



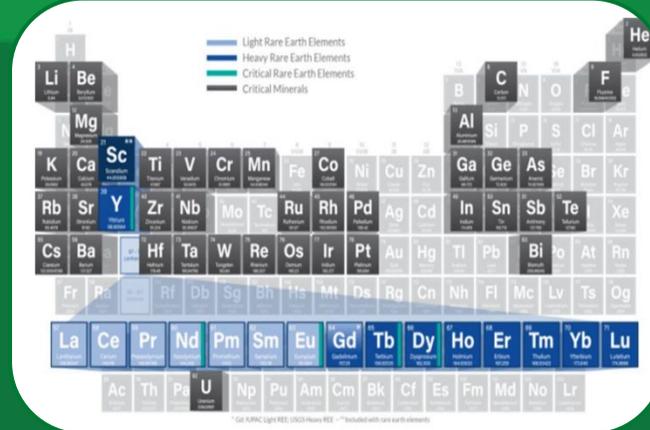
U.S. DEPARTMENT OF
ENERGY

Fossil Energy and
Carbon Management

Carbon Capture, Utilization, and Storage in the United States: Key Policy and Regulatory Updates

CCS Technical Workshop 2022

January 21, 2022 (Tokyo)



Biden Administration: climate priorities

- Re-establishing U.S. leadership in climate: climate crisis will be central to U.S. foreign policy and national security
 - Rejoined the Paris Agreement
 - Held the Leaders' Climate Summit to raise climate ambition
- Taking a government-wide approach to the climate crisis: National Climate Task Force
- Building a 100% clean energy economy
 - 50% emissions reduction by 2030
 - 100% clean electricity by 2035
 - net-zero carbon emissions by 2050
- Developing a climate finance plan
- Modernizing infrastructure towards a sustainable economy
 - “Greening” federal government procurement
 - Ensuring procurement and awards support the use of American-made goods and services in the clean energy supply chain
- Empowering workers and marginalized communities

Biden Administration: priorities for CCUS and CDR

- **Energy:** Department of Energy (DOE) will be essential to President Biden's climate mission to push the frontiers of science and engineering and catalyze clean energy jobs through research, development, demonstration, and deployment (RDD&D)
- **Carbon capture, utilization, and storage (CCUS) and Carbon Dioxide Removal (CDR)**
 - Expanding CDR technologies such as direct air capture (DAC) and bio-energy with carbon capture and storage (BECCS)
 - Simultaneously bring new carbon capture technologies to market and continue to fund carbon capture research, development, and demonstration (RD&D)
 - Enhance tax incentives for CCUS
 - Retrofits for existing power plants
 - Decarbonizing industry, especially in hard-to-abate sectors

Strong legislative support for CCUS/CDR/clean hydrogen

- Recently enacted bipartisan bills provide policy support & funding:
 - **Energy Act of 2020** – an update of U.S. energy policy & a funding authorization bill that includes consensus provisions from the American Energy Innovations Act
 - **Consolidated Appropriations Act (2021)** – provides funding for CCUS/CDR & incorporates authorization provisions contained in the Energy Act of 2020
 - **Infrastructure Investment & Jobs Act (IIJA)** – appropriated over \$20 billion for CCUS/CDR & Clean Hydrogen RD&D, including many authorized under the Energy Act of 2020
- Bill being debated/negotiated:
 - The ***Build Back Better Act*** is still being negotiated but is likely to support CCUS/CDR (a recent version reportedly included a \$180/metric ton carbon credit for DAC)

Carbon Management funding in the bipartisan Infrastructure Law (IIJA)

- Through the Bipartisan Infrastructure Law, DOE will deploy approximately **\$12 billion** in new direct carbon management funding and financing over 5 years:
 - Carbon Dioxide Removal through DAC
 - Regional DAC Hubs: \$3.5 billion
 - DAC Technology Prize Competition: \$115 million
 - Engineered Stack Capture (point-source)
 - Carbon Capture Demonstrations and Large Pilots: \$3.5 billion
 - Carbon Capture Technology Program: \$100 million
 - Carbon Dioxide Utilization and Storage
 - Carbon Storage Validation and Testing: \$2.5 billion
 - Carbon Utilization Program: \$310 million
 - Carbon Dioxide Transportation Infrastructure Finance and Innovation: \$2.1 billion
- DOE will deploy an additional **\$8 billion** for hydrogen hubs:
 - At least four projects, including at least one using fossil fuels with carbon management

