



U.S. DEPARTMENT OF
ENERGY

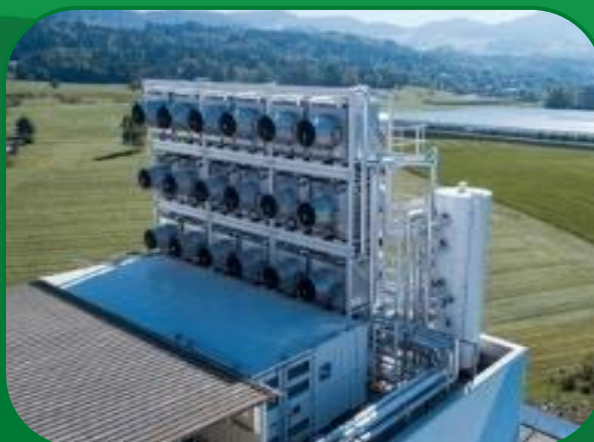
Fossil Energy and
Carbon Management

Hubs on the Horizon

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PRINCIPAL DEPUTY ASSISTANT SECRETARY
FOSSIL ENERGY AND CARBON MANAGEMENT

June 8, 2022



Legend:

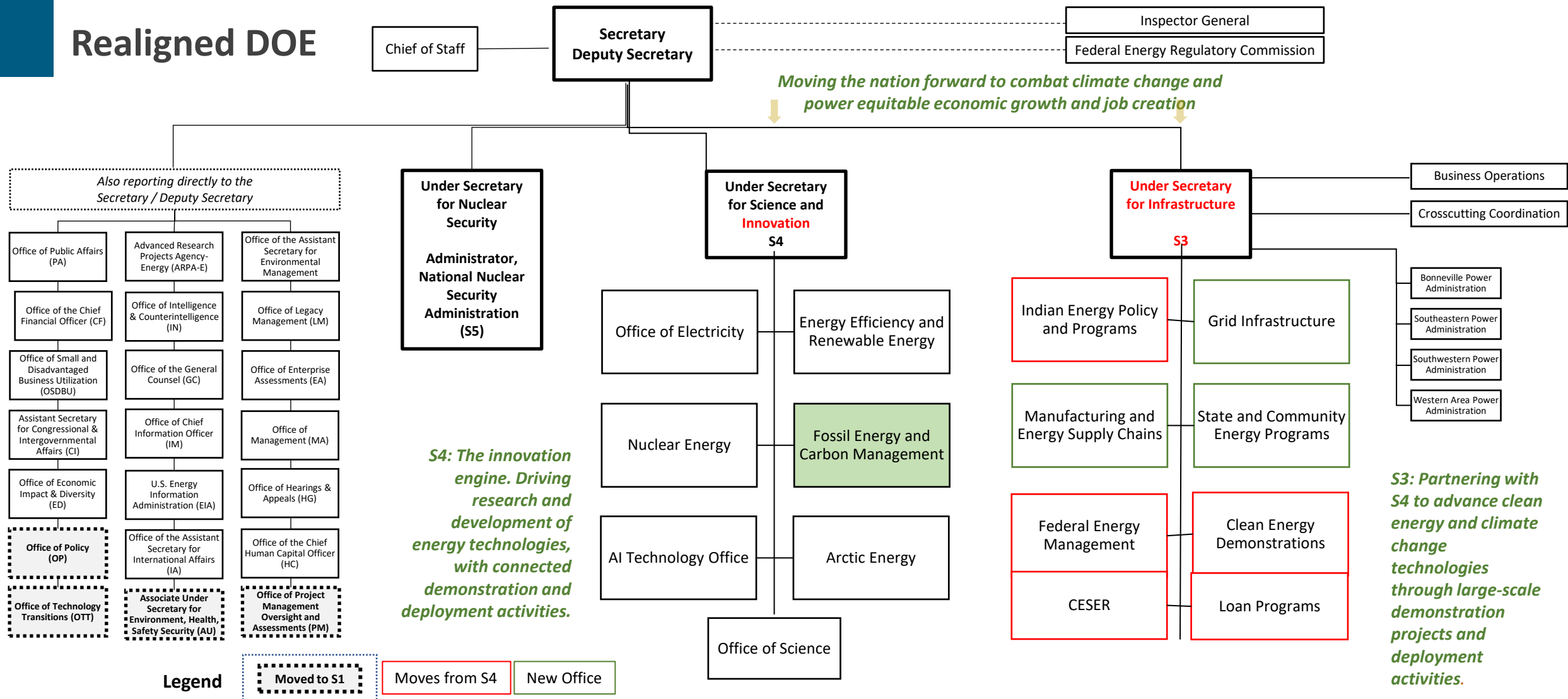
- Light Rare Earth Elements
- Heavy Rare Earth Elements
- Critical Rare Earth Elements
- Critical Minerals

