MISSION INNOVATION

Carbon Dioxide Removal (CDR) Mission

Mark Ackiewicz, Mission Director
U.S. Department of Energy

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About the Mission

SCOPE:

Technological CDR approaches, including:

- Direct Air Capture (DAC)
- Enhanced mineralization
- Biomass with carbon removal and storage (BiCRS)

Emphasis on secure CO_2 storage and conversion into long-lived products.

Goal:

"100 in 10" – Enable CDR technologies to achieve a net reduction of 100 million metric tons of CO_2 per year globally by 2030.

Activities

- Methodologies for lifecycle analyses (LCAs) and technoeconomic analyses (TEAs)
- RD&D for CDR technologies
- Lessons learned from first-generation CDR projects and business models

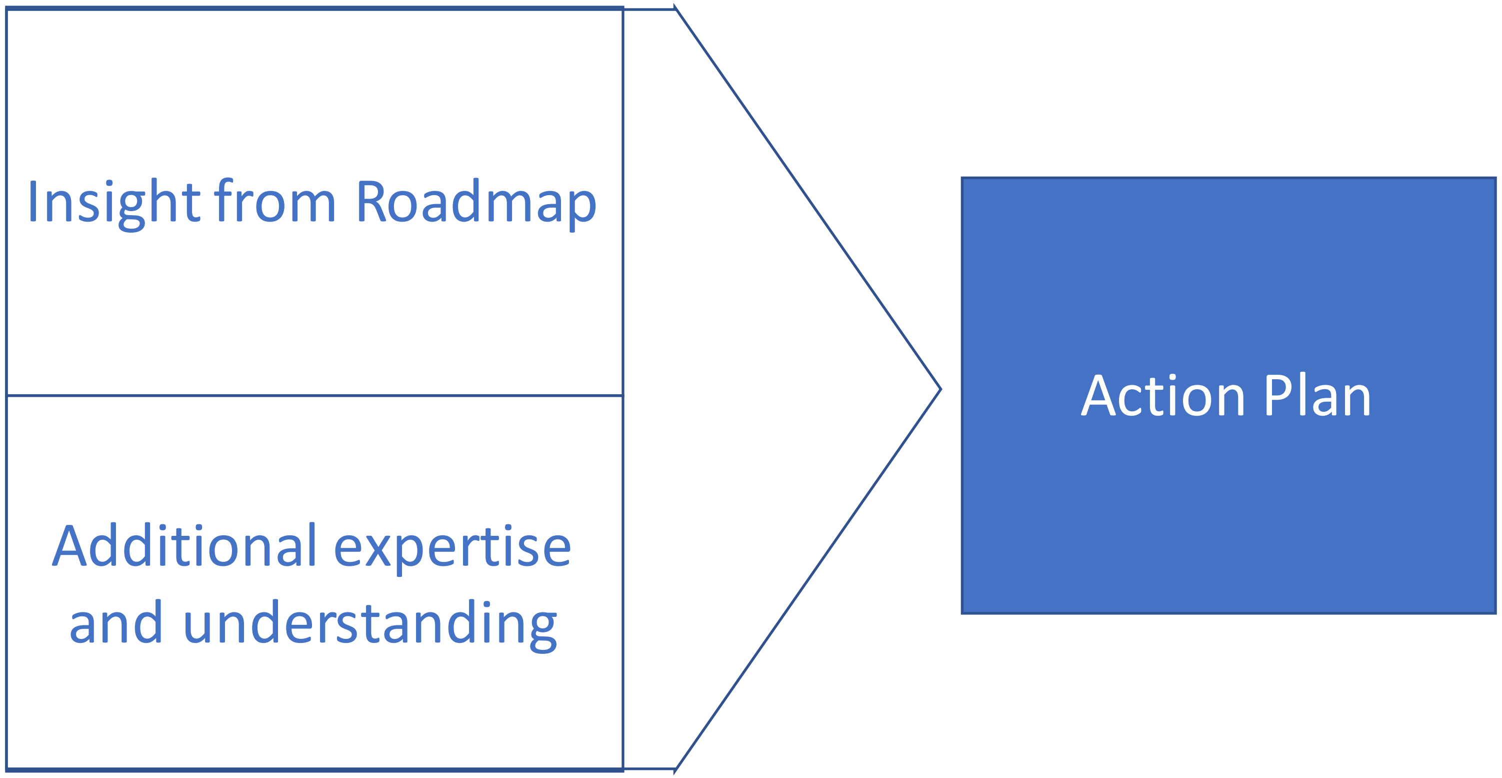
Coalition:

