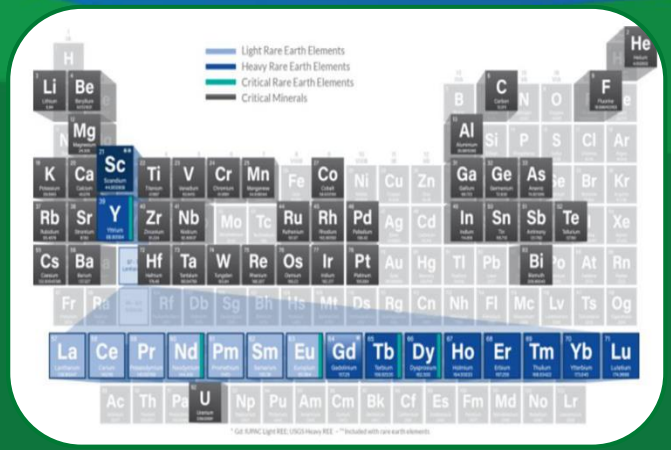
U.S. DEPARTMENT OF ENERGY
Fossil Energy and Carbon Management

IOGCC Annual Meeting

October 17, 2022

Fossil Energy and Carbon Management Priorities

Joseph Giove III
Director of Business Operations
Office of Carbon Management



Office of the Assistant Secretariat of Fossil Energy and Carbon Management (FECM)

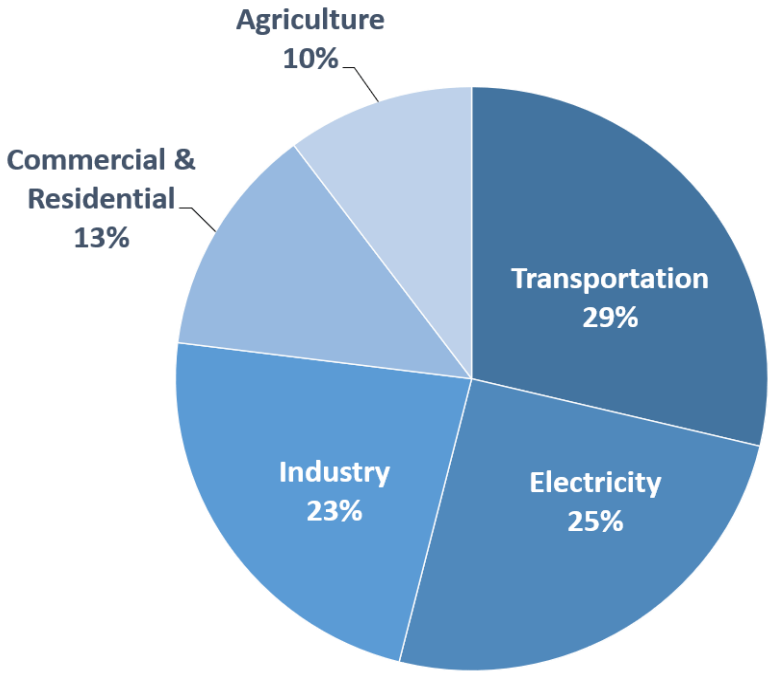
Office of Fossil Energy and Carbon Management

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. Reliable CO_2 storage
4. Hydrogen production

Office of Carbon Management
(FECM-20)

5. Critical minerals production
6. Methane mitigation
7. Advanced remediation technologies

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

Advancing Technologies that Lead to Sustainable Energy Resource: Domestic Critical Minerals (CM) Production

Pillar 1	Pillar 2	Pillar 3a	Pillar 3b
			
Resource Characterization & Technology Development	**Sustainable Resource Extraction Technology Development**	**Processing, Refining, & Alloying Technology Development**	**Processing and Manufacturing Technology Development**
• Characterization for opportunities • Resource assessment and predictive capabilities • Web-based platform for integrated database system with AI/ML	• Transformation, conventional and unconventional extraction technologies • Integration of industrial beneficiation/ concentration methods and technologies • Remediation of existing sites and abandoned mine residuals	**Critical Materials** • Advanced extraction, purification, and reduction technologies through refining and alloying materials • Enable commercial production through innovations • First mover and second-generation large-scale pilot projects	**Carbon Ore** • Housing and infrastructure development • Advanced carbon material (carbon fiber, graphene, and nanomaterial) production • Reinvest in critical (graphite and silicon) supply chains

