U.S. DEPARTMENT OF ENERGY | Fossil Energy

Crosscutting R&D Program

Technology innovations improve the efficiency, flexibility, environmental performance, and affordability of fossil-based power plants. The U.S. Department of Energy's (DOE) Office of Fossil Energy (FE) conducts research and development (R&D) in advanced power generation; power plant efficiency; water management; and carbon capture, utilization, and storage technologies.

FE's Crosscutting R&D program conducts research that supports advances in a range of fossil and non-fossil energy systems. The program identifies market needs; accelerates technology development through partnerships; and transfers innovations to the private sector for further development and commercialization. Many program research activities are carried out by the National Energy Technology Laboratory (NETL) in partnership with industry, universities, and other government agencies or national labs.

Crosscutting R&D activities in five areas benefit a broad range of energy generation systems.

Program Components & Successes

The Crosscutting R&D program activities focus on five primary research areas to enhance fossil energy systems, which include the following:

Sensors & Controls

Sensors and Controls research explores novel instrumentation, sensors, and controls to enhance the performance of advanced power systems. For example:

- **Raman Gas Analyzer:** Researchers at NETL developed a real-time gas composition monitoring instrument that utilizes Raman laser spectroscopy to provide better process control for power generation systems and for industries that use natural gas, gasifier syngas, biogas, or other types of fuel gas.
- **High-Temperature Sensor:** In partnership with Sporian Microsystems, Inc., NETL produced smart temperature sensors that can operate at temperatures up to 1,800˚C and pressure sensors that can operate at temperatures up to 1,600˚C to better monitor gas turbines, combustion systems, and more.

High-Performance Materials

This R&D explores new alloys for components that must withstand extreme environments, which is characteristic of most fossil energy systems. For example:

- **Advanced Ultrasupercritical (AUSC) Component Testing Consortium:** FE supports an AUSC Component Testing Consortium, a 15-year effort supported by DOE, the Ohio Coal Development Office, and industry partners. The consortium is working to develop materials for boiler and steam turbines for AUSC coal plants. Materials development, including significant manufacturing trials, focuses on nickel-based alloys for temperatures consistent with 760˚C steam cycle conditions.
- **EXtremeMAT Project:** This project addresses the materials of construction challenges by harnessing the unparalleled computational and experimental materials science expertise and capabilities within the DOE national laboratories, into an integrated, mission-focused team aimed at improving heat-resistant alloys and improving models to predict long-term material performance in existing and future fossil energy power systems. FE and NETL lead the consortium with partner laboratories. For more information, please click here.
- **Crosscutting R&D Program:** This program also participates in the multi-year collaboration with DOE and the United Kingdom's Department for Business, Energy, & Industrial Strategy on fossil energy technologies with a strong emphasis on materials. The objective of the partnership is to share and develop knowledge and expertise in high-temperature materials for advanced fossil energy power plant applications. For more information, please click here.
- **High-Performance Computing for Materials (HPC4Mtls) Program:** The HPC4Mtls program is a part of DOE's High-Performance Computing for Energy Innovation Program. HPC4Mtls accelerates industry discovery, design, and development of materials in energy technologies by enabling access to computational capabilities and expertise in the DOE laboratories. For more information, please click here.

- **Alloys for Supercritical CO_2 Pilot Project:** This pilot project demonstrated that nickel superalloys—Inconel 740 and Haynes H282—have the fabricability, castability, long-term mechanical strength, and corrosion/steam oxidation resistance needed for fossil energy power plants to operate at temperatures up to 760ºC and 5000 pounds per square inch steam. For more information, please click here.

Modeling, Simulation & Analysis

This R&D is active in computation, simulation, and modeling to optimize plant design and shorten developmental timelines. For example:

- **Multiphase Flow with Interphase eXchanges (MFIX) Software Suite:** Researchers at NETL developed a multiphase software suite, MFIX, for modeling the computational fluid dynamics of reacting multiphase systems. This open-source software suite has more than 5,000 registered users worldwide. For more information, click here.
- **Institute for Design of Advanced Energy Systems (IDAES):** In 2016, NETL formed IDAES to improve the efficiency and reliability of existing coal-fired power plants and accelerate the development of advanced fossil energy systems. For more information, click here.

Water Management

Water management research analyzes new methods to conserve water usage in fossil fuel-based generating systems. Examples include:

- **Commercial SPX ClearSky Plume Abatement:** NETL worked with SPX on the development of Commercial SPX ClearSky Plume Abatement, a fully integrated system that condenses a significant portion of moisture before it exits the power plant tower, thereby reducing the plume. For more information, click here and view a video here.
- **Commercial DryFining™:** This innovative coal-drying technology extracts more energy from high-moisture coal at less cost and simultaneously reduces potentially harmful emissions. Developed with funding from the first round of the Clean Coal Power Initiative, the technology has been awarded nine U.S. patents; was commercialized by Great River Energy; and is marketed by a joint venture with the North American Coal Corporation, Great American Energy. After nine years of operation at Coal Creek Station, the Commercial DryFining™ technology has saved approximately $20 million annually in operations and maintenance, and the DOE loan is being repaid. For more information, click here.

University Training

The Crosscutting R&D program sponsors two key programs to prepare the next generation of energy scientists and engineers:

- University Coal Research program; and
- Historically Black Colleges and Universities and Other Minority Institutions program.

These efforts have engaged more than 3,000 students and led to the publication of more than 1,500 papers to ensure technologies—including advanced manufacturing, cybersecurity, and high-performance computing—will be integrated into future energy systems.

Program Strategy

The Crosscutting R&D program actively engages with utilities and the private sector to inform investments in R&D and innovation. The program's research leads to enhancements including improved plant efficiency, new methods to address the challenges of load following, better ways to counter cyber intrusions, and advancements in affordable, scalable technical solutions. Additionally, due to the broad applicability of the Crosscutting R&D portfolio, its technologies often have applicability to other energy sectors, including gas-based power generation, oil and gas infrastructure, and commercial and military aviation.

For further information, please contact:

For Modeling & Simulation, or University Training programs

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