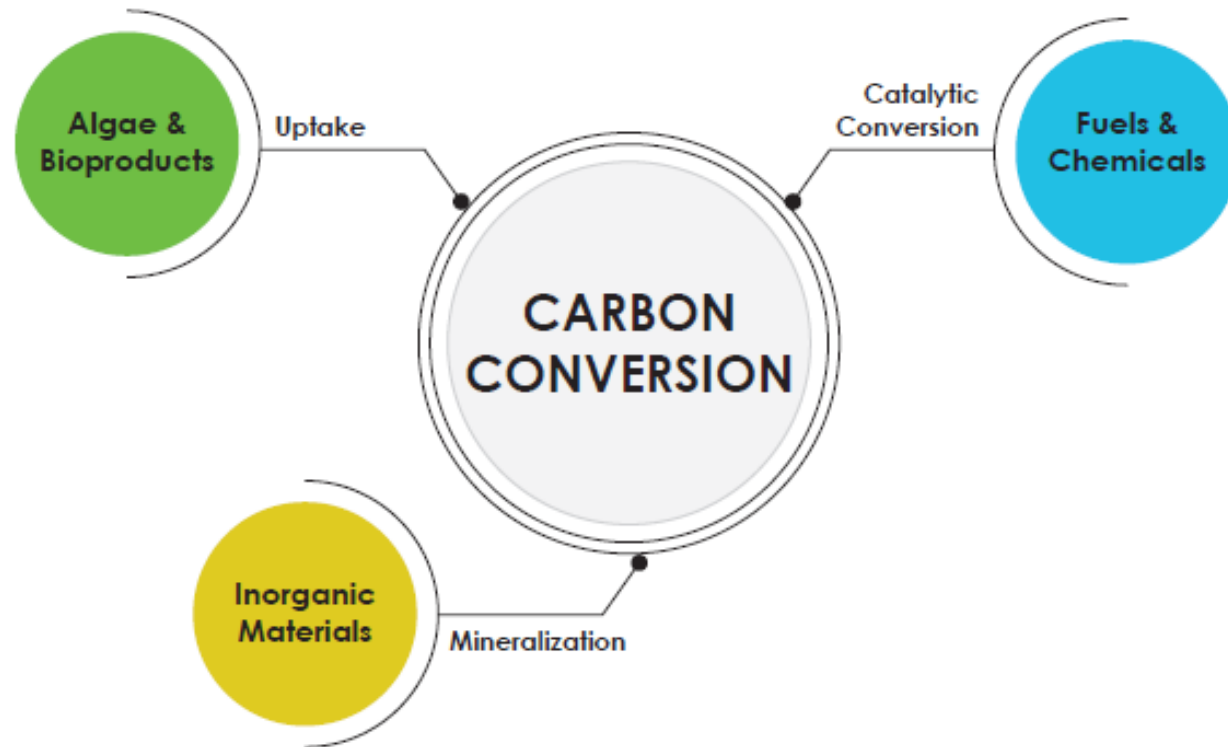Lab & Bench — TRL 2-4

Small Pilots — TRL 4-5
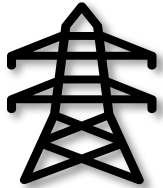
Large Pilots — TRL 5-7

FEED Studies

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 CONVERSION

- Algae & Bioproducts — Uptake
- Fuels & Chemicals — Catalytic Conversion
- Inorganic Materials — Mineralization

CARBON DIOXIDE UTILIZATION LIFE CYCLE ANALYSIS GUIDANCE FOR THE U.S. DOE CARBON USE AND REUSE PROGRAM

March 22, 2019

NATIONAL ENERGY TECHNOLOGY LABORATORY

LCA
Life Cycle Analysis
energy sustainability

TIMOTHY J. SKONE, P.E.; MICHELE MUTCHEK; MICHELLE KRYNOCK; GREGORY COONEY; AMBICA PEGALLAPATI; SRIJANA RAI; JOSEPH CHOU; DERRICK CARLSON; MATTHEW JAMIESON; ARANYA VENKATESH; JAMES LITTLEFIELD; GEORGE G. ZAIMES; SELINA ROMAN-WHITE; AND EVELYN DALE