International Engagements, Standards and Supply Chain Development

Ni, CO, Cr for Superalloys

- Identify co-production sources to meet increased demand in these metals
- Application of innovative processing, refining, and alloying technologies to increase purity from the waste materials

Carbon Ore to Products

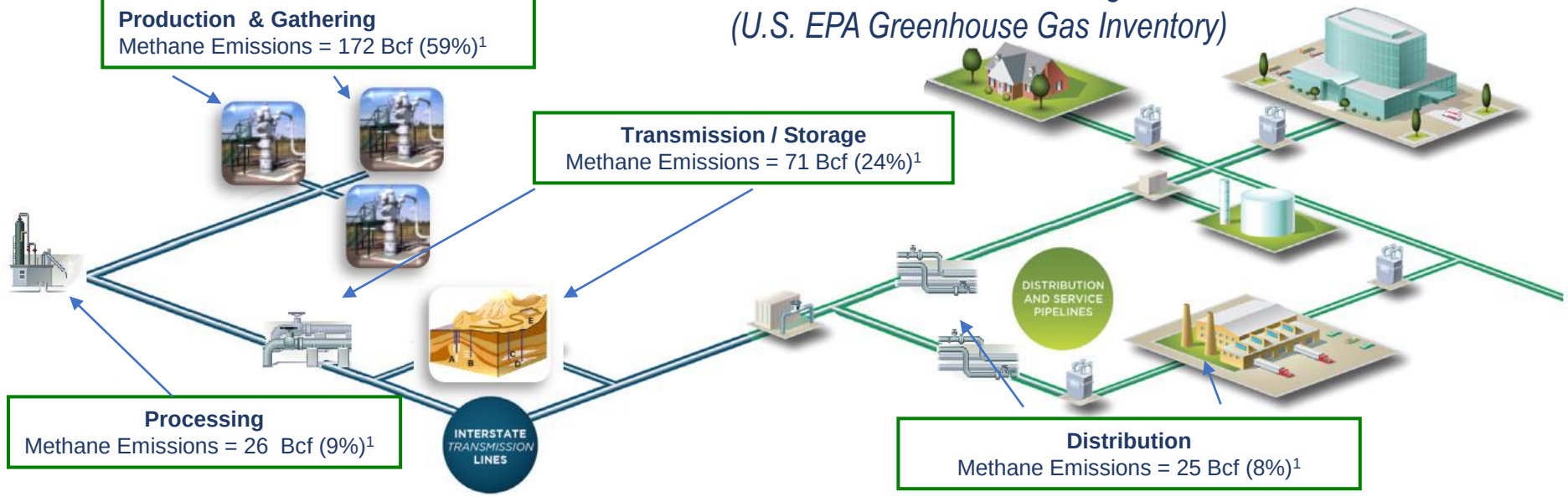
- Assessment and characterization of coal and waste materials
- Environmentally responsible extraction and beneficiation
- Co-production of high purity carbon and critical material products

Advancing Technologies that Lead to Sustainable Energy Resource: Methane Mitigation

22% of Total U.S. Anthropogenic Methane Emissions, 294 BCF (5,600 Gg), ~1.1% emission rate from extraction through distribution in 2018 (U.S. EPA Greenhouse Gas Inventory)

Production & Gathering
Methane Emissions = 172 Bcf (59%)[1]

Transmission / Storage
Methane Emissions = 71 Bcf (24%)[1]



Processing
Methane Emissions = 26 Bcf (9%)[1]

Distribution
Methane Emissions = 25 Bcf (8%)[1]

Infrastructure Characteristics[2]

Production
405,000 gas wells

Gathering
5,400 gathering stations
17,500 gathering compressors
381,000 miles of gathering pipe (typically 8-5/8" or less) 500 psi

