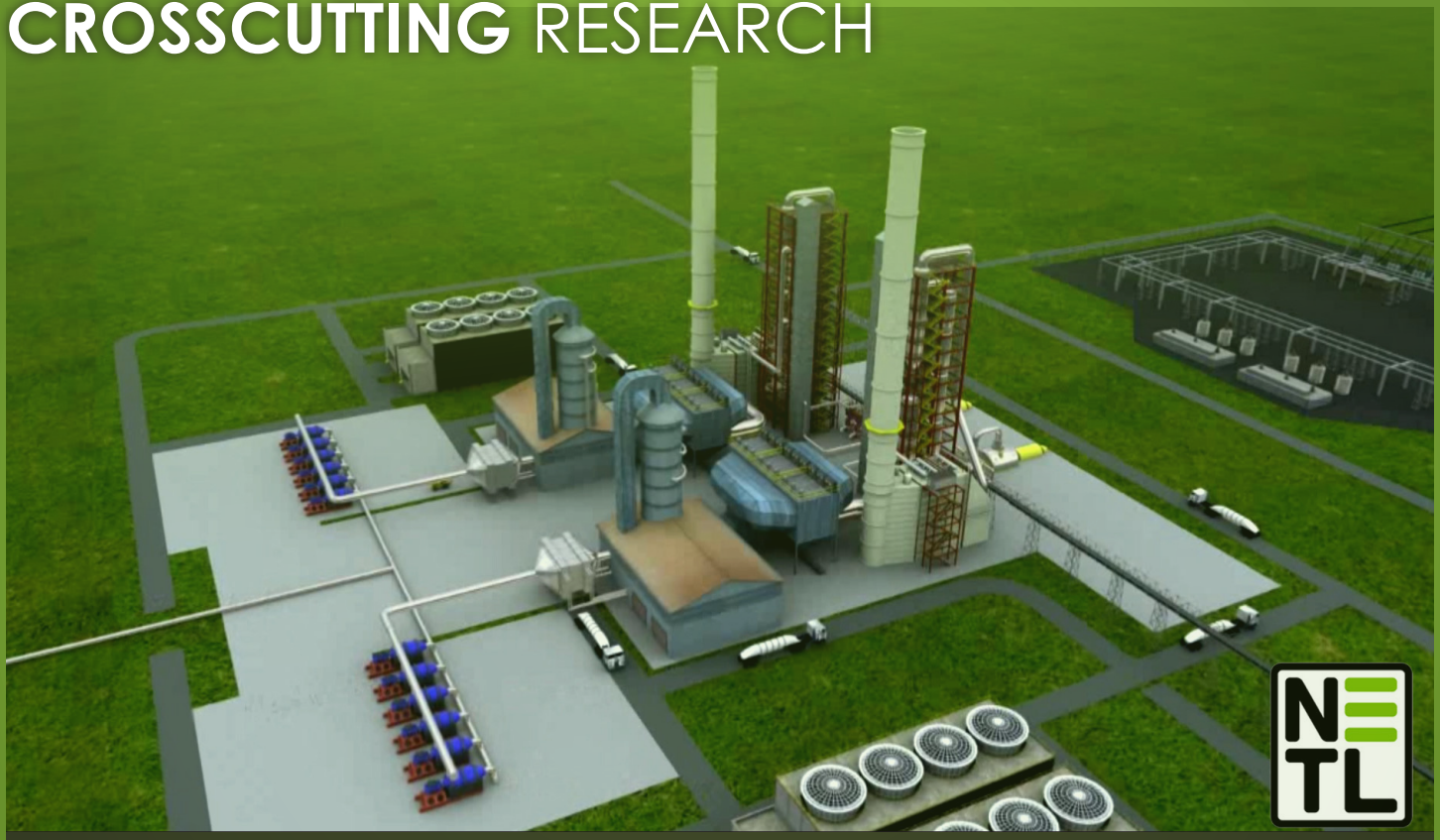
CROSSCUTTING RESEARCH



The Crosscutting Research Program (CCR) serves as a bridge between basic and applied research by fostering research and development (R&D) in four key technology areas: High-Performance Materials, Sensors and Controls, Simulation-Based Engineering, and Water Management Research and Development. These key technology areas target enhanced availability and cost reduction for advanced power systems across the spectrum of the Clean Coal and Carbon Management Research Program.

NATIONAL ENERGY TECHNOLOGY LABORATORY

When ready, successful Crosscutting technologies are transitioned to other fossil energy (FE) Coal and Power Research and Development Programs: Advanced Energy Systems (Gasification Systems, Advanced Combustion Systems, Advanced Turbines, and Solid Oxide Fuel Cells); Carbon Capture; and Carbon Storage. For some technologies, transition directly to industry for development and demonstration is possible without additional FE support.

These CCR technology areas benefit and provide value to FE programs and relevant industrial programs. Consistent with this R&D path, CCR serves as the lead program to incubate novel concepts and foster the growth of those concepts that hold the potential to advance fossil-fueled power systems and carbon capture and storage technologies.