- Co-leads – Canada, Saudi Arabia, United States
- Members – Australia, EC, India, Japan, Norway, United Kingdom

Always open for additional members

Aim of Innovation Roadmap

[Provide insight for the MI CDR Mission to develop an impactful Action Plan]



DAC Technology Challenges and Innovation Gaps

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CO_2 capture capacity

- Novel materials with high CO_2 capture flux
- Advanced packing materials with increased interactions with CO_2
- Materials that have minimal loss of CO_2 loading capacity in the presence of heat and oxidizing components
- Effect of elevation/altitude on the CO_2 capture performance

CO_2 capture and desorption

- Liquid phase mass transfer
- Engineered materials with pore sizes that span many scales (Sorbent)
- Effect of temperature and humidity
- Novel desorption approaches (e.g., electro-swing, microwave-swing, steam-swing, moisture-swing)
- Co-product generation (e.g., capturing the humidity in air)

Energy use

- Optimizing strength of chemical base for regeneration
- Lower specific heat capacity and higher thermal conductivity of capture material
- Contactor designs to reduce pressure drop
- Integration with existing airflow infrastructure (e.g., HVAC units and cooling towers)
- Passive transport of ambient air
- Development of materials that can capture CO_2 at low temperatures (e.g., -20 °C) and be regenerated under mild conditions (e.g., 25 °C)

Materials scale up

- Manufacturing supply chains with low cost, low emissions, and low environmental impact

BiCRS Technology Challenges and Innovation Gaps

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Biomass Feedstocks

- Biomass optimized for life-cycle carbon removal
- Cultivation of macroalgae in marine waters at large scales while minimizing ecological risks
- Pretreatment techniques for heterogeneous biomass feedstocks

Biomass Conversion

- Fast pyrolysis among different feedstocks and process designs
- Gasification of heterogeneous biomass feedstocks for H_2
- Use of high temperature working fluids (>1,100°C)
- Engineering of microbes and bacteria to selectively convert biomass to products in biochemical pathways

CO_2 Capture

- Optimization of BioCCS facilities for variable feedstocks, capacity, and biomass availability
- Catalysts for removal of tar from bio-based gas products
- Extraction of valuable materials from residues of municipal solid waste

Utilization

- Development of long-lived bio-based products
- Understanding biochar impacts on agriculture
- Incorporating biomass in industrial applications

System Logistics

- Assessment of supply chain logistics for network configuration considering biomass resources
- Availability of biomass in competition with other uses

Enhanced Mineralization Technology Challenges and Innovation Gaps

Mineralization kinetics

- Rate limiting step of mineralization under different conditions
- Optimal reaction conditions
- Effect of mineral properties (e.g., size, shape) on reaction
- Dosage requirements (mass per land area) for achieving large scale CO_2 removal
- Enhanced mass transport of CO_2 via sparging, improved stirring, or other techniques
- Pre-treatment methods to improve reaction rates

Energy use, land use, and environmental impacts

- Optimization of particle size
- Reduced energy demand for rock mining, grinding and pre-treatment
- Preventing particulate matter, hazardous components in minerals and industrial wastes from entering the environment
- Reduced energy demand during metal oxide regeneration and recovery

Monitoring CO2 uptake

- Methods for measuring flux of CO_2 in atmosphere and in groundwater

System logistics

- Optimization of rock source and dispersal locations
- Understand degradation rate of materials employed for repeated cycles of enhanced mineralization
- Recovery of critical materials as co-benefit

Next Steps

A. Roadmap Workshop

Identify innovation priorities / short-list potential sprints. **Held last week.**

B. Continued stakeholder engagement

Build on introductory calls with private sector actors and other international initiatives

C. Finalize products for Global Clean Energy Action Forum

Innovation Roadmap • Mission Action Plan • Sprint(s). **Scheduled for September 21-23, 2022, Pittsburgh, PA, USA. https://gceaf.org/**

Questions?