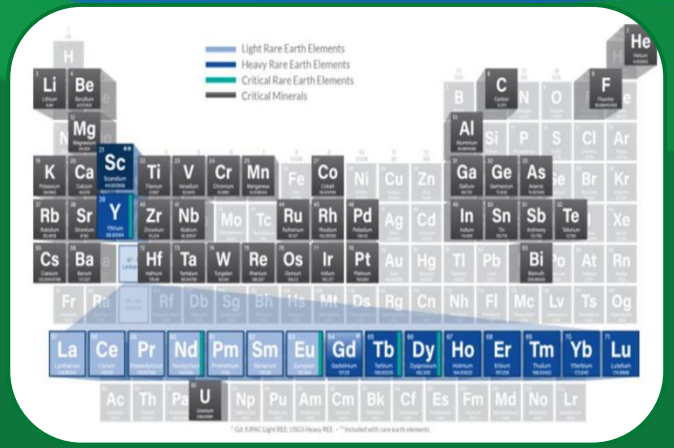
U.S. DEPARTMENT OF ENERGY
Fossil Energy and Carbon Management

The Role of Fossil Energy and Carbon Management in Achieving Net-Zero Greenhouse Gas Emissions Goals

Dr. Jennifer Wilcox

PRINCIPAL DEPUTY ASSISTANT SECRETARY
FOSSIL ENERGY AND CARBON MANAGEMENT

May 3, 2022



Fossil Energy and Carbon Management (FECM)

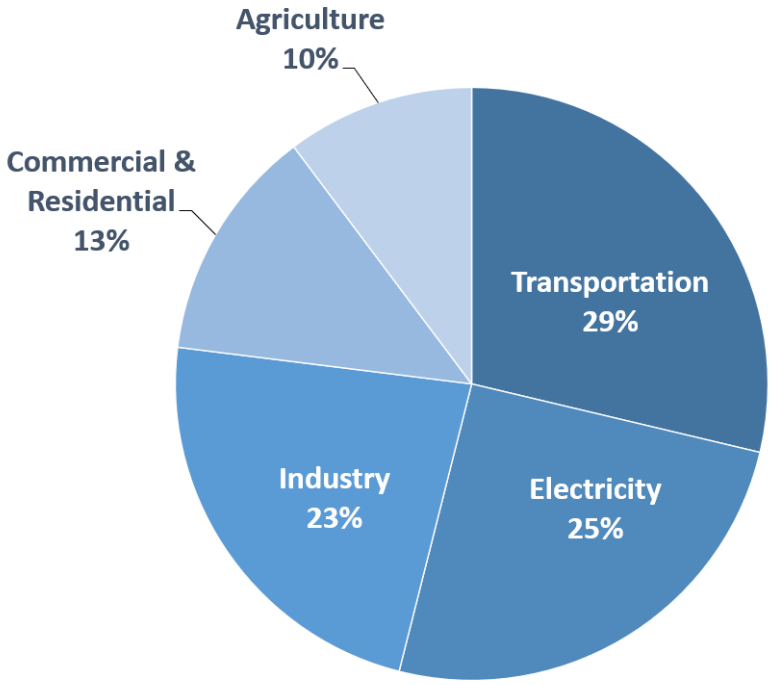
Office of Fossil Energy and Carbon Management