Processing
667 Natural Gas Processing Plants

Transmission & Storage
302,000 Miles of large diameter transmission pipe 24"-48"1,000 psi
2,000 compressor stations
- **7,200** engines (61 billion hp-hr)
- **2,400** turbines (15 billion hp-hr)

19,089 storage wells

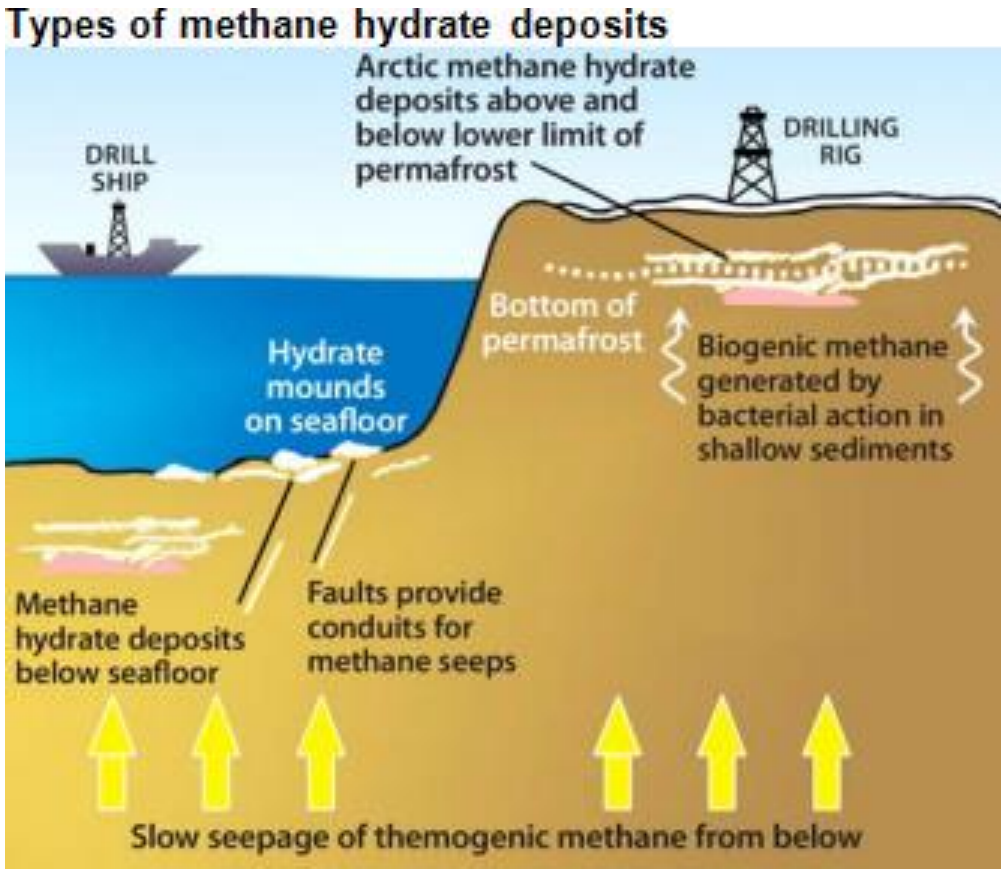
Distribution
1.3 million miles of distribution

[1] EPA, 2019a. Inventory of U.S. Greenhouse Gas Emissions and Sinks. Table 2-1 and Table 3-58 (https://www.epa.gov/ghgemissions/inventory-us-greenhouse-gas-emissions-and-sinks)
[2] EPA, 2019b. Annex 3.6 (https://www.epa.gov/sites/production/files/2020-02/2020_ghgi_natural_gas_systems_annex36_tables.xlsx)
* Methane emission rate (1.1%) calculated by dividing EPA inventory for 2018 natural gas methane emissions (294 Bcf) by Energy Information Administration (EIA) data for total gas delivered to consumers in 2018 (27,600 Bcf).

