



The U.S. Department of Energy's (DOE) Office of Fossil Energy (FE) research and development (R&D) efforts advance transformative science and innovative technologies that enable the reliable, efficient, affordable, and environmentally sound use of fossil fuels. Fossil energy sources constitute over 77 percent of the country's total energy use and are important to the Nation's security, economic prosperity, and growth. FE's Office of Clean Coal and Carbon Management R&D is focused on developing and demonstrating advanced power and hydrogen generation, crosscutting fossil energy research, and carbon capture, utilization, and storage technologies for existing facilities and new fossil-fueled power plants by increasing overall system efficiencies and reducing capital costs. In the near term, FE is working on implementing successful R&D projects in industrial and power plant components to improve the overall heat rate of these plants through the component efficiencies.

In the longer term, the goal is to increase energy plant efficiencies; make them more flexible, resilient, and reliable; and reduce both the energy and capital costs of carbon dioxide (CO₂) capture and storage from new, advanced plants and existing plants. These activities will help allow coal to remain a strategic fuel for the Nation, while enhancing environmental protection.

The **Coal FIRST** (Flexible, Innovative, Resilient, Small, Transformative) initiative will develop the coal plant of the future needed to provide secure, stable, and reliable power, with carbon-neutral or net-negative greenhouse gas (GHG) emissions. This initiative is a top priority for the Office of Clean Coal and Carbon Management. This R&D will underpin coal-fired power plants that are capable of flexible operations to meet the needs of the grid; use innovative and cutting-edge components that improve efficiency and reduce emissions; provide resilient power to Americans; are small compared to today's conventional utility-scale coal; and will transform how coal technologies are designed and manufactured. Additionally, an export opportunity for Coal FIRST technologies exists, especially in developing countries. Technologies promoted by this initiative have the potential to improve a country's energy security, and in many cases, to expand energy access for those who live without electricity by enabling them to use indigenous fuels. Coal FIRST technologies will also enhance the U.S. advantage as a coal supplier for domestic and international markets.

Research and Development Divisions

Advanced Energy Systems

The Advanced Energy Systems program focuses on improving the efficiency of coal-based power systems, enabling affordable CO₂ capture, increasing plant availability, and maintaining the highest environmental standards. The program supports the development of advanced turbine systems and gasification systems to convert coal into synthesis gas. That synthesis gas can then be converted into electricity, chemicals, hydrogen, and liquid fuels. The program also focuses on transformative power systems to meet the demands of the future electricity grid, solid oxide fuel cells to improve the competitiveness of coal, and the development of supercritical CO₂ power cycles for fossil fuels. For more information click [here](#) or visit energy.gov/fe/science-innovation/office-clean-coal-and-carbon-management/advanced-energy-systems.

Crosscutting Research

The Crosscutting Research program serves as a bridge between basic and applied research by fostering the development and deployment of innovative systems through the R&D of instrumentation, sensors, and controls. The program is also active in the areas of computation, simulation, and modeling focused on optimizing plant design and shortening developmental

timelines. This research improves efficiency and environmental performance and enhances the availability of advanced power systems while reducing costs. The program also supports R&D by looking for new markets and products from coal and the extraction of rare earth elements and critical materials. For more information click [here](#) or visit energy.gov/fe/science-innovation/office-clean-coal-and-carbon-management/crosscutting-research.

Carbon Capture, Utilization, and Storage

The Carbon Capture, Utilization, and Storage R&D program advances safe, cost-effective capture and permanent geologic storage or use of CO₂. The technologies developed and large-volume capture, utilization, and injection tests conducted through this program will be used to benefit the existing and future fleet of fossil fuel power generating facilities by:

1. Developing advanced technologies that reduce the cost of carbon capture;
2. Advancing technologies that transform CO₂ into valuable products; and
3. Creating tools to increase our understanding of geologic reservoirs appropriate for CO₂ storage and the behavior of CO₂ in the subsurface. For more information click [here](#) or visit energy.gov/fe/science-innovation/office-clean-coal-and-carbon-management/carbon-capture-utilization-and-storage.