H																	He															
Li	Be																	B	C	N	O	F	Ne									
Mg																	Al	Si	P	S	Cl	Ar										
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr															
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe															
Cs	Ba	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn																
Fr	Ra	Ac	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr																
																		La	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
																		Ac	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr

* Gd, Rb, Ni, Light REE, U, Os, U, Heavy REE ** Included with rare earth elements.



Realigned DOE



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fecm.energy.gov

Fossil Energy and Carbon Management (FECM)

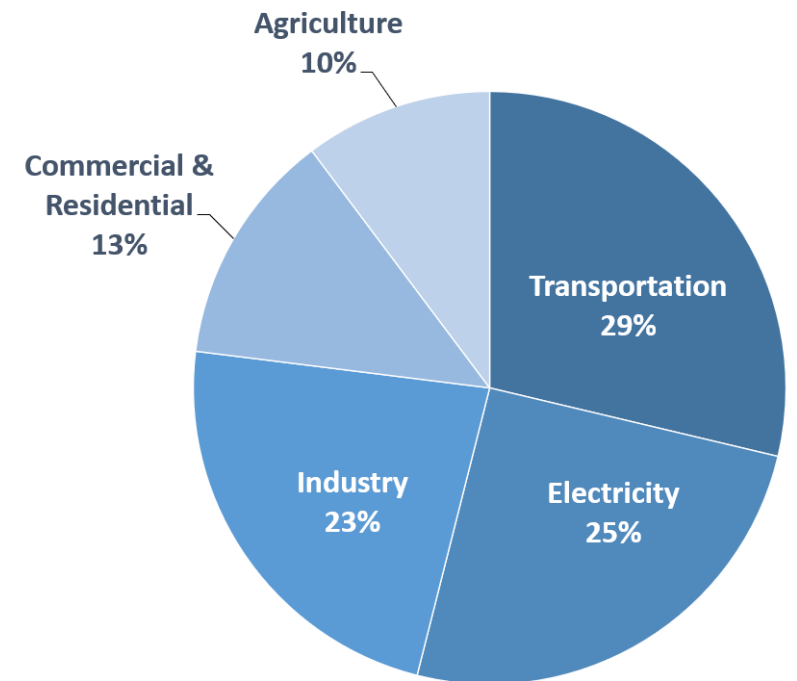
Office of Fossil Energy and Carbon Management

DOE-FE is now DOE-FECM

New name for our office reflects our new vision

- President Biden's goals:
 - 50% emissions reduction by 2030
 - CO₂ 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

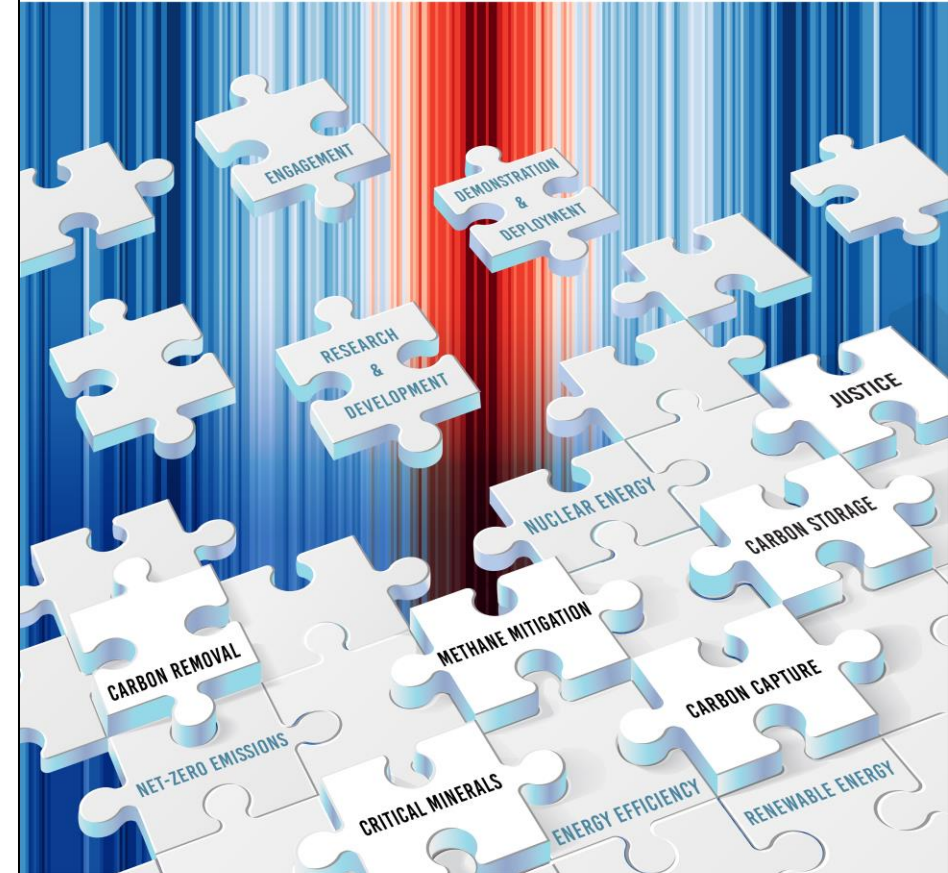
Priorities: Hydrogen with carbon management, domestic critical minerals (CMs) production, and methane mitigation