Advanced Remediation Technologies

Focuses on the following…

- Produced water treatment and reuse technologies
- Environmental impacts of unconventional oil and gas resources, both onshore and offshore
- Gas hydrates



Abandoned Oil and Gas Wells

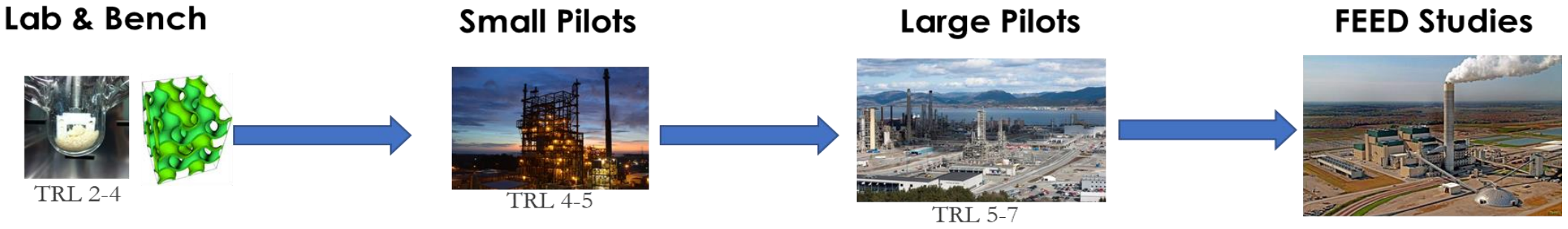
- NETL traveling Appalachia locating abandoned wells.
- $30 million established a research consortium aimed at developing technologies to locate wells, determine methane emissions, wellbore integrity and overall environmental impacts for state and federal agencies
- Efforts in NY, PA, and KY

DOE Awards for Geothermal Potential at Abandoned Oil and Gas Wells

- Geothermix, LLC (Austin, TX)
  - Will harvest waste heat from existing oil and gas wells in Texas to generate commercial quantities of geothermal electricity.
- ICE Thermal Harvesting (Houston, TX)
  - Will produce electricity from 11 existing oil and gas wells in California's San Joaquin Valley using an innovative power generation technology.
- Transitional Energy (Aurora, CO)
  - Will install state-of-the-art, American-made geothermal heat engines at Blackburn Oilfield in Nevada for electrical power production. As a result of the project, Transitional Energy will generate geothermal energy at the site and construct new rural electric vehicle charging infrastructure.
- University of Oklahoma (Norman, OK)
  - Will produce heat from an Oklahoma oilfield for use in Tuttle Elementary and Middle Schools in Tuttle, Oklahoma. With access to four hydrocarbon wells within a mile, the schools will benefit from the 'recycling' of oil and gas infrastructure at considerable savings for the schools.