DOE/NETL-2019/2069

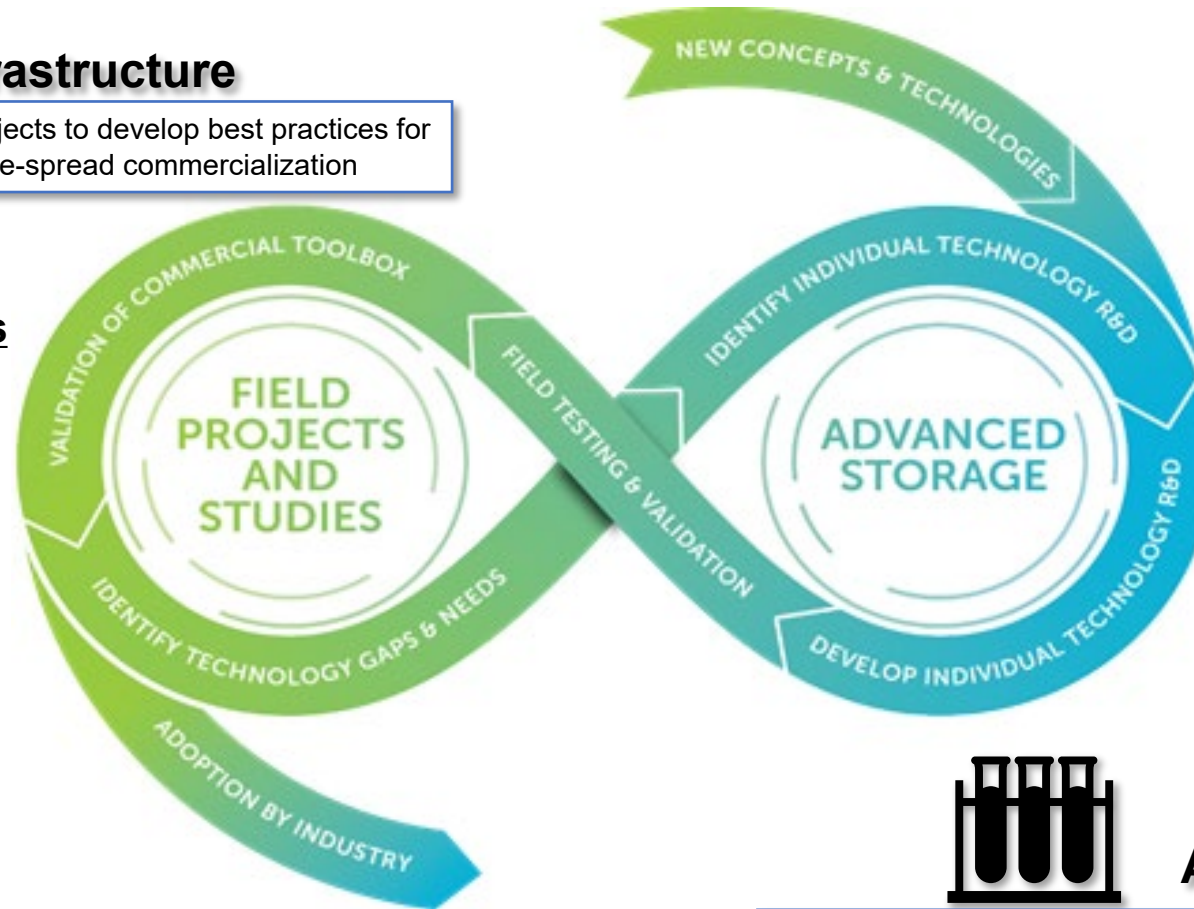# Carbon Transport and Storage RD&D: An Iterative Process towards Deployment