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 Strategic Vision

Advancing Carbon Management Approaches Toward Deep Decarbonization

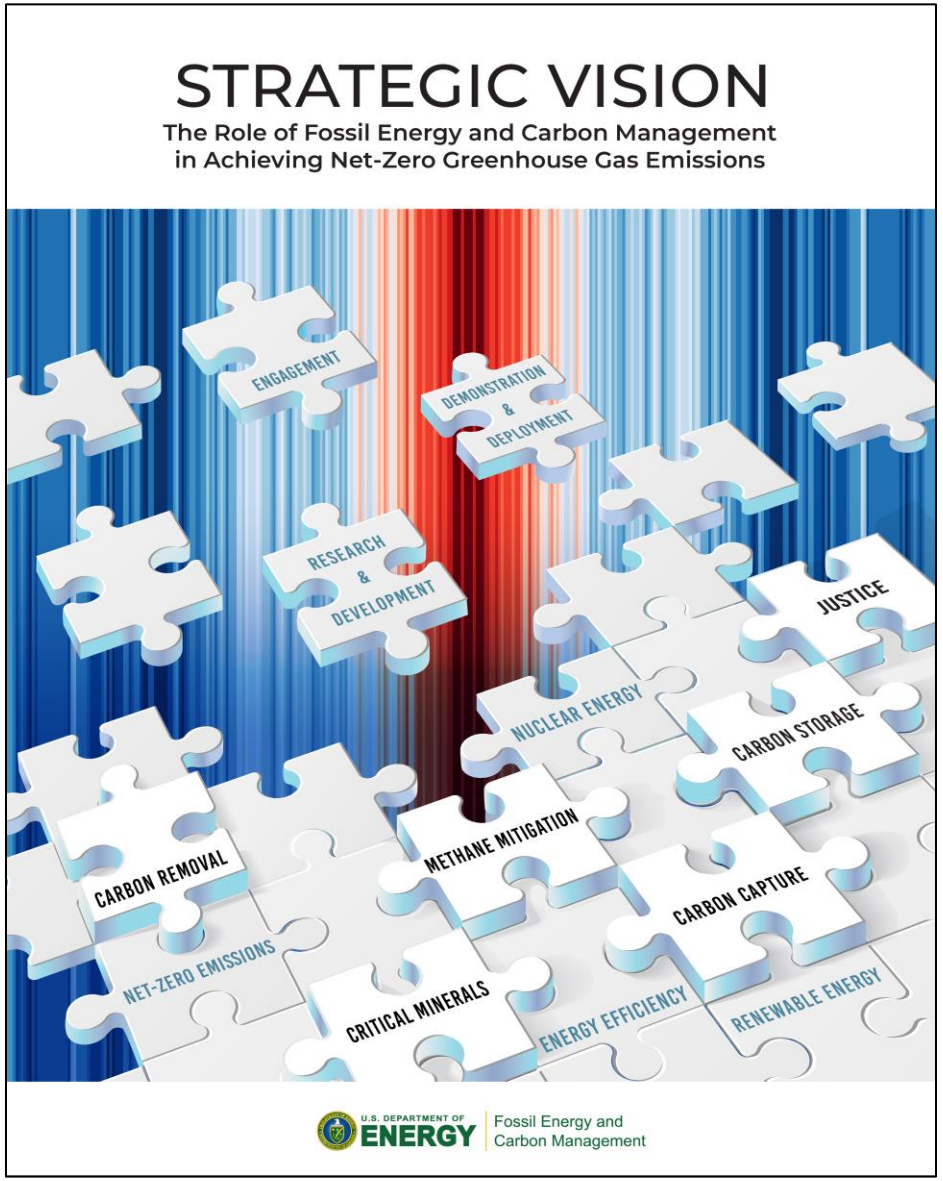
Priorities: *Point-source carbon capture, carbon dioxide conversion, carbon dioxide removal (CDR), and reliable carbon transport and storage*

Advancing Technologies that Lead to Sustainable Energy Resources

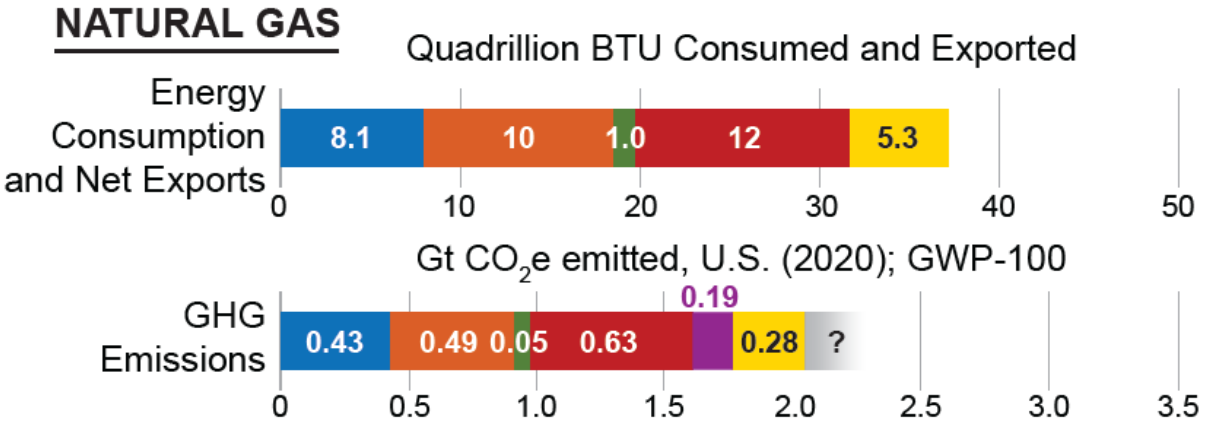
Priorities: *Hydrogen with carbon management, domestic critical minerals (CMs) production, and methane mitigation*