Advancing Justice, Labor, and Engagement

Priorities: Justice, labor, and international and domestic partnerships

STRATEGIC VISION

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



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 (CO₂) removal
3. CO₂ conversion into products
4. Reliable CO₂ 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



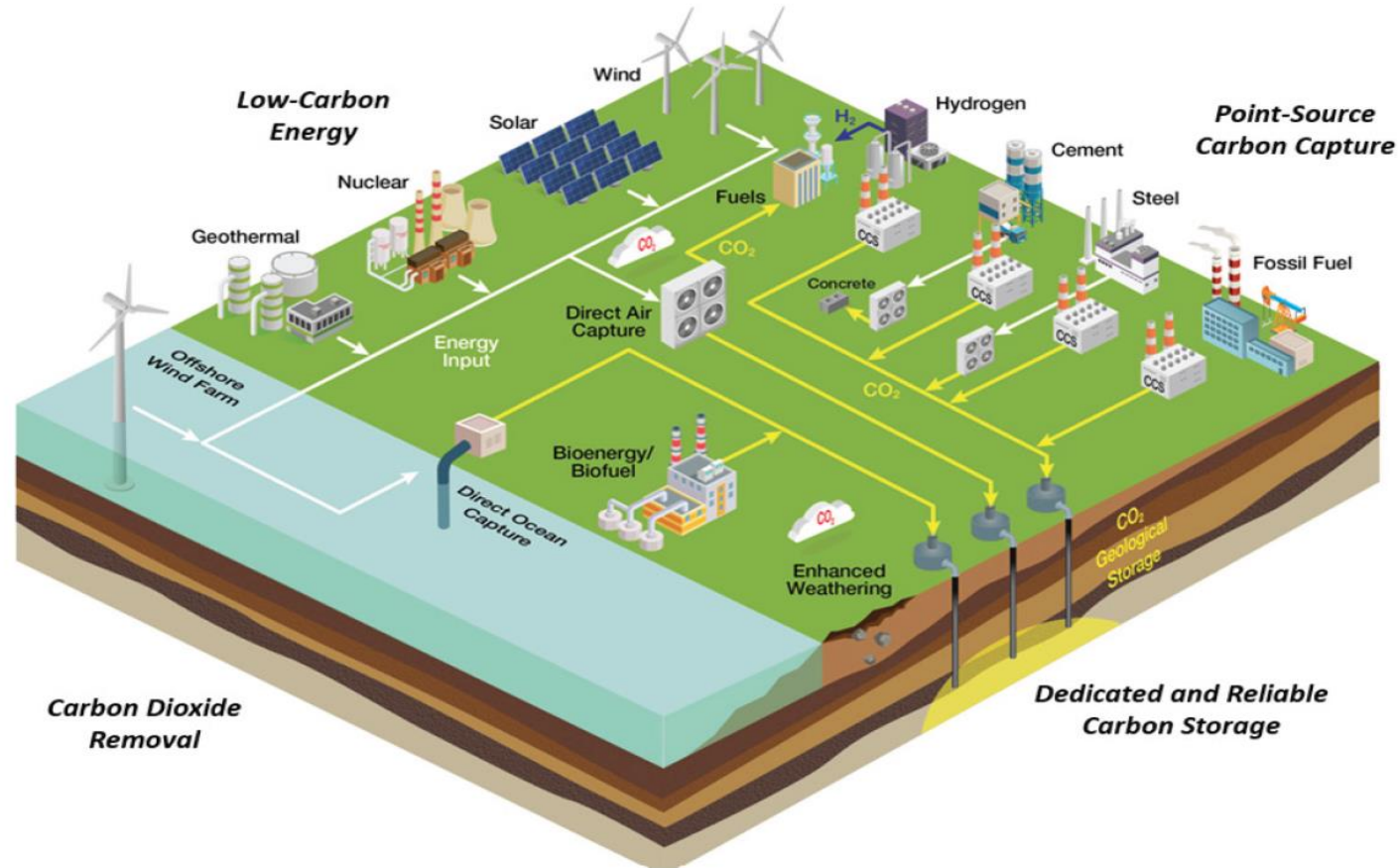
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The Role of CCS