On December 6, DOE released a Request for Information on Deployment-Ready Carbon Reduction and Removal Technologies to Guide the Selection and Management of Investments under the Bipartisan Infrastructure Law. Responses are due at 5pm on January 24

IJA: Large-scale pilot and commercial demonstration projects for DAC

- Provides \$3.5 billion for four regional DAC hubs with at least 50% private sector cost sharing
- Defines a DAC regional Hub as a “network of DAC projects, potential CO₂ utilization off-takers, connective CO₂ transport infrastructure, subsurface resources, and sequestration infrastructure located within a region”
- Requires that each Hub must facilitate the deployment of DAC projects; have the capacity to sequester and/or utilize 1 million metric tons of CO₂ annually, must demonstrate the capture, processing, delivery, and sequestration or use of the captured carbon, must show it could be developed into a regional carbon network to facilitate CO₂ sequestration or use

IJA: Large-scale pilot and commercial demonstration projects for point-source carbon capture

- Provides \$937 million for pilot projects with at least 20% private sector cost sharing
- Provides \$2.5 billion for commercial demonstration projects with at least 50% private sector cost sharing
- Provides \$100 million for front-end engineering and design (FEED) under the Carbon Capture Technology Program

IJA: CO₂ utilization, transportation, and storage

- Adds a CO₂ utilization grant program authorized in P.L. 116-26 and provides \$310 million
- Amends P.L. 116-26 to add FEED program for CO₂ transport infrastructure and provides \$100 million
- Requires DOE to develop a large-scale carbon storage commercialization program and provides \$2.5 billion for new or expanded commercial, large-scale carbon sequestration projects and the associated CO₂ transport infrastructure (with at least 20% private sector cost sharing)
- Provides \$2.1 billion for DOE to establish a CO₂ Infrastructure Finance and Innovation Act (CIFIA) Program to provide CO₂ transportation infrastructure projects or associated equipment with federal credit instruments, loans, and grants to finance shared CO₂ transport infrastructure