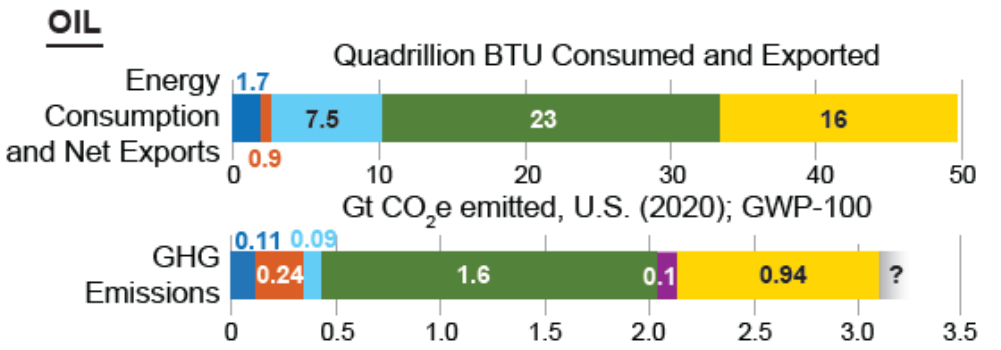
Advancing Justice, Labor, and Engagement

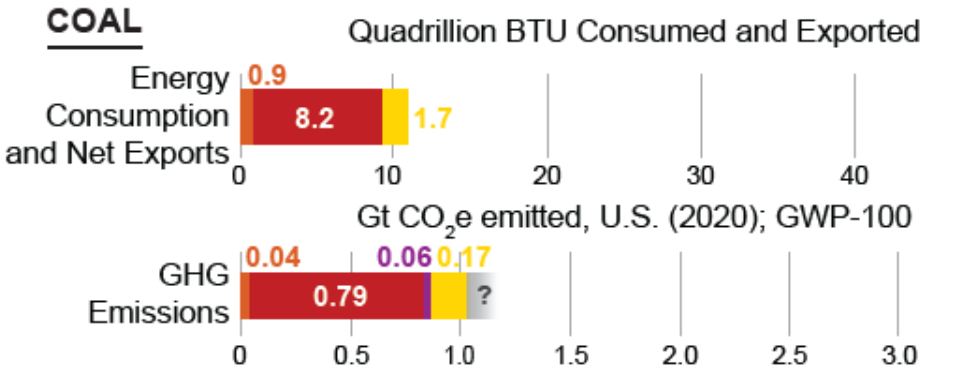
Priorities: *Justice, labor, and international and domestic partnerships*



Fossil Energy and Role of Carbon Management







- Heat (commercial, residential)
- Heat (industrial)
- Industry (non-heat)
- Transportation
- Electric Power
- Supply Chain
- Exports
- Additional unknown supply chain emissions associated with coal, natural gas and oil production. Both quantification and mitigation of these emissions is an FECM priority.

FECM Mission

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)