Figure 4 | Integrated carbon management hub that includes point-source capture and carbon dioxide removal all coupled to reversing the flow of carbon back into the earth.



Reference: FECM Strategic Vision, April 2022



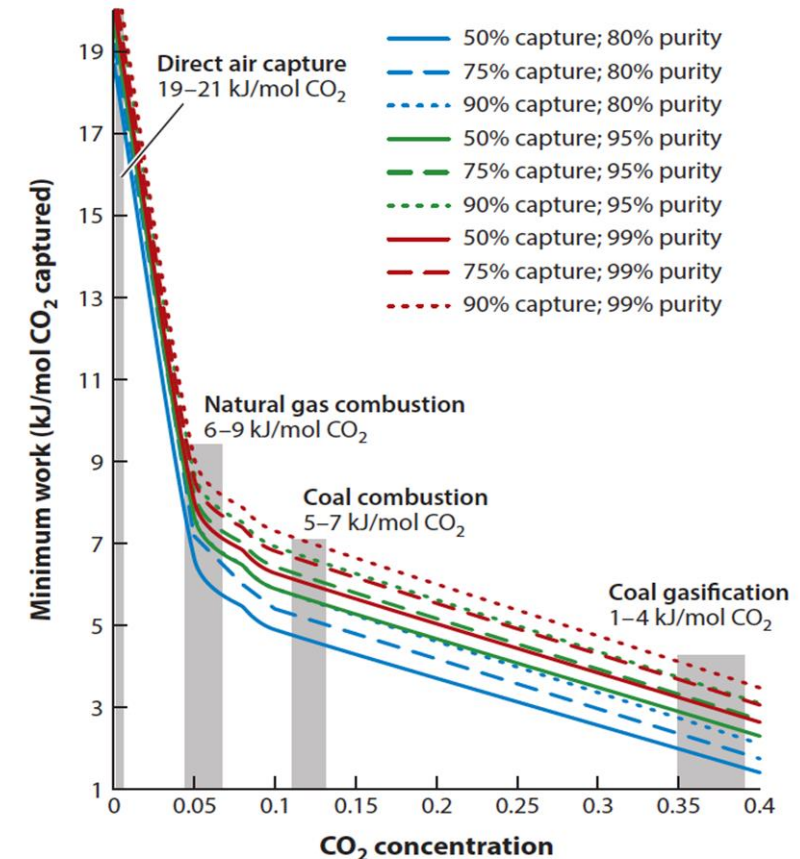
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CCS and CDR Need to Be Done In Parallel

- Minimum work for separation may be derived from combined 1st and 2nd laws of thermodynamics
- Energy scales with dilution – > 3× more energy to do DAC vs exhaust streams
- 300× greater contactor area for CO₂ separation to do DAC vs exhaust
- High purity is desired for transport
- Direct air capture should not be seen as a replacement for avoiding carbon



