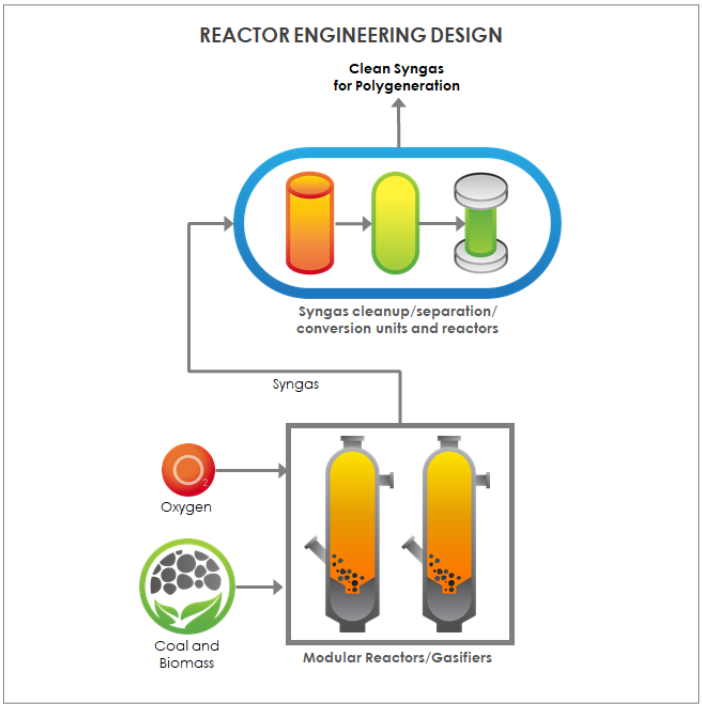
U.S. DEPARTMENT OF ENERGY | Fossil Energy

Advanced Energy Systems

The Advanced Energy Systems (AES) program, under the Office of the Clean Coal and Carbon Management's research and development (R&D) portfolio, is developing a new generation of clean coal-fueled energy technologies capable of producing competitively priced electric power while reducing carbon dioxide (CO_2) emissions. The focus of this program is on improving efficiency, increasing plant availability, reducing water consumption, and achieving ultra-low emissions of traditional pollutants. Much of this research is targeted at improving overall system efficiency, reducing capital and operating costs, and enabling affordable carbon capture.

By leveraging advances in technology, the U.S. Department of Energy (DOE) can meet the challenges facing coal power plants, such as the increased cycling of these plants. DOE can also represent and expand U.S. markets focused on technology development that can enable the coal plant of the future to respond to emerging issues and opportunities, such as improved efficiency and reduced emissions.

The AES program develops innovative, near-zero-emissions technologies that integrate with carbon capture, utilization, and storage (CCUS) capabilities and improve fuel conversion efficiency. The R&D portfolio includes, Gasification, Advanced Turbines, Solid Oxide Fuel Cells (SOFC), Coal and Coal By-Products, Sensors and Controls, Extreme Environment Materials, Water Management, and Innovative Energy Concepts. A description of each AES program follows:



Gasification Systems

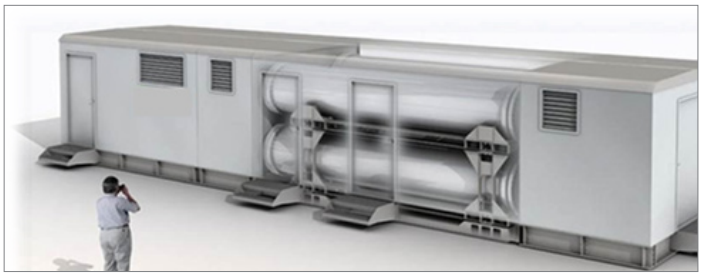
Gasification Systems R&D focuses on developing small-scale revolutionary modular designs for converting diverse types of coal into clean synthesis gas to enable the low-cost production of electricity, high-value chemicals, hydrogen, transportation fuels, and other useful products to suit market needs. Advancements in this area will help enable advanced power generation and other syngas-based technologies to be competitive in both domestic and international markets. It will also spur on the use of abundant domestic coal resources, in turn contributing towards increased energy security and reviving depressed markets in traditional coal-producing regions of the United States.

Advanced Turbines

The Advanced Turbines program manages a research, development, and demonstration (RD&D) portfolio designed to remove environmental concerns over the future use of fossil fuels by developing revolutionary, near-zero-emission advanced turbines technologies. In response to the Nation's increasing power supply challenges, DOE is researching next-generation turbine technology with the goal of producing reliable, affordable, diverse, and environmentally friendly energy supplies. Program and project emphasis is on understanding the underlying factors affecting combustion, aerodynamics/heat transfer, and materials for advanced turbines and turbine-based power cycles.

Solid Oxide Fuel Cells

The Solid Oxide Fuel Cells portfolio focuses on the development of low-cost SOFC power generation systems that produce electric power from coal or natural gas with intrinsic carbon capture capabilities. SOFC power systems have the potential to achieve greater than 60% efficiency and more than 97% carbon capture at



a cost-of-electricity projected to be 40% below presently available integrated gasification combined cycle systems equipped with carbon capture. The SOFC's operating temperature (less than 1650°F) is lower than combustion-based processes and precludes nitrogen oxide formation; there are near-zero emissions of CO_2, criteria pollutants, and particulates. Furthermore, SOFC power systems require approximately one-third the amount of water relative to conventional combustion-based power systems.

Coal and Coal By-Products

Coal and Coal By-Products addresses both enhancing the value of coal as a feedstock and developing new, high-value products derived from coal. Research includes testing of laboratory- and pilot-scale technologies to produce upgraded coal feedstocks and additional revenue-producing products. Expanding existing coal property databases assists research efforts and informs potential consumers in domestic global markets.

Sensors & Controls R&D

Sensors & Controls R&D makes new classes of sensors and measurement tools that manage complexity available, lower costs, and enable robust monitoring and real-time optimization of fully integrated, highly efficient power-generation systems. Controls R&D centers around self-organizing information networks and distributed intelligence for process control. The networking of sensors and the use of improved decision-making capabilities promote the reliability of these systems.

Extreme Environment Materials

Extreme Environment Materials research focuses on structural and functional materials that will lower the cost and improve the performance of fossil-based power-generation systems. It incorporates computational tools to support predictive performance, failure mechanisms, and molecular design of materials. The program develops advanced manufacturing technologies to economically fabricate components that cannot be made using conventional techniques.

Water Management

Water Management R&D addresses the need to reduce the amount of freshwater used by power plants and the need to minimize any potential impacts of plant operations on water quality. This can be accomplished through a variety of means (e.g. efficiency gains, improvements in water recovery and reuse, or through the use of alternate feed sources). The effort requires crosscutting research directed at ensuring sustainable, efficient water and energy use; developing technology solutions; and enhancing understanding of the intimate relationship between energy and water resources.

Innovative Energy Concepts

Innovative Energy Concepts research centers around the development of innovative cost-effective technologies that enhance the efficiency, environmental performance, and availability of advanced energy systems. It aims to create computational tools that shorten the development timelines of those systems. This area conducts fundamental and applied research in innovative concepts with a 10- to 25-year developmental horizon. The concepts offer the potential for technical breakthroughs and step-change improvements in coal power systems with CCUS and minimize the environmental impacts from fossil-based power systems.

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