

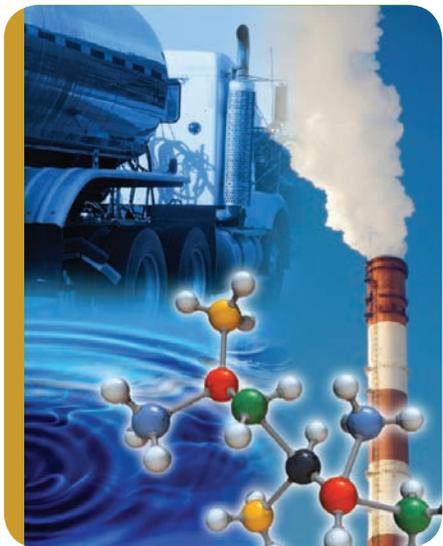
*As part of its quest to become a Top 20 University, the University of Kentucky investigates energy technologies to improve our surroundings; contributes to technically-sound policies related to coal, energy and the environment; and develops viable technologies for producing clean electricity and energy from Kentucky's fossil resources.*

*Research efforts are directed to: coal cleaning and preparation, beneficiation, utilization, and conversion process technologies. Environmental issues relating to mining, fuel use and coal combustion by-products constitute a major effort, along with pollution control, the derivation of high added-value materials and chemicals from energy resources and waste products.*

## ENERGY PRODUCTION and PREPARATION

Using a dry, clean-coal technology at the mine to reject the high-density rock would enhance energy efficiency, improve economics and reduce the environmental impacts of mining coal. New, low-cost, dry coal-cleaning technologies have demonstrated the ability to de-shale some coals. Research focuses on a dry coal-cleaning technology at a 5 tph capacity. Other work demonstrates the application of a patented triboelectric technology to upgrade the energy value of Kentucky coals.

Approximately 10 million tons of ultrafine coal is produced from Kentucky coal mining annually. However, less than 50% of mines use technologies that will recover the ultrafine coal, due to moisture concerns. Part of the moisture problem is a result of ultrafine clay particles that are difficult to remove using traditional separation technologies. UK is investigating the use of novel clay binders that will selectively agglomerate the particles.



## Pollution Control

There is no near-term alternative to reduce our dependence on fossil fuels. It is imperative that we develop technologies that can reduce carbon dioxide (CO<sub>2</sub>). UK is undertaking carbon management projects to lower the energy penalty for CO<sub>2</sub> capture. Various research looks at: developing and heating a new kind of CO<sub>2</sub> Scrubber; developing an integrated CO<sub>2</sub> capture/fertilizer byproduct process; developing chemical looping combustion/gasification for solid fuels; and liquid membrane for solvent-based post-combustion CO<sub>2</sub> scrubbers. The Kentucky Geological Survey is involved in CO<sub>2</sub> partnerships that look at carbon storage that reduces CO<sub>2</sub> by capturing it and storing it underground.

## ENVIRONMENTAL IMPACTS OF Energy Production

Kentucky's coal byproducts will increase by three million tons of scrubber gypsum and one million tons of fluidized bed combustion materials (FBC) soon. The Center for Applied Energy Research (CAER) is investigating ways to recover and use coal ash. One is by using a hydraulic classifier/separator to recover minute-sized ash. This size is ideal for polymer filler use and improves the composite's compressive strength.

These materials can also be used to make low-energy cements, which may reduce CO<sub>2</sub> emissions and energy consumption over that of Portland cement. These cements require less energy to grind, and because they can be produced from waste, produce less CO<sub>2</sub>.



Many challenges have resulted from mining. Researchers are developing methods to re-establish diverse forest ecosystems that provide a renewable and sustainable multi-use resource. Techniques for reclaiming mining operation sites for forest production have been developed. To date, UK and partners have demonstrated this on thousands of acres in eastern and western Kentucky.

## PRODUCTS from COAL

Coal and other hydrocarbon resources can be converted into fuels and chemicals. The CAER operates the largest open-access coal-to-liquids testing and development lab in the world. It is exploring catalysts to convert synthesis gas to paraffin, diesel and jet fuels, as well as separate and upgrade products.

The Consortium for Fossil Fuel Science (CFFS) is a research center led by UK. CFFS has many years of experience in converting coal to transportation fuels and hydrogen and in research on environmental problems associated with coal combustion.



**KGS staff and drilling contractors examining a newly-drilled core during research on coal bed methane in western Kentucky.**

Coal-derived carbon materials are used by industries such as metals production; composite materials; purification; and energy-storage systems. Due to poor quality petroleum coke for metals production, an alternative supply of anode coke is needed for calcined petroleum coke. Domestic coal

reserves could represent an alternative. Researchers are exploring anode-grade coke production by mild-solvent extraction of coal.

Work also is ongoing to develop carbon materials that satisfy requirements for thermal management of electronic and electric power devices. Carbon fibers are being developed for automotive, aerospace and defense industries. Researchers are also working on electro-chemical capacitors based on activated carbon materials derived from coal, coal tar or extract pitch.



### **EDUCATIONAL Outreach**

KGS outreach includes its Earth Science Education Network, which provides teachers with resources using the Web, and an annual Energy Open House for the public. CAER's K-12 outreach focuses on a local elementary school partnership, an annual teacher energy education workshop, and an energy fair for over 200 students from local elementary schools. The Dept. of Mining Engineering supports the UK student chapter of the Society of Mining Engineers. All three host a distinguished lecture series.

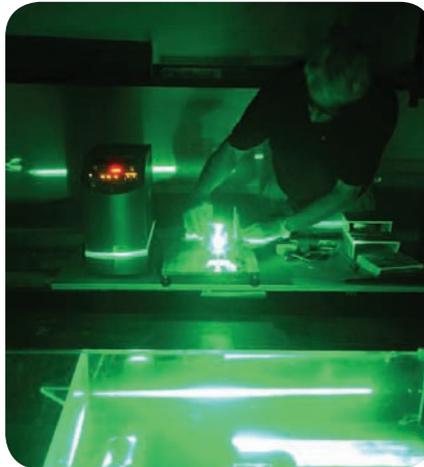
The Kentucky Geological Survey's web site serves nearly one million users each year seeking information on oil, gas, and coal, as well as groundwater and wells for environmental protection. The CAER's Mine Mapping program receives over 1200 requests per year regarding mine mapping issues. The program's mapping website receives over 19,000 hits a day.



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### **MULTIDISCIPLINARY Collaborations**

UK is involved in multidisciplinary collaborative work with institutions like West Virginia University, Auburn University, University of Pittsburgh, Penn State, University of Utah and Virginia Tech through consortia such as CAST (Center for Advanced Separation Technologies); CPCPC (Consortium for Premium Carbon Products from Coal); and the Consortium for Fossil Fuel Science (CFFS).



**Modeling of ventilation networks for coal extraction; use of laser technology to trace air flow utilizing a dust tracer.**

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# **FOSSIL FUEL RESEARCH**

*— UK's land-grant mission and the fact that Kentucky is a major fossil-fuel-producing state, have positioned the university as an international leader in energy and environmental research —*