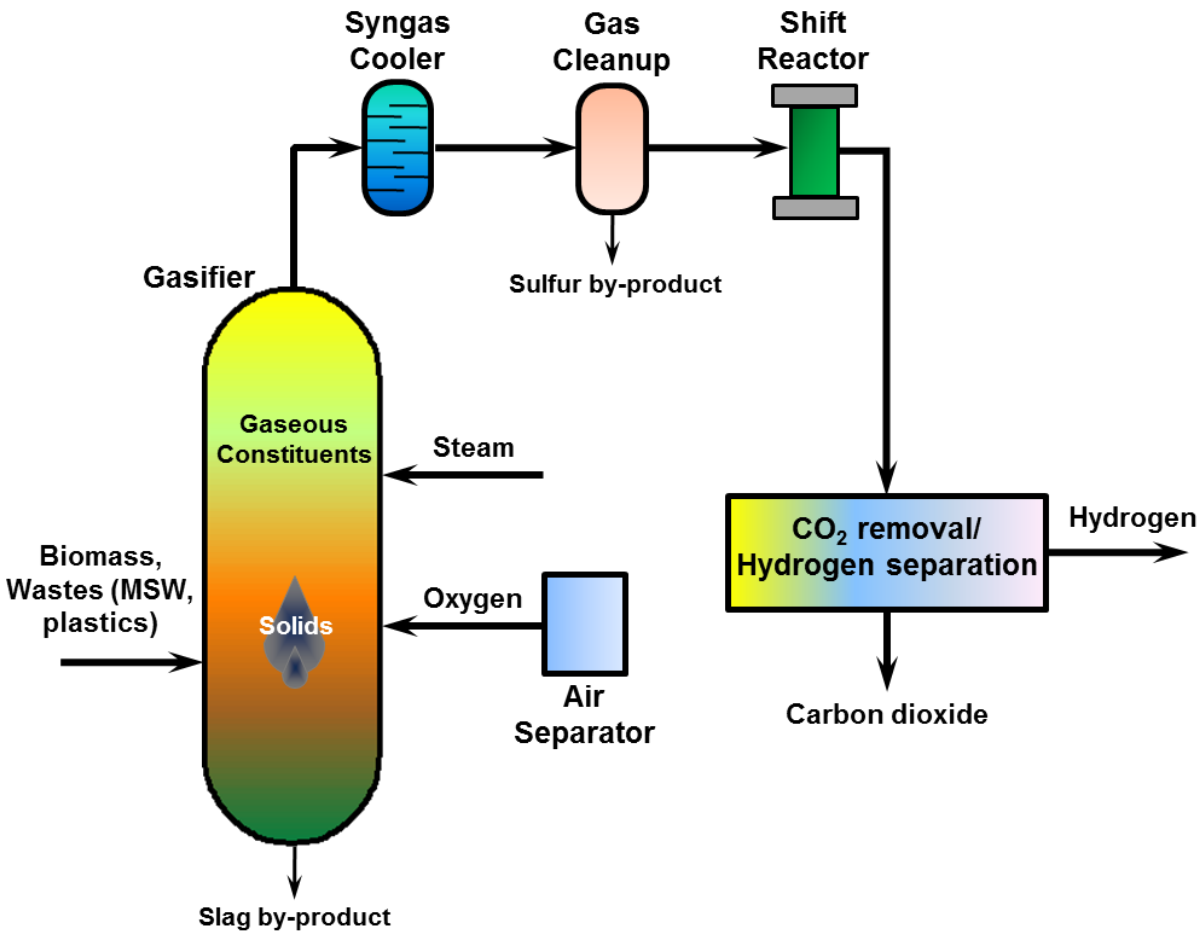
Supporting Legacy Communities (Justice)

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

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

Clean Hydrogen Production with Feedstock Flexibility

- Gasification enables versatile use of sustainably-sourced biomass plus wastes (MSW, plastic) as feedstock
- Gasification pathway to clean hydrogen
  - low carbon
  - When coupled to CCS, sustainably-sourced biomass enables net-negative emissions



Addressing Gasification Technology Challenges

Today's Approach

- Multiple Unit Ops/Separate Reactors and Process Steps
  - Gasifier
  - Syngas cleanup
  - Multiple-stage Water gas Shift
  - CO_2 separation
- Air Separation
  - Cryogenic (big and expensive, worse at small scale)
  - Membranes (costly, purity limitations)
- Hydrogen Separations/Carbon Capture
  - Energy intensive (PSA, solvent approaches)

Solutions

- Process Intensification
- Advanced Air Separation
- Novel High-Purity Hydrogen Separations
- Modular Gasification and Processes

Upcoming Hydrogen R&D (1)

- Clean Hydrogen Cost Reductions via Process Intensification & Modularization for Hydrogen Shot (FOA 2400 Amend. 6 – 11 applications)
  - Innovative modular systems enabling lower capital investment and accessing viable market applications
  - Overcome economy of scale limitations
  - Support Hydrogen Shot initiative's goal (1:1:1)

- Clean Hydrogen from High-Volume Waste Materials and Biomass (FOA 2400 Amend. 6 – 10 applications)
  - Enabling gasifier technology & processes for complex mixtures of carbonaceous feedstocks
  - Targeted feedstock use addresses environmental liabilities
  - Inexpensive feedstock use helps Hydrogen Shot targets

Upcoming Hydrogen R&D (2)

- Sensors & Controls for Co-gasification of Waste Plastics in Production of Hydrogen with Carbon Capture (FOA 2400 Amend. 6 – 4 applications)
  - Enabling sophisticated control of gasification of mixed wastes feedstocks
  - Robust sensors & controls essential to process cost reductions helping Hydrogen Shot

- Front-End Engineering Design Studies for Carbon Capture and Storage Systems at Domestic Industrial Facilities Producing H_2 from Natural Gas
  - Understand system costs, performance, and business cases for point source carbon capture at current fleet of hydrogen plants
  - Accelerate deployment of clean hydrogen
  - Achieve greenhouse gas reduction targets noted in Executive Order 14008

