

flexible, clean, efficient, competitively priced coal-derived products, and low-cost environmental compliance energy systems. Subsequently, this focus remains key to this nation's continuing prosperity and our commitment to tackle environmental challenges, including climate change. It is envisioned that these advanced systems can competitively produce low-cost electricity at efficiencies higher than 60% with coal. This class of facilities will involve "near-zero discharge" energy plants—virtually no emissions will escape into the environment. Sulfur dioxide and nitrogen oxide pollutants would be removed and converted into environmentally benign substances, perhaps fertilizers or other commercial products. Carbon dioxide could be (1) concentrated and either recycled or disposed of in a geologically permanent manner, or (2) converted into industrially useful products, or (3) by creating offsetting natural sinks for CO<sub>2</sub>.

Coal-fired powerplants remain the major source of electricity for the world while distributed generation, including renewables, will assume a growing share of the energy market. Technological advances finding their way into future markets could result in advanced co-production and co-processing facilities around the world, based upon Vision 21 technologies developed through universities, government, and industry partnerships.

Recent improvements within advanced coal-based power systems, in many ways is the culmination of decades of power and fuels research and development (R&D). The most advanced systems have the full energy potential of fossil fuel feedstocks and "opportunity" feedstocks such as biomass, petroleum coke, and other materials that might otherwise be considered as wastes, can be tapped by integrating advanced technology "modules." These technology modules include fuel-flexible coal gasifiers and combustors, gas for fuels and chemical synthesis and can be built in the configuration best suited for its market application by combining technology modules. Designers of these systems would tailor their use of the desired feedstocks and produce the desired products by selecting and integrating the appropriate "technology modules."

The DOE goals for these advanced systems are to effectively eliminate, at competitive costs, environmental concerns associated with the use of fossil fuel for producing electricity and transportation fuels. Research objectives for these advanced power systems are based on three premises: that we will need to rely on fossil fuels for a major

share of our electricity and transportation fuel needs well into the twenty-first century; that it makes sense to rely on a diverse mix of energy resources, including coal, gas, oil, biomass and other renewables, nuclear, and so-called "opportunity" resources, rather than on a reduced subset of these resources; and that R&D directed at resolving our energy and environmental issues can find affordable ways to make energy conversion systems meet ever more strict environmental standards.

To develop and sustain a national program of university research that advances the previously stated objectives, DOE is interested in innovative and fundamental research pertinent to coal conversion and utilization. To accomplish the program objective, applications will be accepted in three program areas: (1) The Core Program and (2) The Innovative Concepts Phase-I Program, and the Innovative Concepts Phase-II Program.

#### **Core Program**

The DOE anticipates funding at least one proposal in each focus area under the Core Program; however, DOE reserves the right not to fund any of the proposals in a given area if they do not meet programmatic needs of the agency. Additionally, high-quality proposals in a higher ranked focus area may be given more consideration during the selection process. Research in the Core Program is *limited* to the following six (6) focus areas and are listed in descending order of programmatic priority:

##### *Materials for Advanced Fossil Energy Systems*

New materials, ideas, and concepts are required to significantly improve performance and reduce the costs of existing advanced power systems or to enable the development of new systems and capabilities for coal combustion and coal gasification, gas separations, hydrogen storage, high-temperature fuel cells, and advanced turbine systems. Materials' issues are related to operation in the hostile conditions created when fossil fuels are converted to energy. These conditions include high temperatures, elevated pressures, pressure oscillations, corrosive environments (oxidizing or reducing conditions, gaseous alkali, chloride or sulfur-containing species), surface coating or fouling, and high particulate loading. The following topics are of interest in this solicitation:

##### **(a) Computer-Aided Design of High-Temperature Materials**

The quest for high-temperature materials is one of the dominant themes

in materials development for efficient energy systems. High-temperature materials is a fast-moving research area with numerous practical applications. Materials that can withstand extremely high temperatures and extreme environments are generating considerable attention worldwide; however, designing materials that have low densities, elevated melting temperatures, oxidation resistance, creep resistance, and intrinsic toughness encompass some of the most challenging problems in materials science. The search for high-temperature materials is largely based on traditional, trial-and-error experimental methods which are costly and time-consuming. An effective way to accelerate research in this field is to use advances in materials simulations and high performance computing and communications to guide experiments. This synergy between experiment and advanced materials modeling will significantly enhance the synthesis of novel high-temperature materials. The studies should only address materials of interest to fossil energy conversion systems.

##### **(b) Coatings for Coal-Fired Environments**

Coatings with superior corrosion resistance in oxidizing, sulfidizing, carburizing and water-containing environments are needed to sustain the life of advanced energy systems. They are of particular interest for improving the corrosion resistance of Fe- and Ni-base alloys to achieve higher operating temperatures in fossil energy systems where sulfur and water vapor can cause severe oxidation problems. For optimum utilization of new coatings, one needs sufficient data about their potential benefits in terms of lifetime and applicable environments. In order to address that issue, model coatings need to be fabricated for corrosion testing and diffusion studies aimed at developing a comprehensive lifetime evaluation approach for the coatings. At least one ferritic and one austenitic alloy should be selected as substrate materials for study. Additionally, nickel-based superalloys are also of interest.

##### **(c) Materials for Hydrogen Storage**

Another critical need of advanced energy systems, is the development of materials for hydrogen storage. These may include alloys and intermetallics, sodium and lithium alanates, nanocubes, carbon nanotubes or other emerging materials. Factors that are relevant for useful materials are hydrogen storage density and stability at