TRANSFORMATIVE POWER GENERATION

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NATIONAL ENERGY TECHNOLOGY LABORATORY

The **Transformative Power Generation Program** aims to advance science, engineering, and technology by inventing, integrating, maturing, and commercializing coal combustion power technologies and systems to enhance the nation's energy production and protect the environment for future generations. The program develops technologies to improve performance and extend the life of existing power plants. Research also focuses on next generation modular coal-fired power plants providing stable power generation with operational flexibility and high efficiency, as well as advanced combustion technologies such as oxy-combustion and chemical looping combustion—technologies that provide options for coal-fired power generation in a carbon-constrained future. The program uses a multi-pronged and coordinated approach to identify and perform research through in-house research and development (R&D), as well as cost-shared R&D with external partners in academia, industry, and other national laboratories. Transformative Power Generation technologies will be market-driven with the best technologies, growing deployment opportunities in an increasingly challenging power generation market.

Transformative Power Generation has three primary R&D areas: 1) Coal First – Coal Plant of the Future; 2) Improvements for Existing Coal Plants; 3) Advanced Combustion.

Albany, OR • Anchorage, AK • Morgantown, WV • Pittsburgh, PA • Houston, TX

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NETL implements this effort as part of DOE's Advanced Energy Systems Program.

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COAL FIRST – COAL PLANT OF THE FUTURE – The Coal FIRST (Flexible, Innovative, Resilient, Small, Transformative) Initiative will develop the coal-based power plant of the future that is needed to provide secure, stable, and reliable power. This R&D will underpin coal-fired power plants that are capable of flexible operations to meet the needs of the grid; use innovative and cutting-edge components that improve efficiency and reduce emissions; provide resilient power to Americans; are small compared to today's conventional utility-scale coal; and will transform how coal technologies are designed and manufactured.

The Coal FIRST Initiative will advance coal power generation beyond today's state-of-the-art to make coal-fired power plants a critical contributor to the grid of the future and offer both "firm and flexible" operations—providing stable power with operational flexibility and high efficiency such that it can quickly meet the needs of the evolving grid for resiliency and reliability. The initiative will integrate critical R&D on power plant components with currently available technologies into a first-of-a-kind system. Through innovative technologies and advanced approaches to design and manufacturing, the initiative will look beyond today's utility-scale power plant concepts (e.g., baseload units) in ways that integrate with the electrical grid in the United States and internationally.

IMPROVEMENTS FOR EXISTING COAL PLANTS – The existing coal power generating fleet plays a critical role in providing reliable power generation required for power grid stability. It is important that these existing units continue to operate in an efficient and reliable manner. Under the current energy landscape, power plants are often required to operate at low and/or variable loads. Since the plants are not designed to operate below baseload, operation at low-load results in lowered efficiency and increased wear on the plant components. Operation at variable loads requires ramping of the plant capacity, which adds to the lowered efficiency and increased wear on plant components. As a result, there is a need for rapid commercialization of technologies to improve the efficiency, reliability, and flexibility of existing coal-based power plants. Existing plant combustion technologies R&D focuses on the identification of impactful, near-term opportunities applicable to the needs of the existing fleet.

R&D has been initiated on cost-effective technologies expected to bring about near-term (three to five years) benefits for incorporation into commercial plants that will continue to operate on coal into the future. Currently, the National Energy Technology Laboratory (NETL) supports several projects in collaboration with academia, industry, and NETL's Research and Innovation Center (RIC), ranging from bench-scale testing to validation testing in actual coal-fired power plants.

ADVANCED COMBUSTION – Advanced combustion power generation combusts coal in an oxygen-rich environment rather than air. This eliminates most of the nitrogen found in air from the combustion process, resulting in flue gas composed largely of carbon dioxide (CO_2) and water. The high concentration of CO_2 and absence of nitrogen simplify separation of CO_2 from the flue gas for storage or beneficial use. Thus, oxygen-fired combustion is an alternative approach for carbon capture and storage (CCS) for coal-fired systems.

Advanced combustion has several challenges, including capital cost, energy consumption, air infiltration that dilutes the flue gas with nitrogen, and energy-efficient purification processes to remove pollutants and excess oxygen from the concentrated CO_2 stream. Cost-shared R&D is being performed both externally (by industry, research organizations, and academic institutions) and internally (through NETL's RIC) to develop oxy-combustion and chemical looping combustion (CLC) technologies to overcome these challenges.

TRANSFORMATIVE POWER GENERATION TECHNOLOGIES PROVIDE THE FOLLOWING BENEFITS:

- Performance upgrades to existing coal-fired plants.
- Accelerated deployment of advanced technologies to improve the reliability, availability, and maintainability of coal-fired generation.
- Modular system designs that can be adapted by industry for smaller, more reliable and efficient facilities that increase deployment opportunities.
- Environmental stewardship through long-term development of near-zero emissions coal combustion technologies.

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