Reference: Wilcox, Carbon Capture, 2012

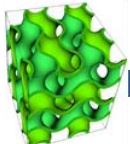
Point Source Capture Program

Integrated Approach to Accelerate Technology Development

Lab & Bench



TRL 2-4



Small Pilots



TRL 4-5



Large Pilots



TRL 5-7



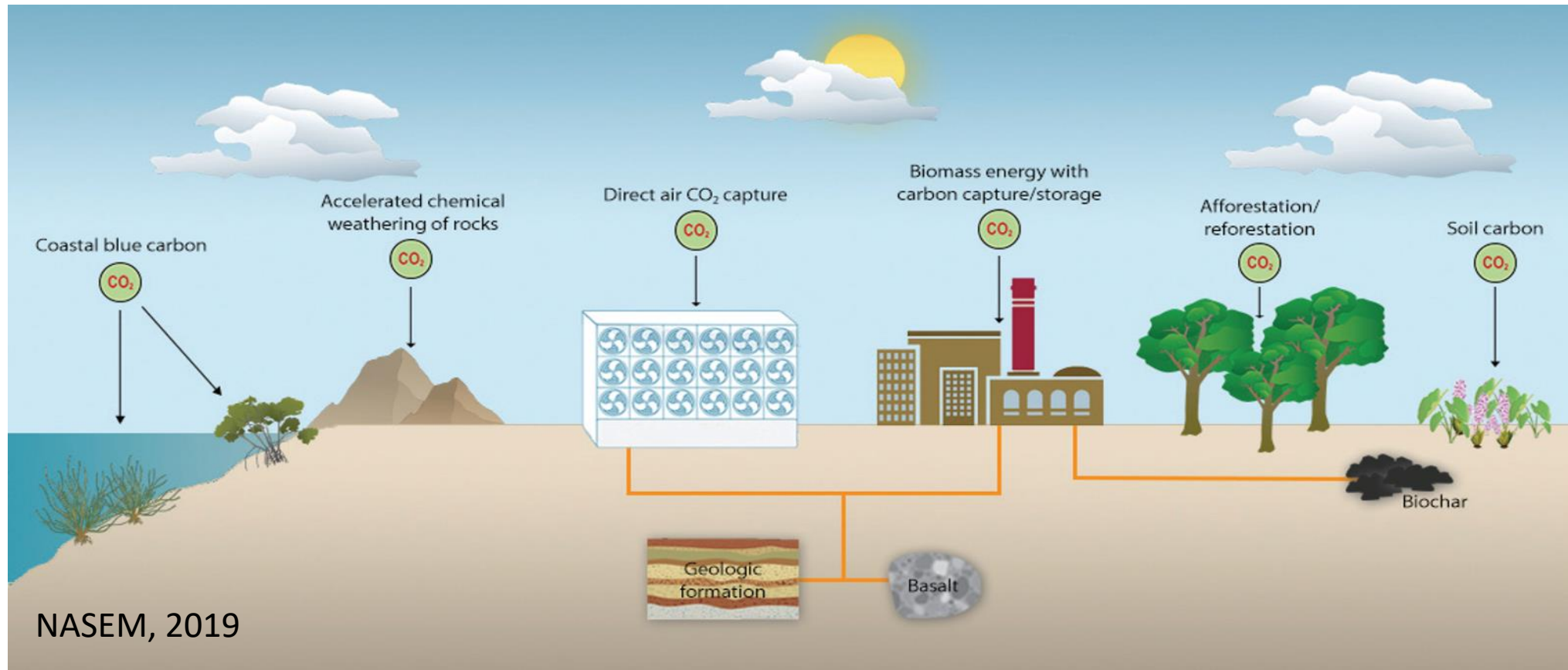
FEED Studies



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 (CCSI²)
- Create low-carbon supply chains (i.e., cement, steel, hydrogen, etc.)

Carbon Dioxide Removal



Carbon
Negative

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



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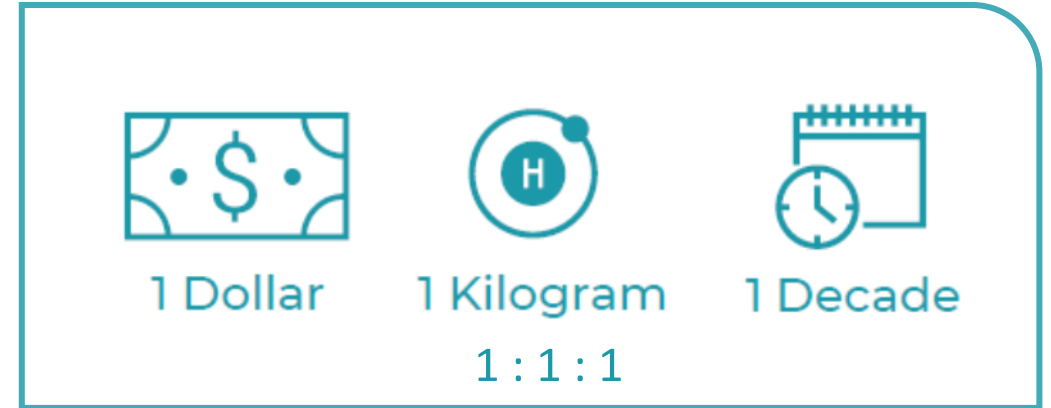
Direct Air Capture Hubs – Current Status and Next Steps