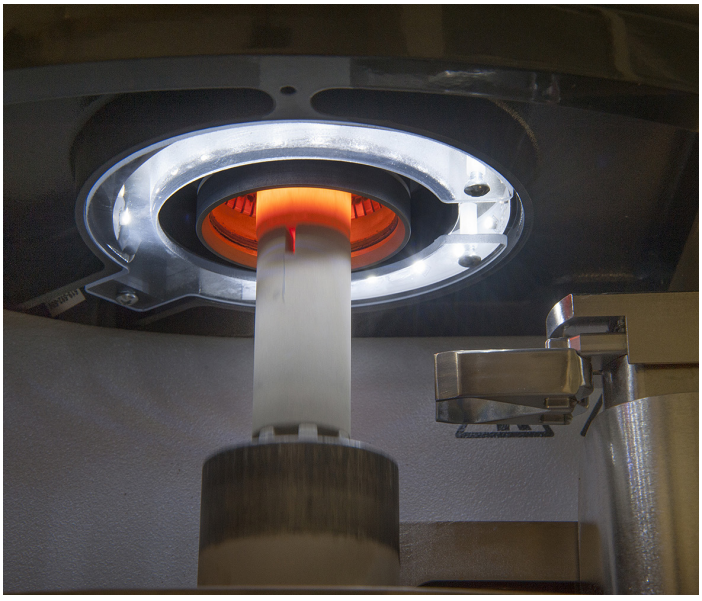
CCR is currently funding the development of a broad portfolio of technologies that have the potential to provide step-change improvements in both cost and performance as compared to current state-of-the-art systems. The execution of the program is primarily through cost-shared R&D in collaboration with universities, national laboratories, government, non-profits, and industry.

HIGH PERFORMANCE MATERIALS

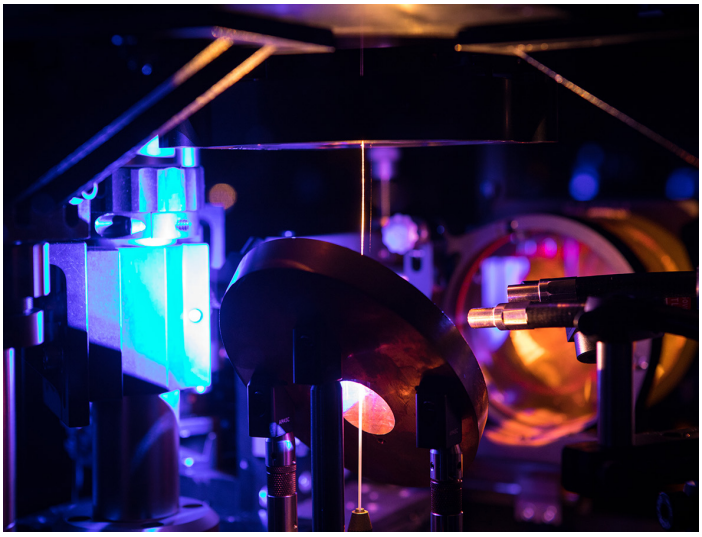
High Performance Materials focuses on developing cost effective structural and functional materials for advanced fossil energy power production technologies, and reducing the cost and time needed to develop and commercialize new materials for FE applications in extreme operating environments. High performance material development also focuses on advanced manufacturing methods for high performance materials and computational materials modeling as enabling technologies. Superalloys can enable operation at pressures and temperatures associated with advanced ultrasupercritical boiler conditions and enable emerging technologies such as supercritical CO_2 (sCO_2), oxycombustion, chemical looping, and direct power extraction. Computational tools support predictive performance, identification of failure mechanisms, and molecular design of materials. Advanced manufacturing technologies are being developed to economically fabricate materials that cannot be made using conventional techniques.

SENSORS AND CONTROLS

Sensors and Controls research supports the development of novel sensors critical to the implementation and optimization of current and new, advanced fossil fuel-based power generation systems, including new classes of sensors capable of monitoring key parameters (temperature, pressure, and gases) while operating in harsh environments. Sensors and Controls makes available new classes of sensor and measurement tools that lower costs and enable robust monitoring and real-time optimization of fully integrated, highly efficient power-generation systems. Controls research utilizes self-organizing information networks and distributed intelligence for process control and decision making, improving control for inherently complex emerging power systems. The overall performance and reliability of plants is enhanced with the improved use of advanced sensor and controls technologies.