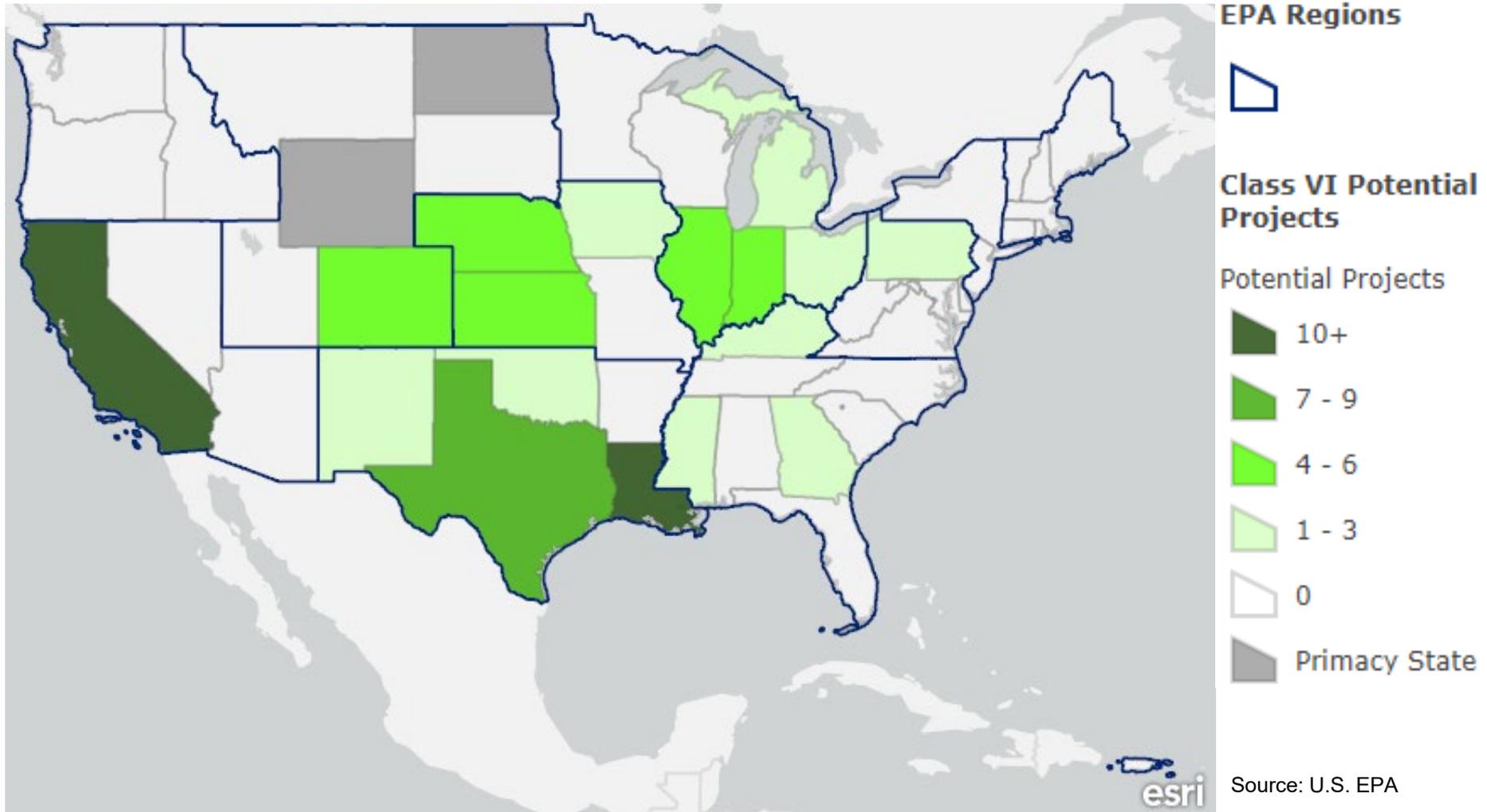
IIJA: Hydrogen Hub provisions

- **Feedstock diversity**, including a requirement that at least one regional clean hydrogen hub demonstrate the production of clean hydrogen from fossil fuels, one from renewable energy, and one from nuclear energy
- **End-use diversity**, including at least one hub to demonstrate clean hydrogen use in the electric power generation sector, one in the industrial sector, one in the residential/commercial sector, and one in the transportation sector
- **Geographic diversity**: including at least two hubs to be located in regions with the greatest natural gas resources
- **Employment opportunities**: hubs most likely to create opportunities for skilled training and long-term employment

IIJA: Other provisions relevant to CCS

- U.S. Environmental Protection Agency (EPA) received funding for Class VI permitting
 - \$5 million for each of fiscal years 2022 through 2026 for EPA permitting
 - \$50 million for the period of fiscal years 2022 through 2026 to establish and implement state permitting programs
- Congress clarified regulations for offshore CO₂ storage
 - Within one year, the Secretary of the Interior shall promulgate regulations for injection of a carbon dioxide stream into sub-seabed geologic formations for the purpose of long-term carbon sequestration

Class VI Project Interest in EPA Implemented Programs



Section 45Q tax credits

- Tax benefits have been available since 2008 for qualified CCUS projects in the United States
- In 2018, benefits were significantly expanded and extended to include:
 - Increased credit amount:
Saline storage: \$50/metric ton; utilization: \$35/metric ton
 - Expanded qualified carbon oxides to include carbon monoxide
 - Expanded qualified uses to include CO₂ utilization other than enhanced oil or natural gas recovery
- Congress recently approved a two-year extension of credit (Consolidated Appropriations Act, 2021)
 - Construction must begin by January 1, 2026
- The Internal Revenue Service (IRS), in consultation with EPA, DOE, and other agencies, finalized the rule in January 2021, providing clarified guidance to stakeholders on areas such as:
 - Monitoring and verification for geologic storage
 - Life cycle analysis provisions for utilization
 - Recapture of carbon dioxide
 - Definition of carbon capture equipment
 - Qualified facility (ex: industrial or DAC)
- Over 80 projects are in various development stages, having been inspired by 45Q updates and state-level incentives

State policies and incentives for CCUS

- **Financial assistance** for CCUS projects and CO₂ pipelines, often as grants or loans
- **Low Carbon Fuel Standards (LCFS)** or other energy market credits (case dependent) recognizing CCUS
- **State assumption of long-term liability** for sequestered CO₂ reduces the long-term costs of CO₂ injection for private project developers
- **Off-take agreements**, which provide a guaranteed buyer for the output from projects integrating CCUS
- **Sector-specific cost recovery mechanism** or **portfolio standards** recognizing CCUS