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

NEW CONCEPTS & TECHNOLOGIES

VALIDATION OF COMMERCIAL TOOLBOX

IDENTIFY INDIVIDUAL TECHNOLOGY R&D

FIELD TESTING & VALIDATION

FIELD PROJECTS AND STUDIES

ADVANCED STORAGE

IDENTIFY TECHNOLOGY GAPS & NEEDS

DEVELOP INDIVIDUAL TECHNOLOGY R&D

ADOPTION BY INDUSTRY

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
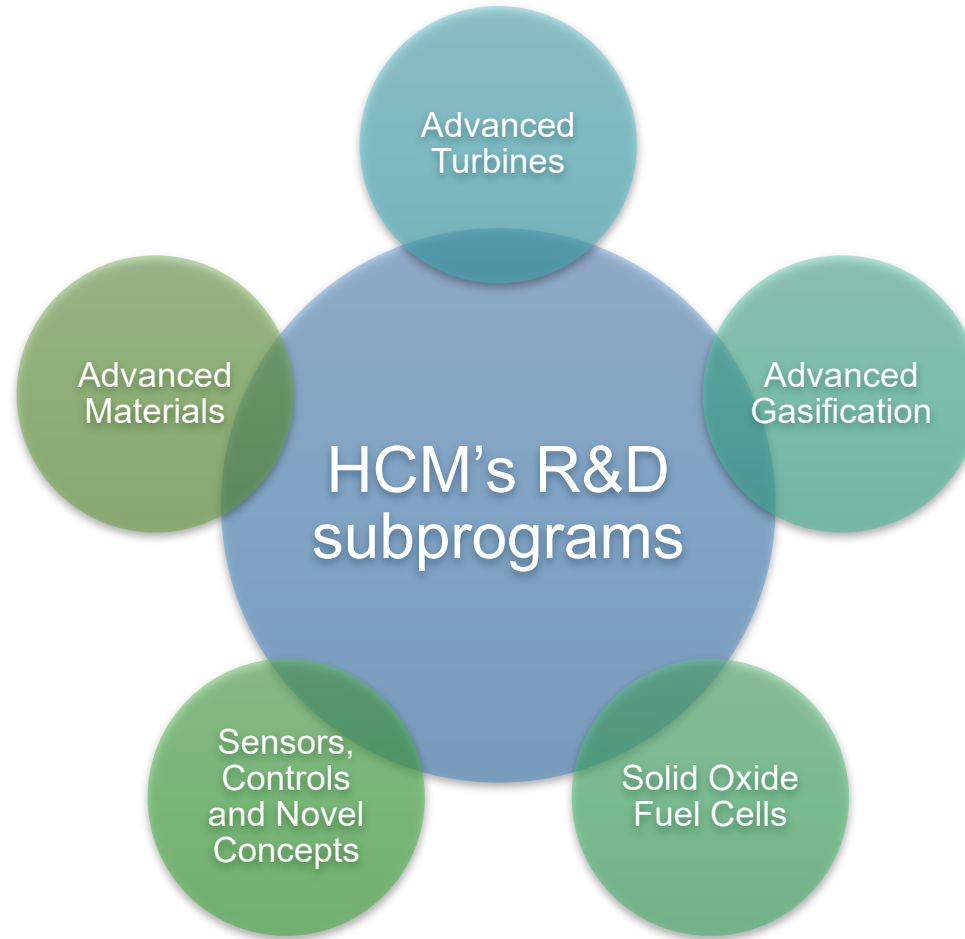- **NRAP:** National Risk Assessment Partnership
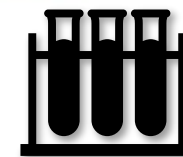
Advanced Storage

