

# Carbon Capture

for Utilization & Storage

# PROCESS



# Carbon Capture, Utilization & Storage

Carbon capture, utilization, and storage (CCUS) is the process of removing CO<sub>2</sub> from the air, fossil fuels, fossil fuel-derived flue gas, and other large industrial sources for perpetual storage or use. CCUS is a key component of global efforts to combat climate change by both curbing CO<sub>2</sub> emissions and reducing ambient CO<sub>2</sub> concentrations. As an incentive, the U.S. offers tax credits of \$35/tonne CO<sub>2</sub> stored through Enhanced Oil Recovery (EOR) and \$50/t for geologic storage through Section 45Q of the Internal Revenue Code. Twelve states also have active carbon-pricing programs, including California and the eleven Northeast states in the Regional Greenhouse Gas Initiative (RGGI).

CCUS can involve any of these four steps, depending upon the source and desired end use:

## Step 1

Pre-treatment and conditioning of the gas stream to promote effective and economical CO<sub>2</sub> capture

## Step 2

Selective removal and subsequent liberation of purified CO<sub>2</sub> from the gas

## Step 3

Drying, compression, and transport (usually via pipelines) of the CO<sub>2</sub>

## Step 4

Geological sequestration or utilization

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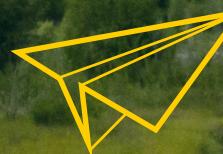
# SERVICES



## Carbon Capture Services

AECOM has 40 years of experience serving as a technology-focused engineering firm dedicated to mitigating the damaging and unhealthy effects of air and water pollution. Our services span paper studies and laboratory investigations to the engineering procurement and construction of commercial installations. AECOM has a documented history of fostering state of the art technologies from idea to implementation. We have the experience and resources to support governments, technology providers, and industry in achieving a low-carbon future with CCUS.

Our Carbon Capture Services include:



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## Paper Studies & Laboratory Investigations

The key to the successful establishment of carbon capture technologies is their continued development and refinement to augment performance, improve economics, and reduce energy requirements.

AECOM is skilled in the review of available research to assess the current state of technology readiness in support of industry's response to regulatory and market drivers, as well as to serve as a springboard for technology development. When the timing is right, we possess the expertise and facilities to develop and administer laboratory-scale experiments to support proof-of-concept and screening tests, fundamental investigations, and process optimization studies.

### AECOM Services Offered:

- Literature reviews
- Paper studies
- Market assessments
- Experimental design
- Fundamental laboratory investigations
- Beaker and bench-scale tests
- Sorbent and solvent evaluations
- Analytical method development
- Simulations and modeling



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# EXPERIENCE

## Paper Studies & Lab Investigations Case Study



### Tackling Challenging Conditions for Pre-Combustion Capture

**TOPIC:** Investigation of Solid Sorbents for Carbon Capture

**CLIENT:** University of Illinois Urbana-Champaign (UIUC)

**SERVICES:** AECOM partnered with UIUC to investigate solid sorbents for carbon capture. The objective was to use first principles to identify materials that could absorb CO<sub>2</sub> from pre-combusted, gasified coal, and test those materials in a bench-scale experiment mimicking a water-gas shift reactor.

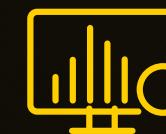
UIUC identified a class of compounds to investigate and performed screening

tests on those materials. High-performance candidate sorbents were then sent to AECOM for bench-scale testing in a high-temperature, high-pressure reactor. The gas matrix included CO, CO<sub>2</sub>, H<sub>2</sub>, H<sub>2</sub>O, and contaminants such as H<sub>2</sub>S and NH<sub>3</sub>. The high pressures and temperatures, and presence of H<sub>2</sub>S introduced unique design, safety, and monitoring requirements.

**RESULTS:** Test results (i.e., removal, regeneration, energy requirements) were used to develop a conceptual process design that could form the basis of a commercial system.



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# Techno-Economic Assessments & FEED Studies

## Techno-Economic Assessments (TEAs)

TEAs are critical to technology development, and the U.S. Department of Energy (DOE) has an established TEA framework to ensure an accurate comparison of disparate CCUS technologies. AECOM has performed many TEAs that adhere to DOE guidelines, serving as an impartial, third-party to benchmark technologies. This experience has exposed us to emerging CCUS technologies for which we have assessed scientific viability, industrial readiness, and capital investment requirements.