FE to FECM: a new mission

- To minimize the environmental impacts of fossil fuels while working towards net-zero emissions. The Office's programs use RDD&D approaches to advance technologies to reduce carbon emissions and other environmental impacts of fossil fuel production and use, particularly the hardest-to-decarbonize applications in the electricity and industrial sectors.
- Priority areas of technology work include point-source carbon capture, hydrogen, methane emissions reduction, critical mineral production, and carbon dioxide (CO₂) removal to address the accumulated CO₂ emissions in the atmosphere.
- The Office recognizes that global decarbonization is essential to meeting climate goals and works to engage with international colleagues to leverage expertise in these areas.
 - Recent announcements: DOE/US Geological Survey Memorandum of Understanding on Storage Capacity
- The Office is committed to improving the conditions of communities impacted by the legacy of fossil fuel use and to supporting a healthy economic transition that accelerates the growth of good-paying jobs.
 - Recent announcements: Communities LEAP (Local Energy Action Program) Pilot

Carbon Negative Shot

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

Carbon Negative Shot defines key performance elements for a **necessary** and **nascent** industry which can help ensure CDR is a **responsive** and **responsible** tool so 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 CO₂e** for both capture and storage
- 2 Robust accounting of full lifecycle emissions
- 3 High-quality, durable storage with costs demonstrated for MRV **for at least 100 years**
- 4 Enables necessary gigaton-scale removal

Hydrogen Energy Earthshot Initiative (HEEI)

HEEI Goals:



1 Dollar



1 Kilogram

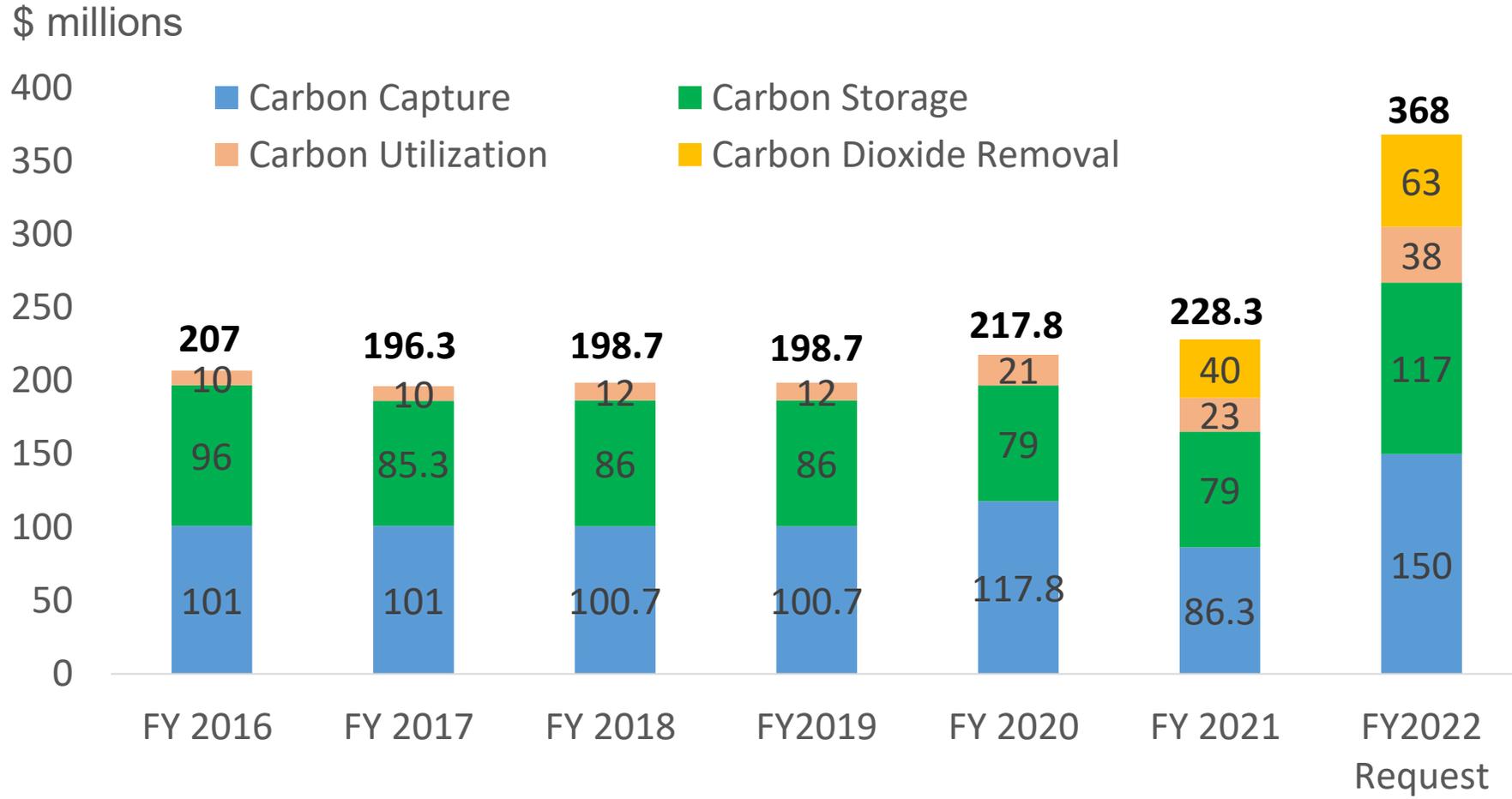


1 Decade

- \$1/kg H₂
- One decade (i.e., 2030)
- “1, 1, 1”

- HEEI launched in June 2021
- FECM hydrogen R&D contributing to HEEI – identify potential pathway to meet the HEEI goals and (informal) emissions intensity goal via screening analyses

FECM R&D funding



FECM RDD&D priorities



Demonstrate and Deploy Point Source Carbon Capture

RDD&D for CCS in the power and industrial sectors to enable wider, strategic commercial deployment to meet net-zero emissions goals by 2050



Advance Carbon Dioxide Removal & Low Carbon Supply Chains for Industry

Develop DAC and mineral carbonation projects and novel approaches to recycle carbon emissions



Develop Low-Carbon Industrial Supply Chains

Develop novel approaches to recycle carbon emissions into value-added products such as concrete, steel, chemicals, and fuels using systems-based carbon management approaches consistent with realizing a net-zero carbon economy by 2050



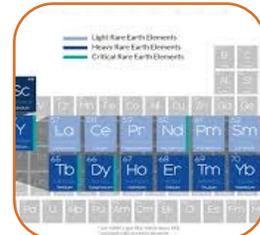
Accelerate Carbon-Neutral Hydrogen (H₂)

Develop technologies that leverage the natural gas infrastructure for H₂ production, transport, storage, & use, coupled to carbon management



Reduce Methane Emissions

Develop technologies and deploy regional initiatives to monitor and reduce methane emissions from fossil fuel infrastructure including coal, oil, and gas



Advance Critical Minerals, Rare Earth Elements (REE), and Mine Remediation

Improve REE separation/recovery technologies to manufacture products from CO₂ and carbon ores and to address current market and process economics. Advance R&D to address abandoned mines



Increase Efficient Use of Big Data and Artificial Intelligence

Use AI, machine learning, and data analysis to create learning algorithms within a large dataset to help discover new material, optimize processes, and run autonomous systems