Point Source Capture Program

Integrated Approach to Accelerate Technology Development



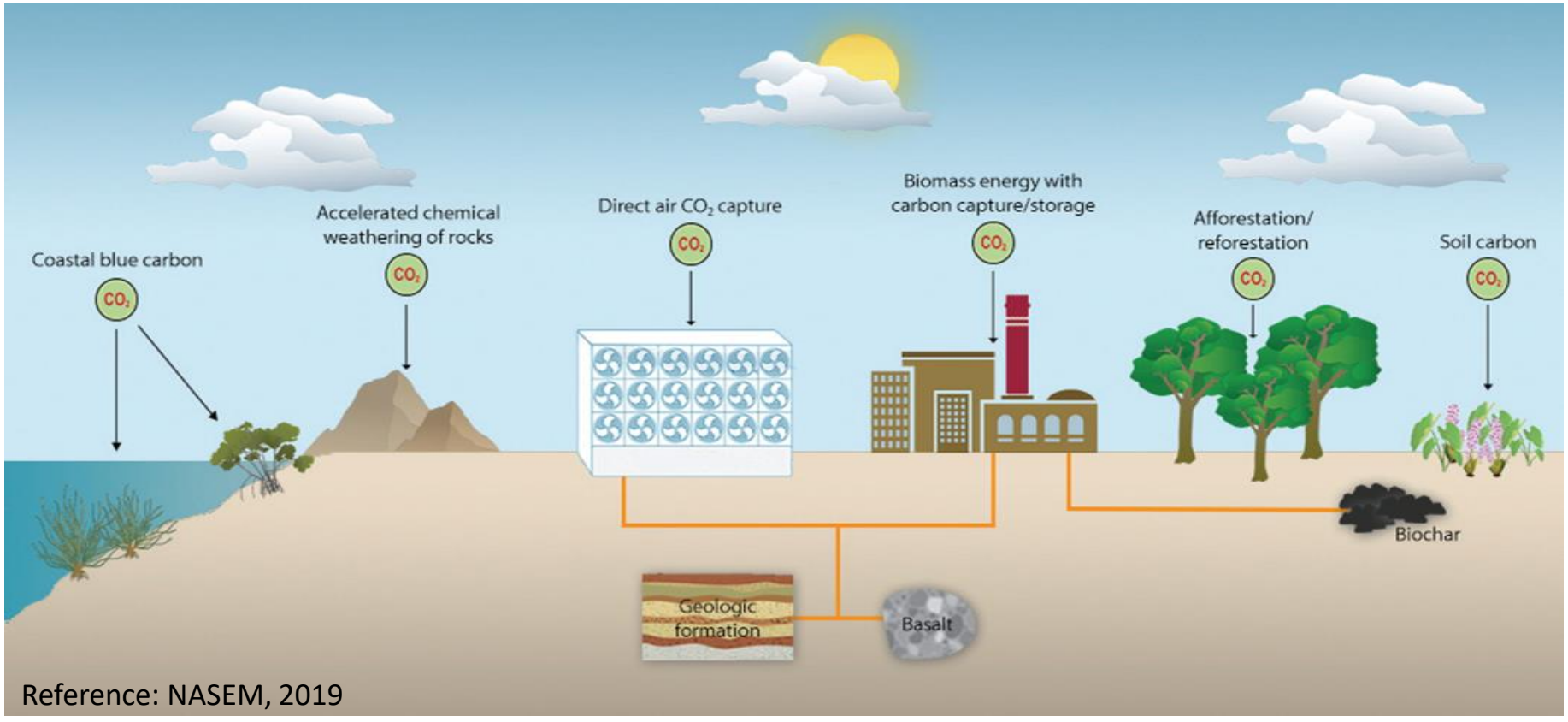
Point Source Capture Focus

- 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.)