Harness early-stage storage concepts to technology demonstration
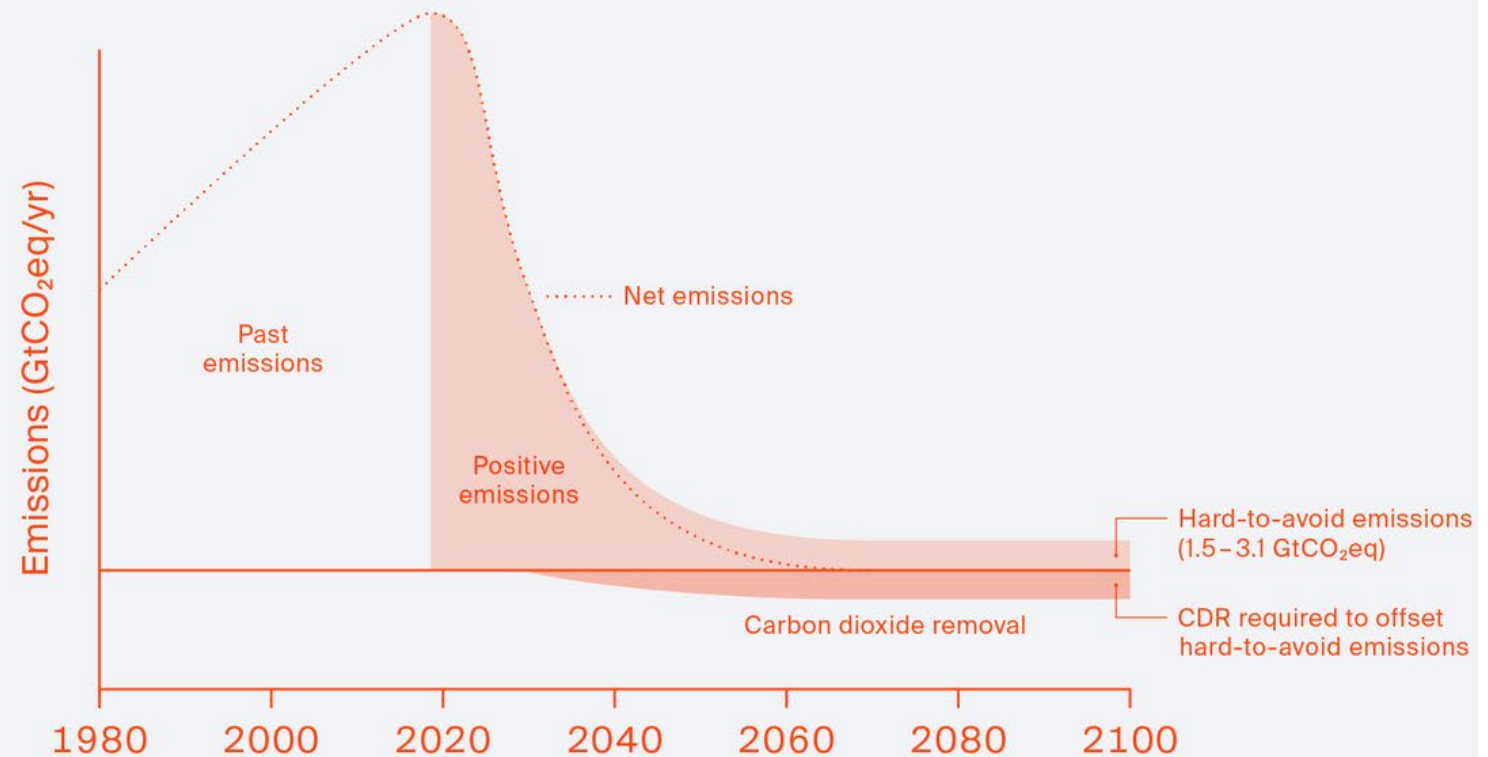
Hydrogen with Carbon Management Division

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

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)

Emissions (GtCO$_2$eq/yr)

Net emissions

Past emissions

Positive emissions

Hard-to-avoid emissions (1.5–3.1 GtCO$_2$eq)