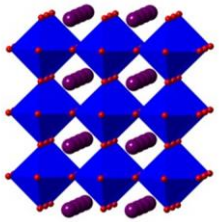
Advances in Low-cost Oxygen

Enabling pre-combustion carbon capture, cost reductions

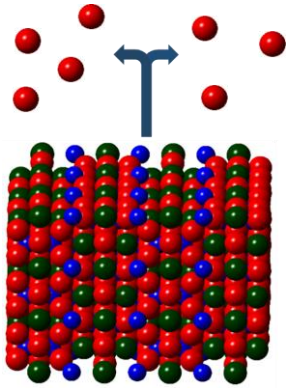
Oxygen Sorbent-Based Technology

NATIONAL ENERGY TECHNOLOGY LABORATORY

Perovskites

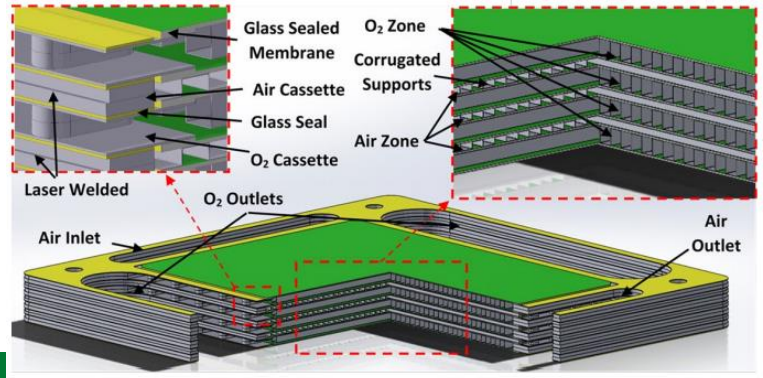


- Easily reduced/oxidized
- Compositional flexibility
- Tuneable oxygen capacity and temperature range
- Stable



