CROSSCUTTING RESEARCH

The U.S. Department of Energy's (DOE) Office of Fossil Energy (FE) 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.

NETL

NATIONAL ENERGY TECHNOLOGY LABORATORY

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.

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

PROGRAM COMPONENTS & SUCCESSES

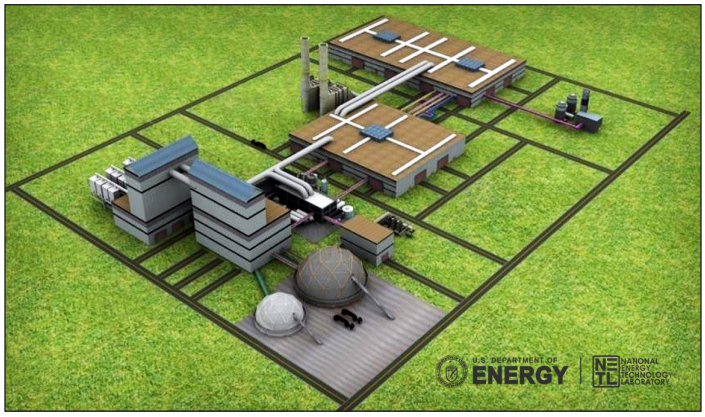
The Crosscutting R&D program activities focus on six primary research areas to enhance fossil energy systems:

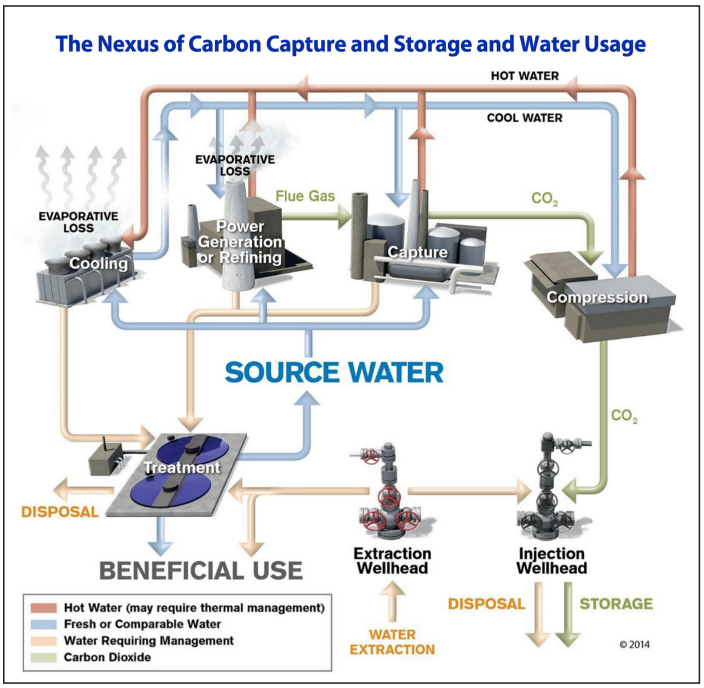
1. SENSORS & CONTROLS—This research explores novel instrumentation, sensors, and controls to enhance the performance of advanced power systems. For example:

- **Raman Gas Analyzer**: NETL researchers developed a real-time gas composition monitoring instrument that utilizes Raman laser spectroscopy to provide better process control for power generation systems and 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.

2. HIGH-PERFORMANCE MATERIALS—This R&D explores new alloys for components that must withstand the extreme environments characteristic of most fossil energy systems. For example:

- **Advanced Ultra Supercritical (AUSC) Component Testing Consortium**: This 15-year effort supported by FE, DOE, the Ohio Coal Development Office, and industry partners develops 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**: Driven by an integrated, mission-focused team, this project aims to improve heat-resistant alloys 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 visit: https://edx.netl.doe.gov/extrememat/
- **Crosscutting R&D Program**: This program collaborates with DOE and the United Kingdom's Department for Business, Energy & Industrial Strategy to share and develop expertise in high-temperature materials for advanced fossil energy power plant applications. For more information, please visit: https://fossil.energy.gov/usuk/
- **High-Performance Computing for Materials (HPC4Mtls) Program**: Part of DOE's High-Performance Computing for Energy Innovation Program, HPC4Mtls accelerates industry discovery, design, and development of materials in energy technologies through access to DOE laboratories' computational capabilities and expertise. For more information, please visit: https://hpc4mtls.llnl.gov/
- **Alloys for Supercritical CO_2 Pilot Project**: This 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 760 ° C and 5000 pounds per square inch steam . For more information, please visit: www.netl.doe.gov/node/8486





3. SIMULATION-BASED ENGINEERING—This R&D aims to optimize plant design and shorten developmental timelines. For example:

- **Multiphase Flow with Interphase eXchanges (MFIX) Software Suite**: NETL researchers developed 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, please visit: https://mfix.netl.doe.gov/
- **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 development of advanced fossil energy systems. For more information, please visit: https://idaes.org/

4. WATER MANAGEMENT—This 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 to develop this fully integrated system that condenses moisture before it exits the power plant tower, thereby reducing the plume. For more information, please visit: http://spxcooling.com/wp-content/uploads/ClearSky-09A.pdf and https://youtu.be/AmGRqJy7yuE
- **Commercial DryFining™**: This innovative coal-drying technology extracts more energy from high-moisture coal at less cost while reducing potentially harmful emissions. Developed with funding from the Clean Coal Power Initiative, DryFining was 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, DryFining saved approximately $20 million annually in operations and maintenance. For more information, please visit: https://youtu.be/z5CR-Wbs9Rc

5. ENERGY STORAGE—This program is critical to advance a flexible, resilient electrical grid and expand affordable mobility options from a diverse suite of energy resources. FE R&D continues to extract maximum economic value from the nation's fossil-fueled energy system assets and advance energy storage technologies such as thermal, chemical, and mechanical to provide significant benefits for future fossil-fueled electric power plants and poly-generation, waste heat recovery, and industrial facilities.

6. 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
- Historically Black Colleges and Universities and Other Minority Institutions Program.

These efforts engaged more than 3,000 students and led to the publication of more than 1,500 papers to ensure integration of technologies such as advanced manufacturing, cybersecurity, and high-performance computing, into future energy systems.

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