## Front-End Engineering Design (FEED)

FEED activities are key to properly funding and thoroughly planning a capital project. By progressing engineering prior to soliciting bids for turnkey delivery, uncertainties can be identified and addressed, including in design, plant layout, utility constraints, and procurement lead times.

Skilled in process development and as an engineering, procurement, and construction firm, AECOM properly evaluates carbon capture technologies and/or CO<sub>2</sub> processing equipment for site-specific conditions based upon the execution approach (e.g., design-bid-build, design-build, etc.) envisioned.



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# EXPERIENCE

## TEAs & FEED Studies Case Study



### Assessing Carbon Capture from a CCGT

**TOPIC:** Piperazine advanced stripper (PZAS) FEED

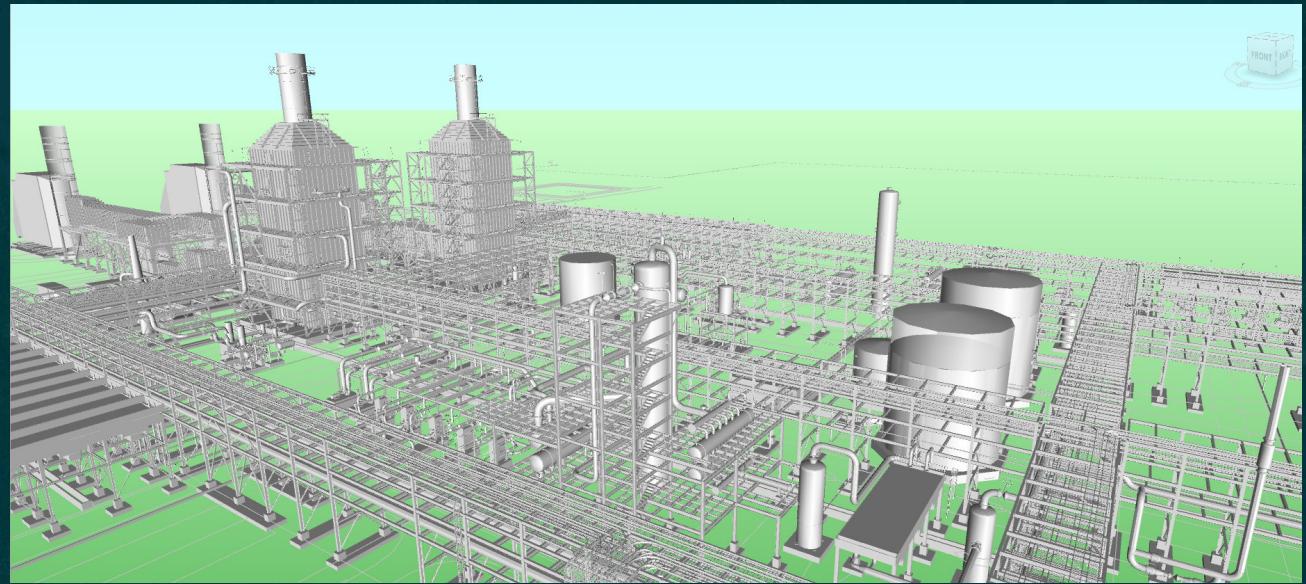
**CLIENT:** US Department of Energy

**SERVICES:** AECOM, as a subcontractor to the University of Texas, provided the discipline-specific and balance-of-plant engineering and design services to complete the FEED, associated with capturing 90% of the CO<sub>2</sub> generated from the combustion of natural gas for the production of power at a plant operating two combined cycle gas turbines (CCGT) in West Texas.

While the host site has advantages like proximity to a CO<sub>2</sub> pipeline and

an open footprint, the project team had to address challenges like a lack of cooling water and steam. This necessitated additional capital investment and operating costs for air coolers and utility boilers.

**RESULTS:** The FEED provides a basis for assessing both the capital and operating expenditures associated with post-combustion carbon capture from a CCGT, and aids in quantifying the investments, incentives, and areas of focus likely necessary for cost cutting.



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# Pilot- & Demonstration-Scale Test Programs

AECOM has successfully planned, designed, implemented, and operated numerous pilot- and full-scale programs intended to demonstrate process performance and reliability using actual process streams at commercial operating conditions.

