

# PROGRAM facts

Power Systems  
Advanced Research

2/2007

U.S. DEPARTMENT OF ENERGY  
OFFICE OF FOSSIL ENERGY  
NATIONAL ENERGY TECHNOLOGY LABORATORY



## CONTACTS

**Heino Beckert**  
Project Manager  
Environmental Projects Division  
304-285-4132  
heino.beckert@netl.doe.gov

**Robert R. Romanosky**  
Advanced Research  
Technology Manager  
304-285-4721  
robert.romanosky@netl.doe.gov

## PROGRAM PARTICIPANTS

Harvard University –  
Cambridge, MA

Massachusetts Institute of  
Technology – Cambridge, MA

Mississippi State University  
– Mississippi State, MS

Monterey Bay Aquarium  
Research Institute –  
Moss Landing, CA

New York State Education  
Department – Albany, NY

## BIOPROCESSING PROGRAM

### Description

The Advanced Research (AR) Bioprocessing Program sponsors basic science and research related to fossil fuel use in the areas of biology, biochemistry, microbiology, and bioengineering. The Program develops new technologies and applications of biological processes and mechanisms with the purpose of increasing usefulness of biological systems to overcome persistent environmental problems associated with energy generation, including concerns regarding global climate change. Through a variety of research pathways — including biosequestration, bioremediation, bioprocessing, and novel microbial biosensors — more effective and more economical approaches to energy generation and its uses are being discovered. The program also focuses on bioprocesses that foster: (1) innovative uses for coal combustion by-products, (2) development of alternative fuels, and (3) identification of biomass fuel sources

### Goals

The primary goal of the Bioprocessing Program is to perform experimental biological R&D and investigate natural biological processes that result in development of technologies that support clean, efficient electric power generation, while ensuring minimal negative environmental impacts. The main emphasis is to produce reliable information regarding processes and mechanisms needed to increase the usefulness of bioprocessing in clean energy generation. Among the Program's specific performance goals are:

- Finding new and innovative uses for coal by-products such as fly ash, bottom ash, off-gases, and coal fines
- Developing new and innovative uses for coal other than combustion
- Developing new biological sources of alternative fuels, such as hydrogen and methane
- Cofiring coal with other materials, such as noxious plants, waste plant products, and other biofuel
- Mitigating carbon dioxide and other greenhouse gas emissions by recycling off-gases
- Developing ways to sequester greenhouse gases in recyclable biomass (e.g., by growing trees, then harvesting the lumber)
- Providing a relatively stable “sink” for greenhouse gases (stable for around 100 years)

**Advanced Research** — To support coal and power systems development, NETL's Advanced Research Program conducts a range of pre-competitive research focused on breakthroughs in materials and processes, coal utilization science, sensors and controls, computational energy science, and bioprocessing — opening new avenues to gains in power plant efficiency, reliability, and environmental quality. NETL also sponsors cooperative educational initiatives in University Coal Research, Historically Black Colleges and Universities, and



Potomac-Hudson Engineering, Inc.  
– Bethesda, MD

University of Delaware –  
Newark, DE

University of Kentucky Research  
Foundation – Lexington, KY

University of Massachusetts  
– Lowell, MA

West Virginia State University  
– Institute, WV

Western Research Institute  
– Laramie, WY

## ADDRESS

### National Energy Technology Laboratory

1450 Queen Avenue SW  
Albany, OR 97321-2198  
541-967-5892

2175 University Avenue South  
Suite 201  
Fairbanks, AK 99709  
907-452-2559

3610 Collins Ferry Road  
P.O. Box 880  
Morgantown, WV 26507-0880  
304-285-4764

626 Cochran's Mill Road  
P.O. Box 10940  
Pittsburgh, PA 15236-0940  
412-386-4687

One West Third Street,  
Suite 1400  
Tulsa, OK 74103-3519  
918-699-2000

## CUSTOMER SERVICE

**1-800-553-7681**

## WEBSITE

**[www.netl.doe.gov](http://www.netl.doe.gov)**

- Addressing environmental issues affecting the power industry, such as bodies of water being heated by once-through cooling water discharges, and cooling water intakes being fouled by invasive zebra mussels
- Addressing mining issues, such as acid mine drainage and reclamation of surface-mined lands

## Program Focus Areas

Electricity deregulation, increasingly stringent environmental regulations, and requirements to control carbon dioxide and other greenhouse gases are driving the need for the development of advanced biological processes. In response, the Bioprocessing Program focuses on pursuit of critical R&D in three closely interrelated areas:

- **Bioprocessing** — Methods are being developed to create value-added products and chemicals from coal and coal waste products via microbial activity. For example, methods are being investigated for alternative fuel production by exploring biohydrogen generation from coal-derived carbon monoxide by extremophilic microorganisms. Producing hydrogen from coal, coal waste products, and biological organisms may provide a low-cost path toward a hydrogen-based transportation system of the future.
- **Bioremediation** — Technologies in this area remove contaminants from coal and coal waste products through microbial action, such as the biomodification of coal for the removal of mercury, iron, and sulfur via bacterial cultures prior to combustion. Research also is being conducted to evaluate microbial cycling of mercury in coal utilization by-products (CUBs) in landfills and settling ponds, with the goal of improving CUB disposal practices, concentrating and removing mercury from CUBs, and developing technologies for remediating mercury-contaminated soils.
- **Novel Approaches** — This key area focuses on the development of new technologies and applications for more effective and economical bioremediation and bioprocessing methods. Currently, novel microbial biosensors are being developed for detecting environmental contaminants in soils and water

## Future Outcomes

The Bioprocessing Program accomplishes its R&D projects through joint participation with industry, other government research facilities, and institutions of higher education. Examples of projects presently under way or planned for coming years include the following:

- Genome sequencing and production of a cost-effective biotoxin for the control of zebra mussels in power plant intakes
- Identification and production of extremophilic/thermophilic microbes to catalyze the conversion of carbon monoxide and water to carbon dioxide and hydrogen for biohydrogen production
- Sampling and characterization of coal utilization by-products (CUBs) from disposal sites for determining the transport and fate of mercury from CUBs to the environment
- Removal, concentration, and recovery of mercury and other heavy metals from coal piles via bacterial action prior to combustion
- Development of more effective sorbents for the removal of mercury from flue gas with the use of mercury-detoxifying thermophiles
- Development of techniques and procedures for industrial use of mercury-free CUBs