

cost are also critical factors in meeting SECA program goals.

#### *Turbine Combustion: Flashback*

In support of the Turbine Program, advanced power systems has goals of very low plant emissions ( $\text{NO}_x$  less than 2-ppm) and turbine combustors capable of stable operation with fuel compositions ranging from natural gas to a broad range for syngas. Although syngas has wide composition variability, the following gives an example of representative properties for a fuel gas from oxygen blown coal gasification: 25%  $\text{H}_2$ , 40%  $\text{CO}$ , 20%  $\text{H}_2\text{O}$ , and 200 BTU/ft<sup>3</sup> lower heating value.

The primary goal for the research is to provide fundamental information and data, or computational tools, that will enable design of turbine combustors with improved stability and emissions. Proposed research should give highest priority to addressing fuel composition and variability issues associated with use of syngas and alternate fuels in gas turbine combustors.

Flashback is an issue for premixed combustors, both in terms of increased emissions and hardware damage. Proposals are sought in this topic for achieving premixing without excessive pressure drop and suitable fuels with a variety of flame speeds, including syngas and hydrogen. Research of interest includes:

- The effect of syngas compositions and percentage concentrations of higher hydrocarbons in natural gas on the propensity of a premixed flame to flashback. Of particular interest is the propensity to flashback in the presence of combustion oscillations (either self-excited or externally driven).
- Measurement of flashback characteristics representing various fuels and fuel compositions (IGCC syngas, natural gas composition variations, liquid fuels, *etc.*), especially for high pressures and in the 700 to 950K temperature range. Of special interest is the effect of higher concentrations of  $\text{H}_2$  in syngas on flashback.

#### **Innovative Concepts Phase-I Program**

The DOE anticipates funding at least eight awards under the Phase-I Program. In the twenty-first century, the challenges facing coal and the electric utility industry continue to grow. Environmental issues such as pollutant control, both criteria and trace pollutants, waste minimization, and the co-firing of coal with biomass, waste, or alternative fuels will remain important. The need for increased efficiency, improved reliability, and lower costs

will be felt as an aging utility industry faces deregulation. Advanced power systems, such as a Vision 21 plant, and environmental systems will come into play as older plants are retired and utilities explore new ways to meet the growing demand for electricity.

Innovative research in the coal conversion and utilization areas will be required if coal is to continue to play a dominant role in the generation of electric power. Innovative Concepts applications will be accepted in any of the six (6) focus areas listed in the Core Program above or the four (4) technical Innovative Concepts Phase-I Program areas listed below. The focus areas under the IC program are not listed in any programmatic priority.

#### **Innovative Concepts Phase-I Technical Topics**

##### *Water Impacts From Coal-Burning Power Plants*

Producing electric power from coal has impacts to water quality from the beginning of the process, mining the coal, to the disposal of ash remaining after the coal has been combusted. Coal mining has left large amounts of overburden wastes that contain sulfide minerals that weather to form sulfuric acid. Many of these areas are causing problems with water quality and re-vegetation. It is estimated that 10,000 miles of streams in the United States are affected by acid mine drainage. The EPA has initiated a Total Maximum Daily Load (TMDL) program to restore impaired water bodies, some of which are degraded from past mining. Coal washing is used to remove pyritic sulfur and other impurities that could be emitted into the air; however, wastewater from this process may release these substances to water bodies. A large quantity of water is used in power plants to condense the steam leaving the turbine. Once-through cooling systems can damage aquatic life and add heat to streams. The EPA has developed new regulations under the Clean Water Act, section 316(b), to reduce once through cooling usage of water and improve cooling water intake structures. Re-circulating cooling towers require the addition of biocides and corrosion inhibitors, which may be released to water bodies during blowdowns. Wet scrubbing of air pollutants from flue gas generates a large quantity of wastewater. Ash ponds have the potential for creating run-off problems and groundwater infiltration. Research opportunities for improving water quality associated with coal combustion for power generation include: (1) Novel active and passive

treatment technologies to address acid mine drainage; (2) Innovative solutions to restoring abandoned mine lands to enhance watersheds; (3) Improved intake and outflow structures for cooling water; (4) Novel uses for waste heat from power plant cooling; (5) Advanced water-related sensors and controls at power plants to minimize adverse impacts to water quality; (6) Novel treatment techniques for scrubber wastewater; and (7) Novel techniques for reducing coal-washing waste and ash pond runoff.

##### *Mercury and Associated Trace Metal Chemistry Studies Within $\text{NO}_x$ Control Systems*

By the year 2010, it is estimated that over 50% of coal-fired utilities will install either selective catalytic reduction or selective non-catalytic reduction units to meet  $\text{NO}_x$  emission limits. Understanding mercury chemistry and process-related speciation mechanisms and transformations related to  $\text{NO}_x$  control systems would provide necessary information to develop more effective, less costly mercury removal processes for industrial and coal-fired boilers. Past research has shown a probable relationship between degree of mercury oxidation and age of  $\text{NO}_x$  catalyst, coal rank, size (or residence time) of  $\text{NO}_x$  control vessel, degree of  $\text{NO}_x$  conversion, amount of  $\text{SO}_2$  converted to  $\text{SO}_3$ , and ammonia slip. Grant applications are sought to further understand partitioning and chemistry of mercury and other trace metal and organic substances in coal-fired (bituminous, subbituminous, and lignite) systems utilizing SCR/SNCR or ammonia injection. Specifically, statistical analysis clarifying the importance of each of these identified parameters and/or their interactions on chemical intermediaries and mechanisms is sought.

##### *Novel Uses of the Calcium Sulfate and Calcium Sulfite-Based FGD Material*

In order to clean up sulfur dioxide emissions from power plants, many utilities have installed either wet or dry flue gas desulfurization (FGD) systems. Currently, the majority of this FGD material is disposed of into landfills. However, there are some utilities that market this material.

The largest reuse market of the material is in wallboard manufacturing processes.

It is estimated that in order to meet future stringent air pollution requirements, many additional utilities will install this technology in the next decade. *Grant applications are*