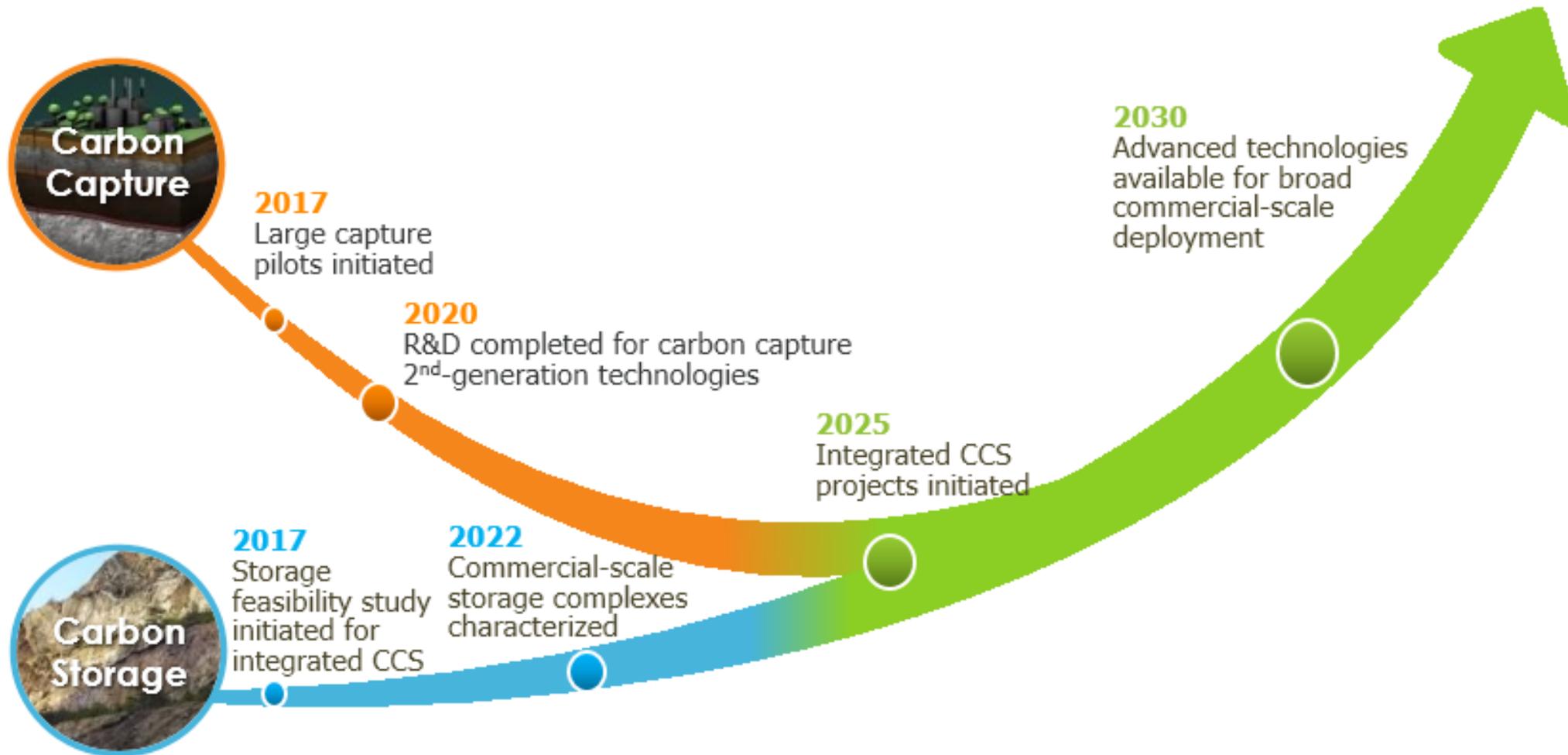
Address Energy Water Nexus

Advance efficient use of scarce water resources and water remediation technologies to address environmental impacts related to produced or displaced water in fossil fuel industries, in addition to that associated with dedicated CO₂ storage

Invest in Thoughtful Transition Strategies

Invest in technologies and approaches and deploy regional initiatives to help create an equitable and just transition to a net-zero carbon economy in energy communities

Integrated R&D approach for future commercial-scale deployment



FECM Memorandum of Understanding with U.S. Geological Survey (USGS)

- Cooperation regarding assessments of global, regional, and national carbon dioxide storage resources
- Collaborate with international governments, geologic surveys, and other organizations
- Technical assistance through discussions, meetings, workshops, and research activities
- Better understanding of current and potential resources for geologic CO₂ storage

International partnerships

Multilateral Partnerships

International Energy Agency (IEA)

- Working Party on Fossil Energy (WPFE)
- CCUS Unit – CCUS Roadmap and International CCUS Regulatory Network

Technology Cooperation Programmes (TCP):

- Greenhouse Gas R&D Programme (GHG)
- Hydrogen

Clean Energy Ministerial (CEM) CCUS Initiative

Carbon Sequestration Leadership Forum (CSLF)

Mission Innovation Carbon Dioxide Removal Mission (MI-CDR)

International Partnership for Hydrogen and Fuel Cells in the Economy (IPHE)

UN Economic Commission for Europe (UNECE)

Accelerating CCS Technologies (ACT) initiative

Global CCS Institute (GCCSI)

Asia CCUS Network

Bilateral Partnerships

(with over a dozen countries)



GLOBAL CCS
INSTITUTE



U.S.-Japan bilateral partnership

- Memorandum of Cooperation on CCUS and Carbon Recycling
 - Cooperation includes DAC and low-carbon hydrogen / fuel ammonia
 - Integral to the U.S.-Japan Clean Energy and Green Growth Initiative (CEGGI)
 - Collaboration through the Asia CCUS Network
- CCUS/Carbon Recycling Working Group
 - Co-led by DOE's Assistant Secretary for FECM and Ministry of Economy, Trade and Industry's Director General for Natural Resources and Fuel Department
 - 1st Working Group (WG) meeting held in December 2021 (virtual)
 - Follow-on WG meetings under planning, including in-person events post pandemic



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Contact Information

Adam Wong, adam.wong@hq.doe.gov

Ayaka Jones, Ayaka.jones@hq.doe.gov