Testing at pilot- through demonstration-scale is critical to fully understanding emerging carbon capture technologies and serves as a valuable segue between laboratory investigations and commercial implementation. Operation at these scales improves the understanding of the underlying principles of the technology and the challenges with process scale up, providing surety for the capital investments needed for commercial facilities.

## AECOM Services Offered:

- Host site identification and negotiation
- Detailed engineering and design
- Balance-of-plant design (including gas pre-treatment)
- System modularization
- Environmental permitting
- Procurement and construction
- Test program development, management, and execution



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EXPERIENCE

## Test Programs Case Study



### Demonstration of Post-Combustion Carbon Capture

**TOPIC:** Demonstration of the Kawasaki Carbon Capture (KCC) technology

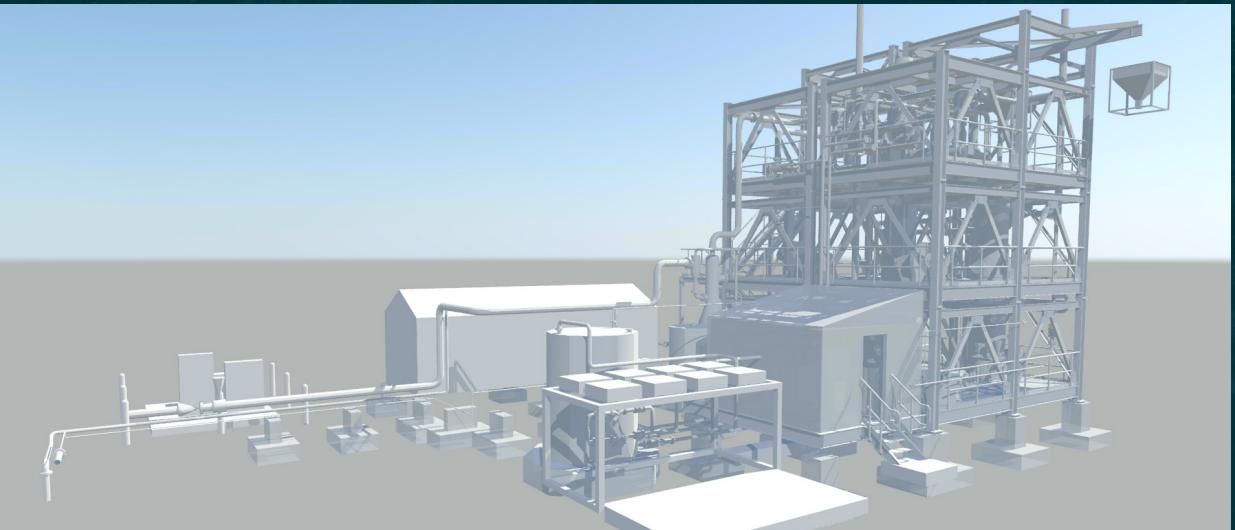
**CLIENT:** Ministry of the Environment, Government of Japan

**SERVICES:** Since 2019, AECOM has collaborated with Kawasaki to provide the preliminary engineering and estimating support for demonstration of the KCC technology at Wyoming's Integrated Test Center (ITC).

Through pre-FEED and FEED execution, the Kawasaki/AECOM team arrived at a modular, skid-based design capable of capturing CO<sub>2</sub> from the

flue gas produced from a coal-fired power plant at a scale of 1,000 Nm<sup>3</sup>/hr, all while complying with host-site constraints, including minimizing on-site construction.

**RESULTS:** With initial funding obtained, AECOM, as the EPC contractor, commenced detailed design in late 2021. Construction completion is planned for late 2023. The testing to follow will focus on the performance and environmental impact of both the carbon capture and sorbent regeneration process.



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# SERVICES



## Detailed Design & Implementation

AECOM has experience successfully advancing processes and technologies from bench-, pilot-, or full-scale demonstrations to commercial operations. With an ability to marry traditional R&D and process consulting with engineering, procurement, and construction (EPC) services, we have supported or partnered with numerous companies and organizations to transition processes into successful commercial offerings. As a trusted partner, we are dedicated to delivering innovative solutions for clients through creative vision, previous experience, technical expertise, and interdisciplinary insight.

### AECOM Services Offered:

- Host site identification and negotiation
- Environmental permitting
- Detailed engineering and design, including balance-of-plant
- System modularization
- Procurement support and/or execution
- Construction management and oversight
- Procedure development and operator training
- Commissioning & startup
- Process optimization & troubleshooting

# Contact

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