Carbon Dioxide Removal Program

- 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

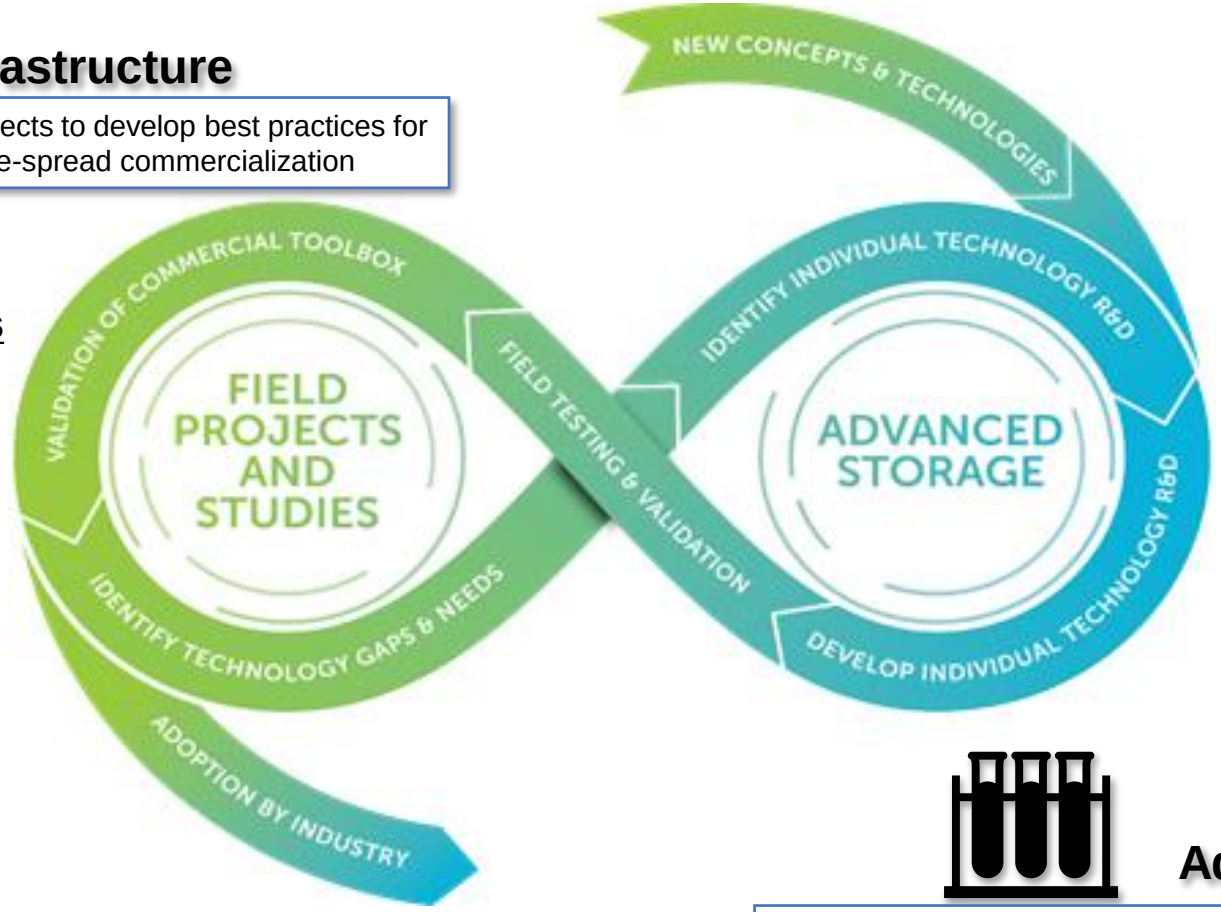
Carbon Transport and Storage Program

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



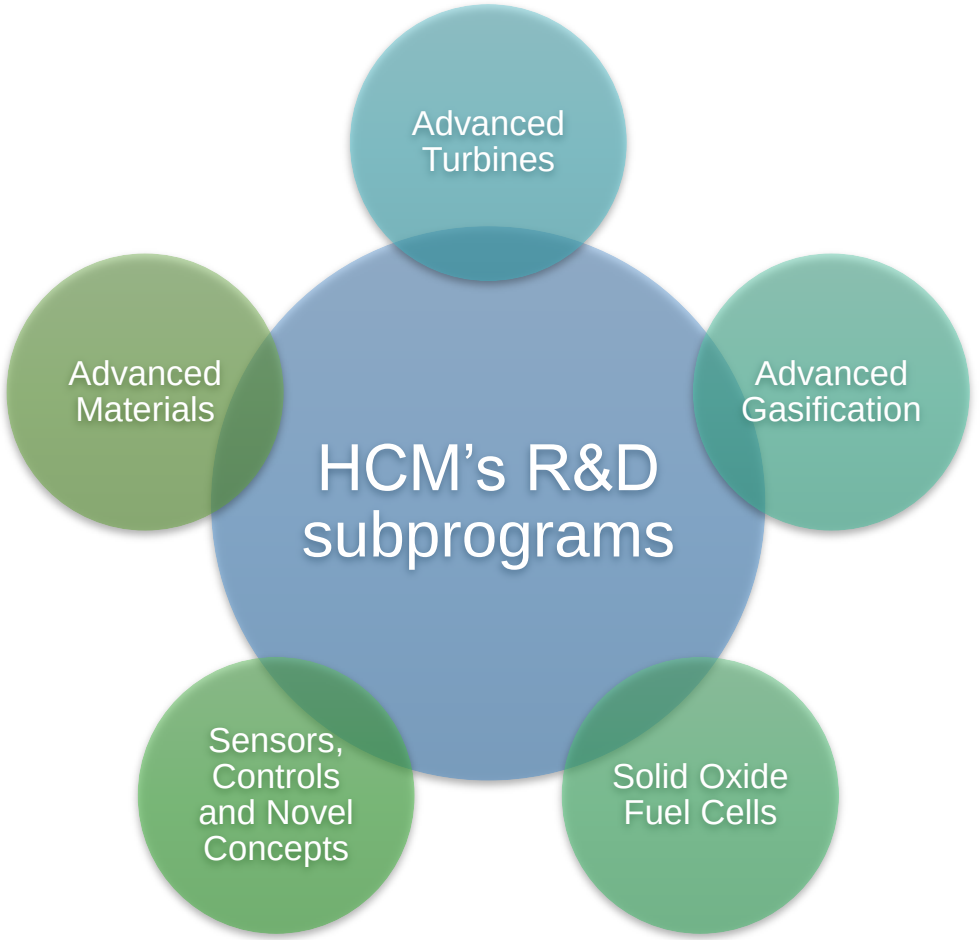
Advanced Storage Focus

- 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 Program



DOE Initiatives: Office of Clean Energy Demonstrations (OCED)

OCED established December 2021:

- 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

DOE Initiatives: Advancing Justice, Labor, and Engagement

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

A Sample of FECM Related Projects Receiving Bipartisan Infrastructure Law Funding

- Oct 12 - $1 Billion to Enhance Energy Systems in Rural and Remote Communities
- Oct 12 - $32 Million to Advance Domestic Supply Chain for Critical Minerals
- Oct 6 - $2 Billion to Finance Carbon Dioxide Transportation Infrastructure
- Sept 23 - $4.9 Billion to Deploy Infrastructure Necessary to Manage and Store Carbon Pollution
- Sept 22 - $7 Billion to Jump-Start America's Clean Hydrogen Economy
- Sept 19 - $156 Million for Critical Minerals Refinery
- Aug 30 - $10.5 Billion to Strengthen America's Electric Grid
- Aug 9 - $675 Million to Expand Domestic Critical Materials Supply Chains
- Aug 3 - $750 Million to Strengthen Clean Energy Manufacturing and Recycling
- July 13 - $2.6 Billion to Slash Carbon Emissions
- July 6 - $2.3 Billion to Strengthen and Modernize America's Power Grid