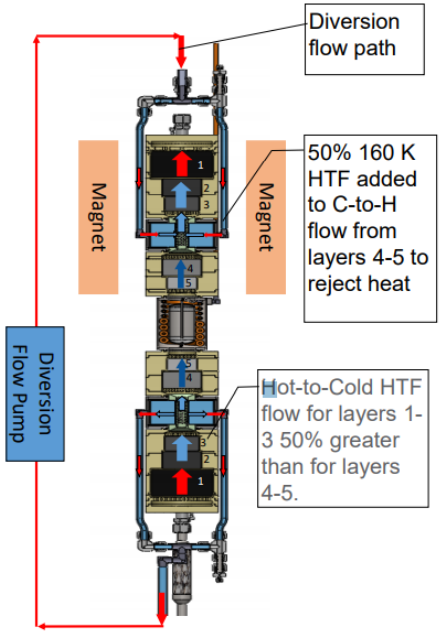
Pressure Driven Oxygen Separation

Pacific Northwest NATIONAL LABORATORY



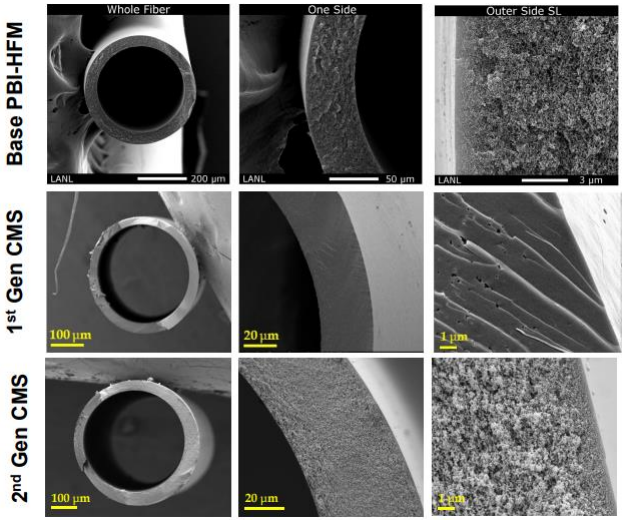
Magnetocaloric Cryogenic System

Pacific Northwest NATIONAL LABORATORY



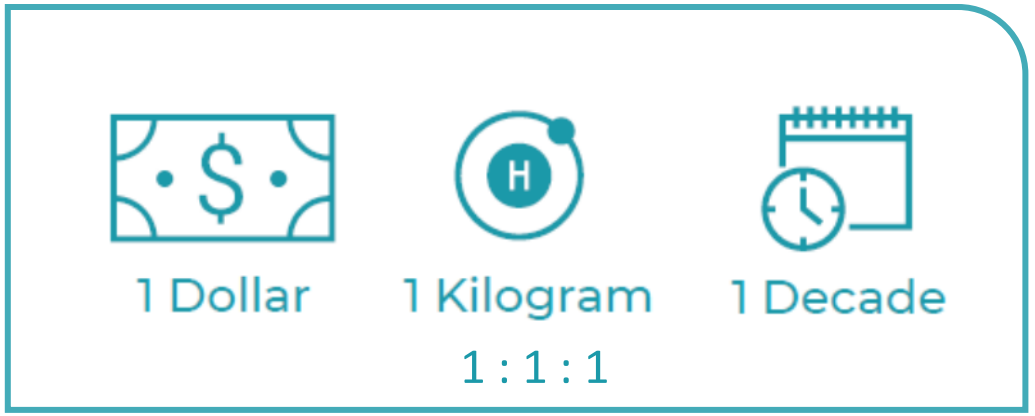
Carbon Molecular Sieve Hollow Fiber Membranes

Los Alamos NATIONAL LABORATORY EST. 1943



Hydrogen Shot: first of the Energy Earthshots

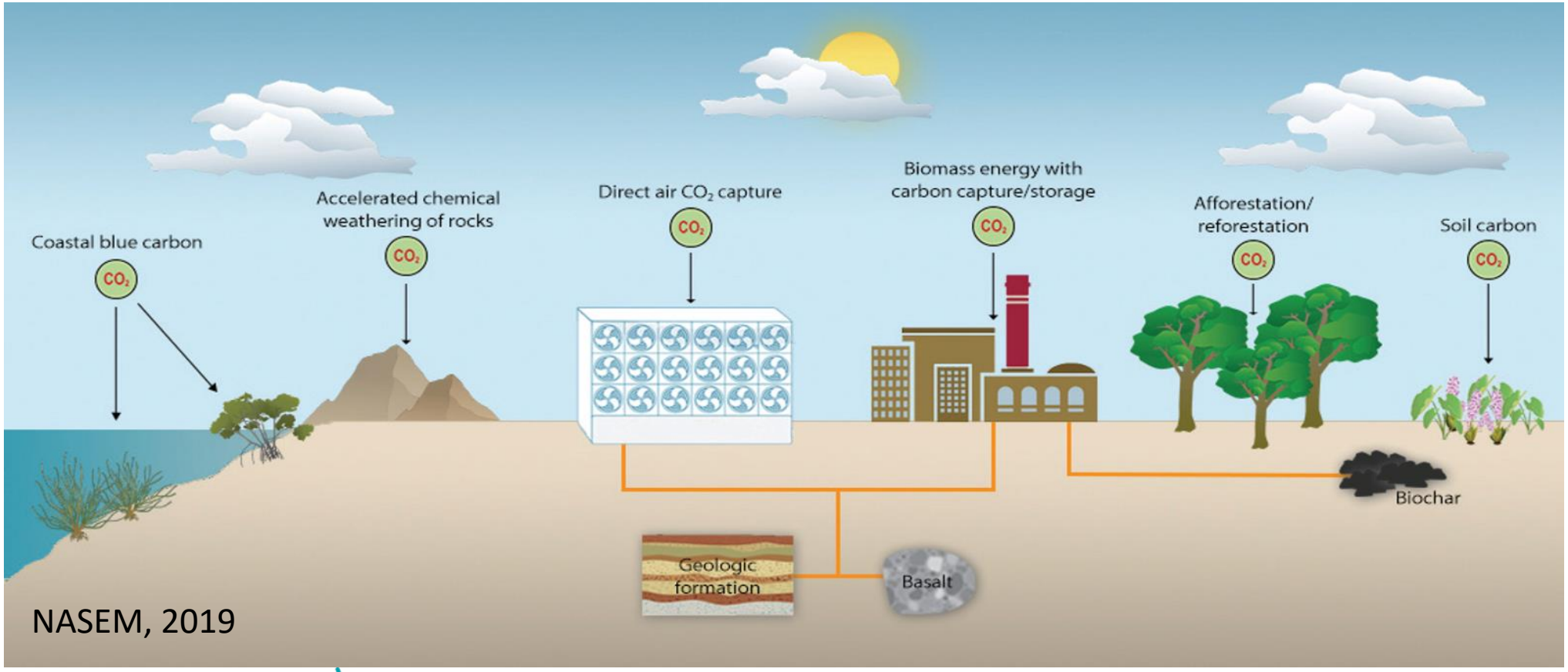
- Accelerate breakthroughs: abundant, affordable, and reliable clean energy
- Facilitate clean hydrogen cost reductions
- Creates $140 billion revenues and 700,000 jobs by 2030



