Office of Fossil Energy Mission

The Office of Fossil Energy's (FE) mission is to discover and develop advanced fossil energy technologies to ensure American energy dominance, create American jobs, support a resilient infrastructure, maintain environmental stewardship, and enhance America's economy. To do this, developers of the next generation of innovative technologies, will likely depend heavily on high-performance computing resources to effectively solve the scientific and technical challenges inherent in FE's mission. Meeting these challenges is critical to the success of the Office of Fossil Energy (FE), the Department of Energy (DOE), and the nation. FE strategic thrusts include:

Transforming Fossil Energy Systems for the Future

- Develop technologies to enable highly flexible and reliable power systems with carbon-neutral or net-negative emissions.
- Modernize existing coal plants to achieve far greater efficiency, flexibility, and resilience for the smart grid of the future.
- Integrate hydrogen production and storage to support grid flexibility and resilience.
- Optimize the environmental performance of energy systems by increasing efficiency and reducing impacts on water and other resources.

Advance technologies to cost-effectively capture and securely store carbon across the economy

- Accelerate the development of transformational carbon capture and storage technologies
- Build and advance the capabilities needed to measure, scale, and validate CCUS technologies.
- Advance direct air capture, storage, and negative emissions technologies to extend the reach of carbon management.
- Pursue new products and uses for captured carbon dioxide.

Create value added products from coal.

- Explore new, high-value products and uses for coal and coal-based resources across the economy.
- Accelerate pathways to valuable products via coal-produced hydrogen.
- Explore opportunities to create new, value-added products from coal waste streams and materials such as bottom and fly ash.

Critical Cross-Cutting Efforts

- Material Development:
    - Exploring the use of HPC for materials design and discovery and materials for the harsh environments of power systems.
    - Extreme Environment Materials (EEM) and Harsh Environment Materials Initiatives, which address new, durable materials for use in aggressive service environments
    - Highly selective membranes (gas separations [hydrogen, carbon capture], water quality, etc.)
    - Materials/alloys designed to operate in high-temperature and/or harsh environments
    - Self-healing materials to prevent oil and gas leaks

    - Materials to enable CO2 utilization by conversion to other products.
    - Models and toolsets accurately predict materials performance and materials service life under conditions (e.g. high temperatures, high pressures, corrosive, multi-axial stress states, cycling conditions, etc.) associated with fossil energy systems
    - Novel products from carbon byproducts (rare earth elements, critical minerals, nanodots).

- Energy-Water Nexus:
    - Support sustainable coal plant water use, treatment and recovery, and conservation,
    - Reduce freshwater usage and improve water efficiency in thermoelectric plants
    - Develop treatments for produced water from power plants.

- Subsurface Science Technology, Engineering, and Research:
    - Real-Time Visualization of key subsurface features and flows
    - Virtual Learning for rapid prediction of reservoir behavior
    - Real-Time Forecasting of actively managed carbon storage systems

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

- Modeling, Simulation & Analysis:
  This R&D is active in computation, simulation, and modeling to optimize plant design and shorten developmental timelines. Such simulations and analysis help to improve the efficiency and reliability of existing coal-fired power plants and accelerate the development of advanced fossil energy systems.

- Energy Storage:
  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.