- June 29 - $500 Million to Transform Mines Into New Clean Energy Hubs

A Sample of FECM Related Projects Receiving Bipartisan Infrastructure Law Funding

- June 6 - $8 Billion for Clean Hydrogen Hubs Across U.S.
- May 20 - $7 Million to Further Decarbonize Manufacturing
- May 19 - $3.5 Billion to Capture Carbon Pollution From The Air
- May 12 - $505 Million to Boost Deployment and Cut Costs of Increase Long Duration Energy Storage
- May 10 - $2.5 Billion to Modernize and Expand Capacity of America's Power Grid
- May 5 - $2.3 Billion to Cut U.S. Carbon Pollution
- May 2 - $3.16 Billion to Boost Domestic Battery Manufacturing and Supply Chains
- April 27 - $2.3 Billion to Strengthen and Modernize America's Power Grid
- Apr 20 - $20 Million Rebate Programs to Upgrade Grid and Commercial Equipment
- Mar 18 - $5 Million to Launch Lithium-Battery Workforce Initiative
- Feb 15 - $9.5 Billion for Clean Hydrogen Initiatives
- Jan 12 - $8.4 Million for Accessing Geothermal Potential from Abandoned Oil and Gas Wells

Key Takeaways

- Critical minerals are essential to the U.S. economy of the future.
- Achieving a CO2 Emissions-Free Power Sector by 2035 and a Net Zero Emissions Economy by 2050 can not be achieved without Carbon Capture.
- Carbon Capture has consistently had the highest level of bi-partisan support in Congress of all Energy R&D.
- The Bipartisan Infrastructure Law (BIL) shows where actual funding meets the energy and climate goals of the administration.

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Thank you