Hydrogen Shot seeks $1/kg clean hydrogen within the decade

NETL gasification Research & Development targeted to increase efficiency and lower costs of hydrogen production to help achieve administration targets
https://www.energy.gov/eere/fuelcells/hydrogen-shot

Carbon Dioxide Removal

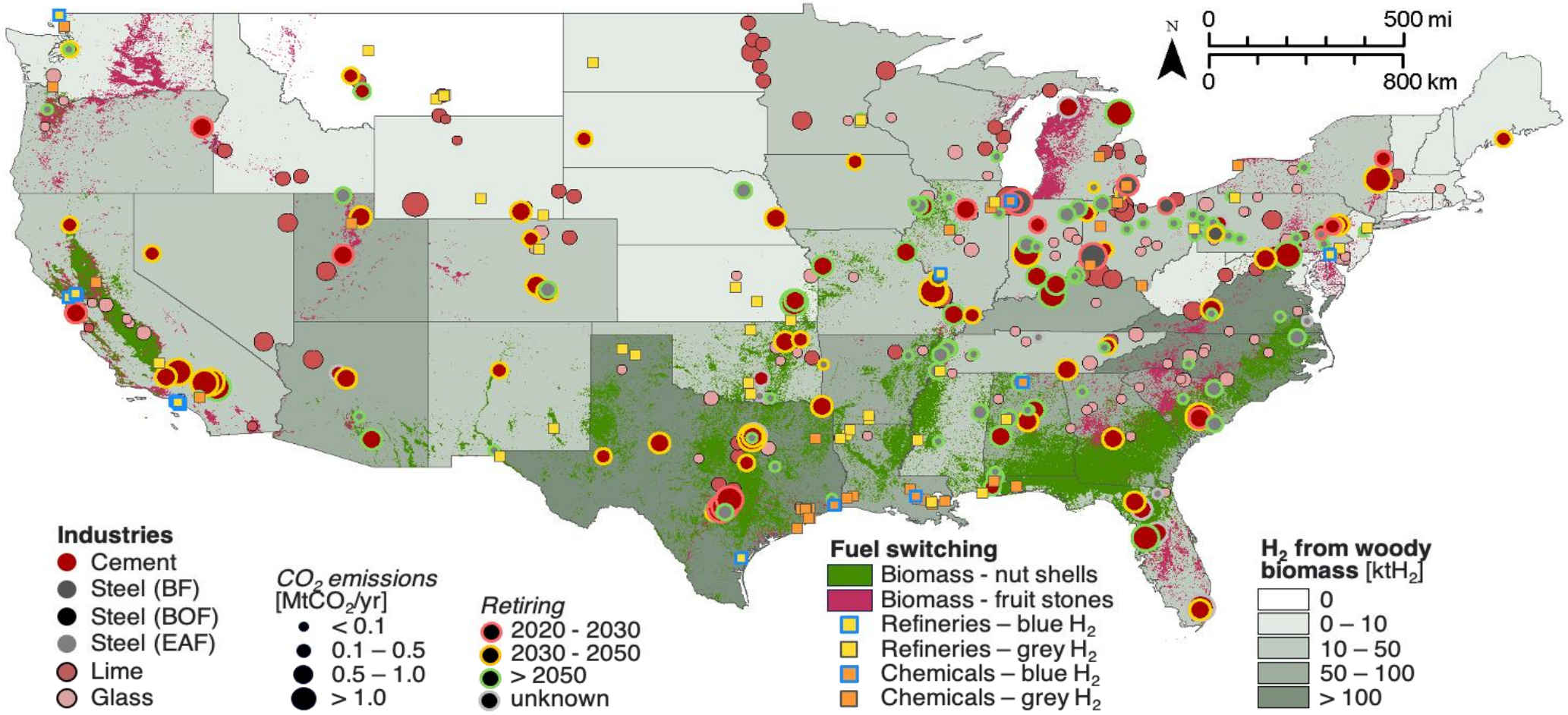


NASEM, 2019

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

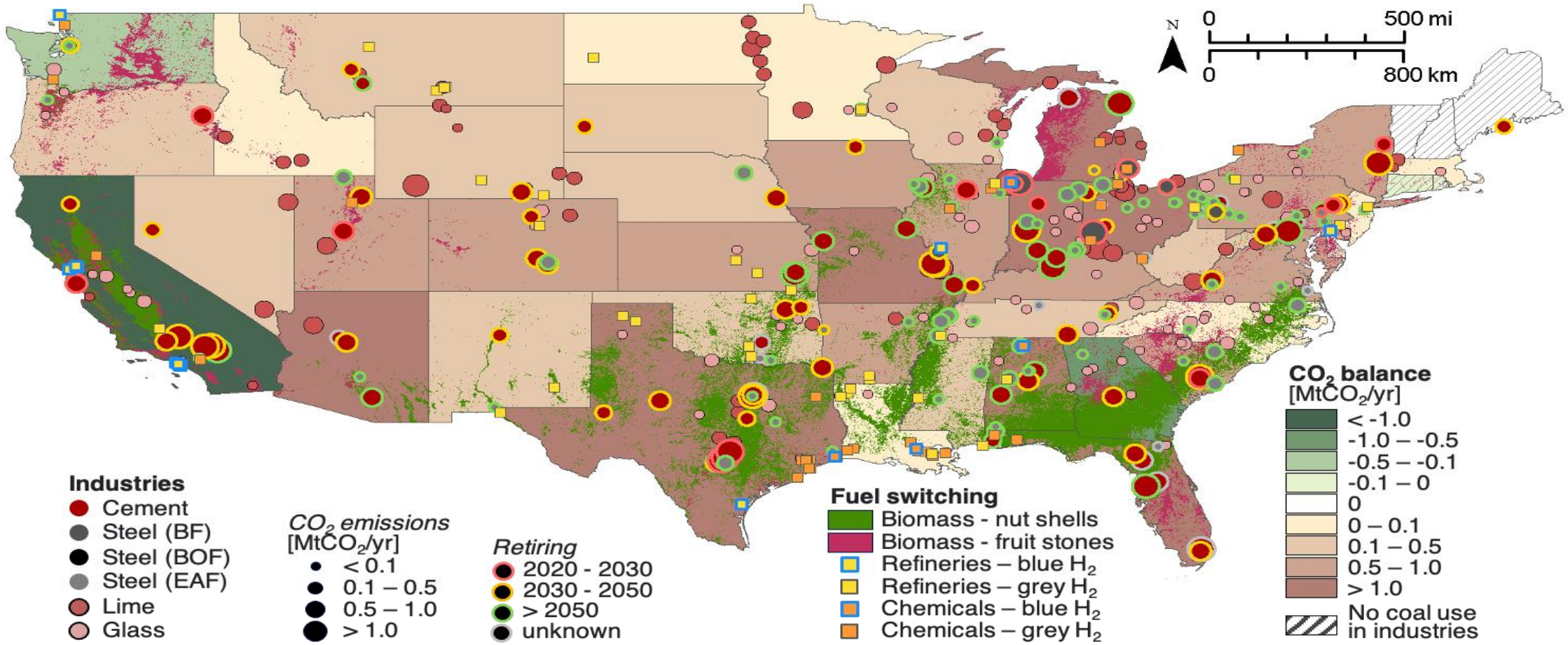
Durable and scalable carbon dioxide removal under $100/net metric ton within a decade

Biomass Sourcing and Hydrogen Opportunities



Reference: Pisciotta, et al., PECS, 2022

Biomass Sourcing and CO_2 Reduction Potentials



