EPRI

BACK POCKET INSIGHT

P178 RESOURCE PLANNING FOR ELECTRIC POWER SYSTEMS

Carbon Capture and Storage in Energy System Resource Planning

by Romey James

Carbon Capture and Storage (CCS) is the process of capturing CO_2 before it is released into the atmosphere and sequestering it underground. Applied to power plants, it could enable low-carbon, firm, baseload electricity.

CCS has been used since the 1970's for enhanced oil recovery (EOR), but in recent years the U.S. Department of Energy and public agencies around the world have funded research into its potential as a climate solution. Two coal plants (Boundary Dam and Petra Nova) have demonstrated at-scale CCS on power generating facilities, yet industry experience remains nascent. Further deployment and learning are needed to reduce costs to competitive levels.

CCS Tax Incentives and Emission Rules: U.S. Legislation Updates

The Inflation Reduction Act of 2022 increased existing 45Q tax credits for carbon captured from point sources to \$85/tCO_2 for storage and \$60/tCO_2 for utilization, if labor criteria is met. For direct air capture, the values are \$180/tCO_2 and \$130/tCO_2, respectively.

In May of 2023, U.S. EPA released proposed rules under section 111 of the Clean Air Act, declaring CCS as a best system of emissions reduction (BSER). The rule would require coal plants without a retirement scheduled before 2040 to implement 90% CCS by 2030, and new baseload natural gas turbine plants to co-fire hydrogen or implement 90% CCS by 2035.

KEY INSIGHTS

- CCS has been demonstrated at power plants. Cost reductions will likely occur after additional deployment allows for greater industry experience.
- There are several approaches to capturing CO_2, including post-combustion, pre-combustion, oxy-combustion, and direct air capture.
- Transportation and storage represent smaller portions of the overall costs than capture but can vary significantly and present uncertainties and potential challenges.
- Utilization of CO_2 offers an alternative to geologic storage though the market is much smaller than the potential supply of captured CO_2.

Major Components of CCS

Capture

Post-combustion carbon capture can be achieved through various mechanisms including absorption, adsorption, membranes, and cryogenic processes. Among these, chemical absorption is the most mature technology. It involves exposing flue gas to an amine-based solvent to absorb CO_2, followed by heating the solvent to release a concentrated CO_2 stream.

Pre-combustion carbon capture involves generating synthesis gas from fossil fuels, converting carbon monoxide to hydrogen and CO_2 through the water-gas shift reaction, and capturing CO_2 before combusting hydrogen for power generation.

Oxy-combustion involves burning natural gas with pure oxygen in turbines instead of ambient air, resulting in a flue gas stream of relatively pure CO_2 and water vapor. Studies suggest oxy-combustion could be a cost-effective method of producing low-carbon electricity from fossil fuels.

Direct air capture (DAC) involves removing CO_2 directly from the atmosphere. While several technological approaches are in development, they are mostly in early stages and costly. DAC is relevant for utility planning due to its high energy requirements and serving as an upper bound for CO_2 mitigation costs.

Transportation

Pipelines stand as the primary economic means for transporting large CO_2 volumes, albeit with infrastructure construction complexities. Although capture costs dominate CCS expenditures, transportation expenses are also considerable and vary significantly depending on distance and infrastructure sharing among facilities (higher utilization lowers specific costs).

Storage

The final step in the CCS process is the injection of CO_2 into deep underground formations for long-term storage. In the U.S., geologic storage of CO_2 requires Class VI wells, which carry stringent requirements to protect drinking water resources. The timelines for permitting, authorization, and construction of the few Class VI wells approved so far have been lengthy, creating uncertainty for resource planning. Favorable geology for storage varies regionally, and greater distance from storage wells yields greater transportation costs.

Utilization

As an alternative to geologic storage, the CO_2 can be utilized in a variety of industrial applications including enhanced oil recovery in oil and gas industry, freezing and drink carbonation in food & beverage industry, and as a chemical feedstock or fire suppressant in other industries.

This insight is derived from research conducted by EPRI Program 222 Advanced Generation and Carbon Capture and Storage and Program 178 Resource Planning for Electric Power Systems

RESEARCH CONTACT
Romey James
RJames@epri.com

FOR MORE INFORMATION
Explore EPRI's
Energy Systems and Climate Analysis
Research at **esca.epri.com**