- Issued a Request for Information (RFI) in December 2021 that received thousands of pages of responses
- Conducted applicant education workshops in person (OH, LA, and UT) and virtually
- Issued a Notice of Intent on 5/13: [FedConnect: Opportunity Summary](#) – our first major step towards getting the funding out the door and into the field
 - Provides a high-level draft plan for DOE’s current vision to meet the BIL requirements for the hubs
- Planning a funding announcement for Q4 of FY22 (July - Sep 2022)

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>

Regional Clean Hydrogen Hubs (\$8 billion) – Overview

Establish at least four regional clean hydrogen hubs across the country to improve clean hydrogen production, processing, delivery, storage, and end use

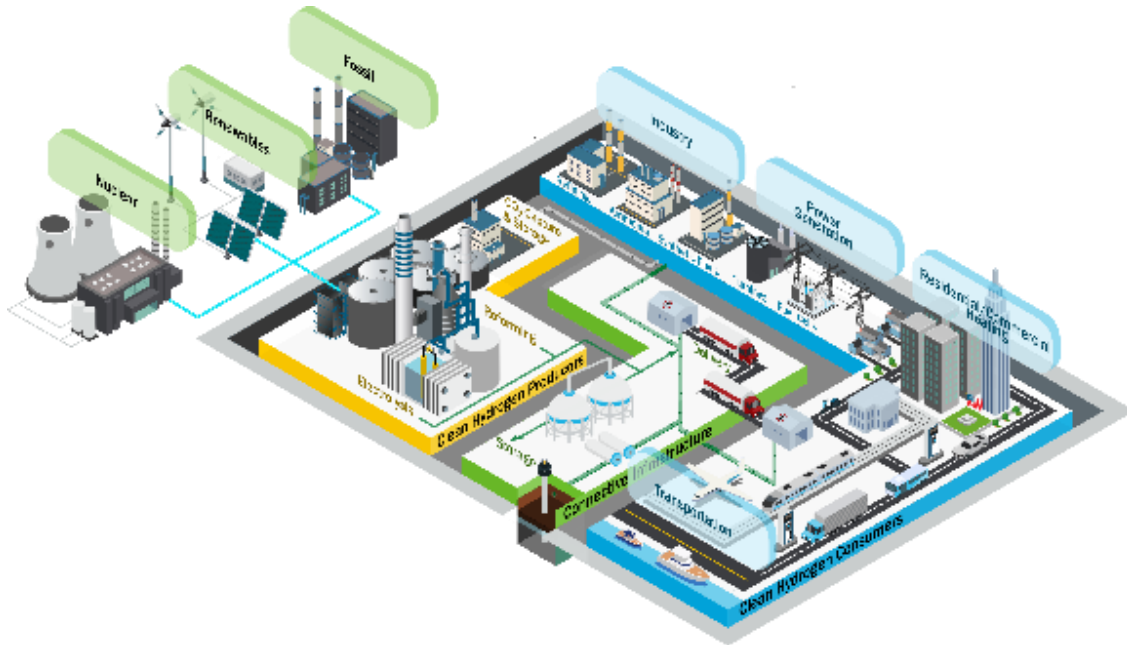
- **Feedstock diversity:** at least one hydrogen hub using fossil fuels, one with renewable energy, and one using nuclear energy
- **End use diversity:** at least one hydrogen hub in the electric power generation sector, one in the industrial sector, one in the residential and commercial heating sector, and one in the transportation sector
- **Geographic diversity:** hubs shall be in different regions and use energy resources abundant to that region
- **Natural gas:** at least two hubs shall be in U.S. regions with the greatest natural gas resources
- **Employment:** priority to hubs likely to create training and long-term employment



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Regional Clean Hydrogen Hubs – Current Status and Next Steps



- Issued a Request for Information (RFI) in March 2022 that received thousands of pages of responses
- Conducted stakeholder workshops and webinars, including a webinar on the RFI and listening sessions with Tribal leaders and energy justice communities
- Issued a Notice of Intent on June 6, 2022 – our first major step towards getting the funding out the door and into the field
 - Provides a high-level draft plan for DOE’s current vision to meet the BIL requirements for the hubs
 - Posted on OCED Exchange: <https://oced-exchange.energy.gov/Default.aspx>
- Planning a funding announcement in the September/October 2022 timeframe



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Bipartisan Infrastructure Law

\$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