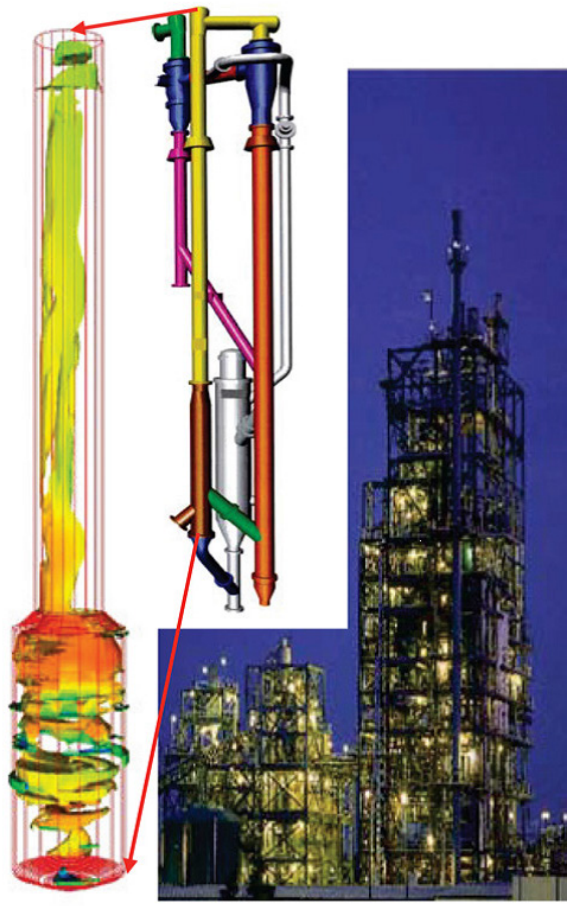
Oxygen/Nitrogen by Inert Gas Fusion
Infrared and Thermal Conductivity Detection



NETL Research and Innovation Center Optical Sensors Lab

SIMULATION-BASED ENGINEERING

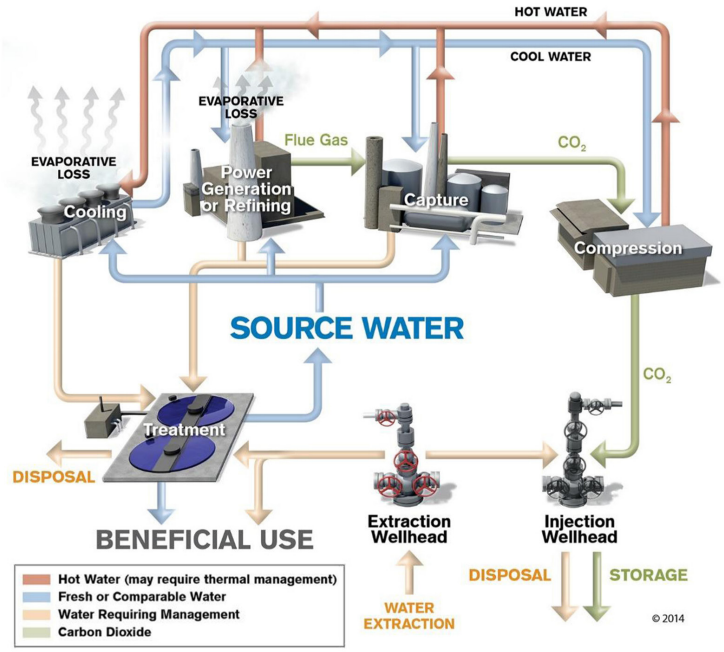
Simulation-Based Engineering (SBE) focuses on predicting the behavior of both materials in extreme and high temperature environments and complex multiphase flow reactors used in fossil-energy technologies. This effort combines theory, computational modeling, experiments, and industrial input. Physics- and chemistry-based computational models and tools are needed to support the development and deployment of advanced fossil-fuel energy devices such as gasifiers and carbon capture reactors. SBE represents a vast amount of expertise and capability to computationally represent the full range of energy science from reactive and multiphase flows up to a full-scale virtual and interactive power plant. Science-based models of the physical phenomenon occurring in fossil fuel conversion processes and development of multi-scale, multi-physics simulation capabilities are just some of SBE's tools and capabilities. Activities include: developing a framework to quantify uncertainties and assess the impact of their propagation in models; providing quantitative error-bars on simulation data; creating simplified models to balance the needs of accuracy and time-to-solution; and model validation.



MFiX Simulation of Pilot Scale KBR/Southern Transport Gasifier

WATER MANAGEMENT R&D

Water Management Research & Development encompasses the need to reduce the amount of freshwater used by power plants and minimize any potential impacts of plant operations on water quality. Field testing of technologies and processes for treating water extracted by injection of carbon dioxide into deep saline aquifers and exploration of water-limited cooling and innovative multi-stage filtration technologies is underway. Data modeling and analysis is being employed to examine existing water availability data on a regional basis. The vision for Water Management R&D is to develop a 21st-century America that can count on abundant, sustainable fossil energy and water resources to achieve the flexibility, efficiency, reliability, and environmental quality essential for continued security and economic health. Crosscutting Research is leading a national effort directed at removing barriers to sustainable, efficient water and energy use, developing technology solutions, and enhancing our understanding of the intimate relationship between energy and water resources.



The Nexus of Carbon Capture and Storage and Water Usage
(image from Klapperich and others, 2011)

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