Reference: Pisciotta, et al., PECS, 2022

Bipartisan Infrastructure Law

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
- Grid-scale energy storage
- Small modular reactors and more

FECM-OCED Project Coordination

Hydrogen Hubs

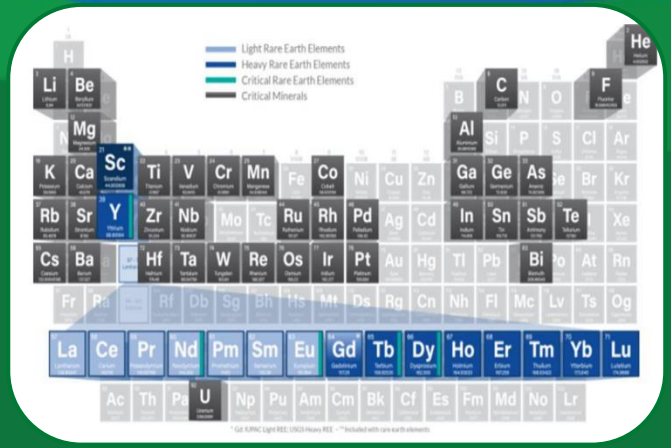
- $8 billion (for at least four projects, including at least one using fossil fuels with carbon management)

Carbon Capture Demonstrations and Large Pilots

- $3.5 billion

Carbon Dioxide Transportation Infrastructure Finance and Innovation Program Account

- Loan Programs Office: $2.1 billion

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

Questions?