Carbon dioxide removal

CDR required to offset hard-to-avoid emissions

1980   2000   2020   2040   2060   2080   2100

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
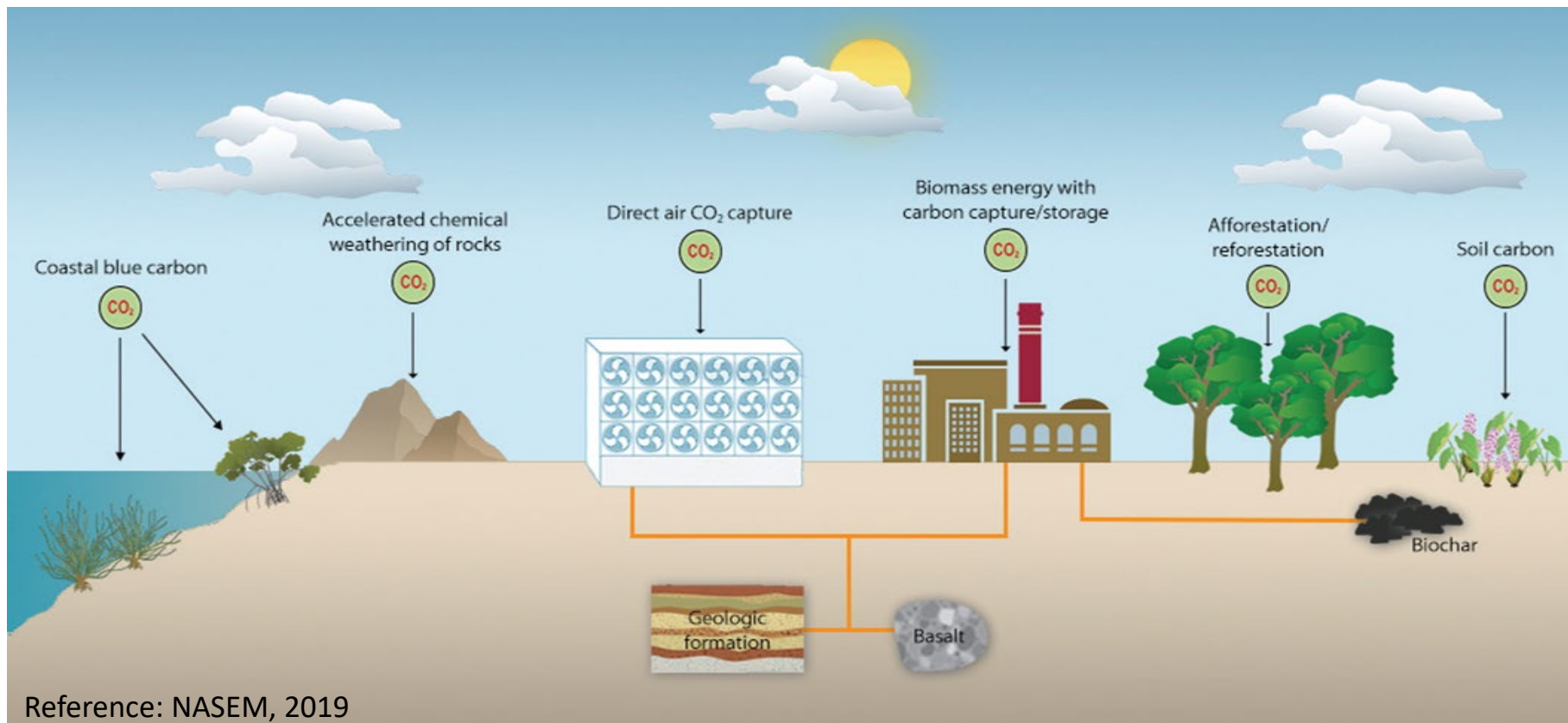
Carbon Negative Shot: Key Performance Elements

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
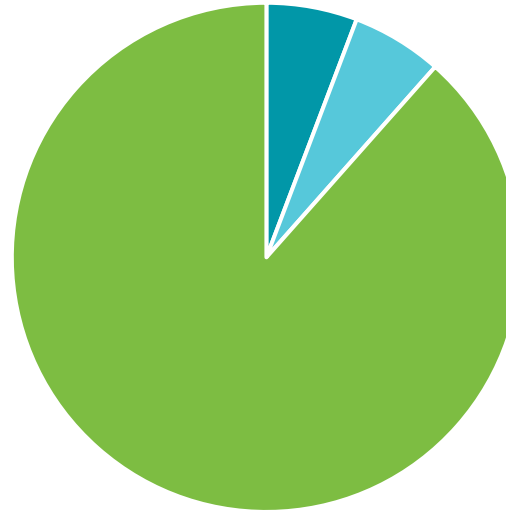
Direct Air Capture and Storage
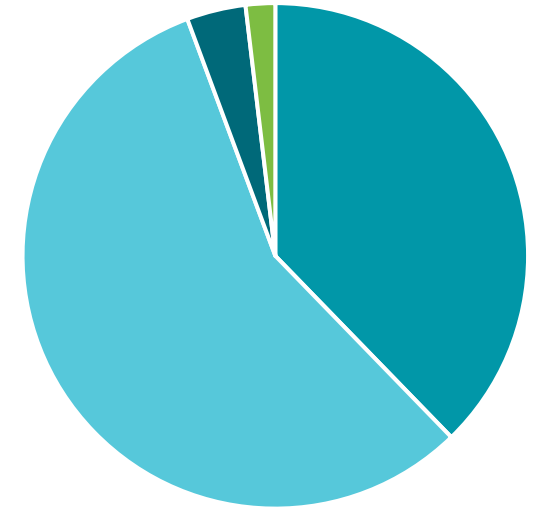
Blue are costs associated with ambient air capture
Green are costs associated with ensuring durable storage

Questions?