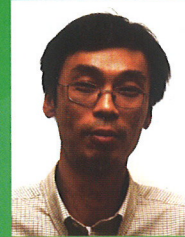


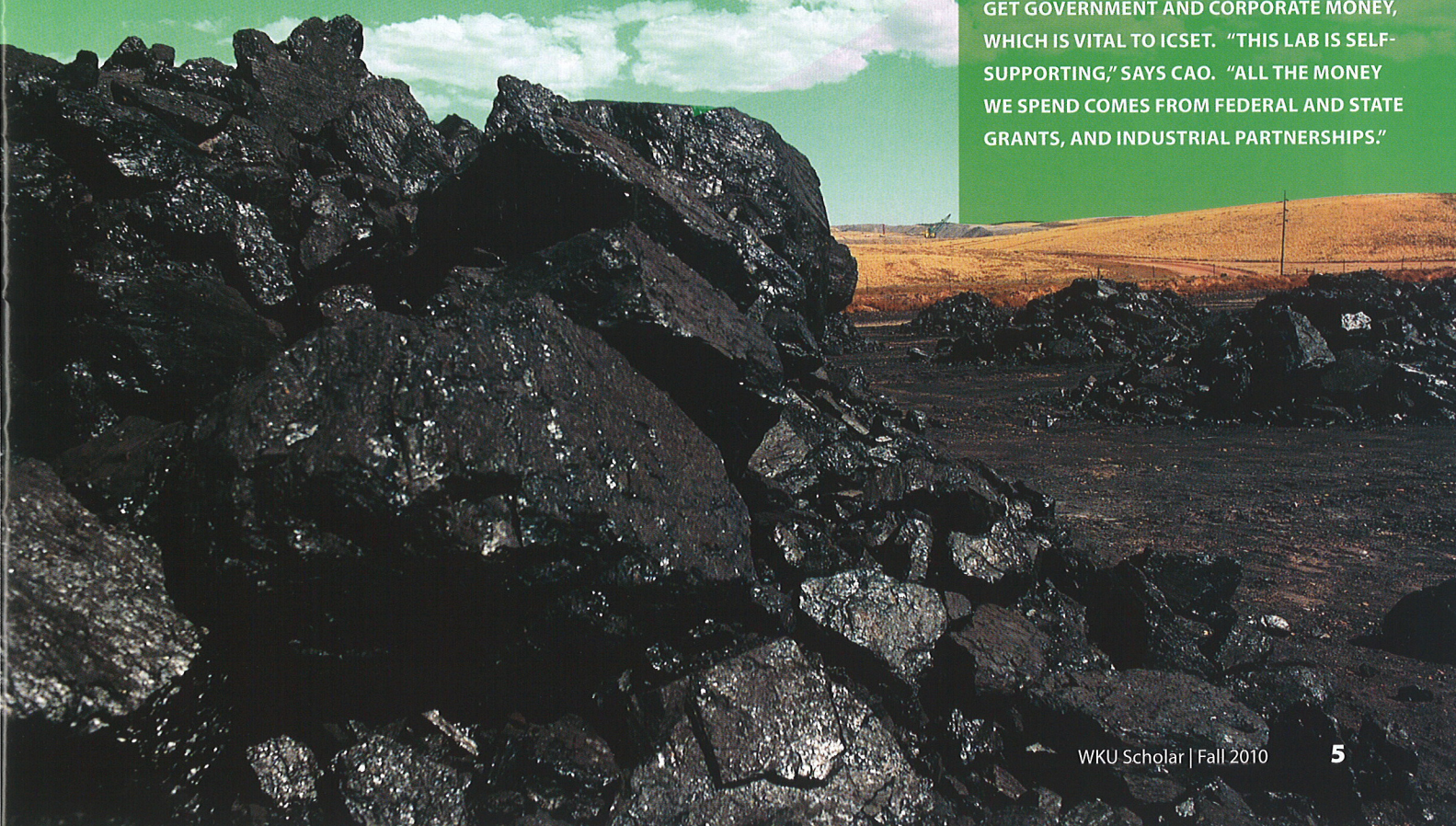
Green RESEARCH

BY KATHERINE PENNAVARIA



Dr. Yan Cao

DR. YAN CAO HAS A PASSION FOR RESEARCH AND FOR THE WORK HE DOES AT WKU'S INSTITUTE FOR COMBUSTION SCIENCE AND ENVIRONMENTAL TECHNOLOGY (ICSET), A WORLD-CLASS RESEARCH FACILITY ON EMISSION CONTROL AND GREEN ENERGY. PERSISTENCE AND HARD WORK PUT HIM IN THE LAB MANY EXTRA HOURS AS ITS ASSOCIATE DIRECTOR, MANAGING MULTIPLE RESEARCH PROJECTS, SUPERVISING STAFF AND STUDENT INTERNS, PUBLISHING RESULTS IN HIGH-IMPACT INTERNATIONAL JOURNALS, AND WRITING GRANT PROPOSALS. HIS LAB COMPETES WITH OTHER UNIVERSITY LABS TO GET GOVERNMENT AND CORPORATE MONEY, WHICH IS VITAL TO ICSET. "THIS LAB IS SELF-SUPPORTING," SAYS CAO. "ALL THE MONEY WE SPEND COMES FROM FEDERAL AND STATE GRANTS, AND INDUSTRIAL PARTNERSHIPS."



The lab has ten full-time staff members, plus visiting scholars and graduate student interns. Cao must spend approximately one-third of his time working on grant proposals. "I write about five grant proposals a year, and maybe only one or two will get funded." He works on grant proposals in conjunction with ICSET's director, Dr. Wei-Ping Pan, whom Cao thinks of as "a remarkable mentor." As a representative of one of only two labs in Kentucky working on energy technologies, Dr. Cao recently testified before a state government commission dealing with emission control and green energy.

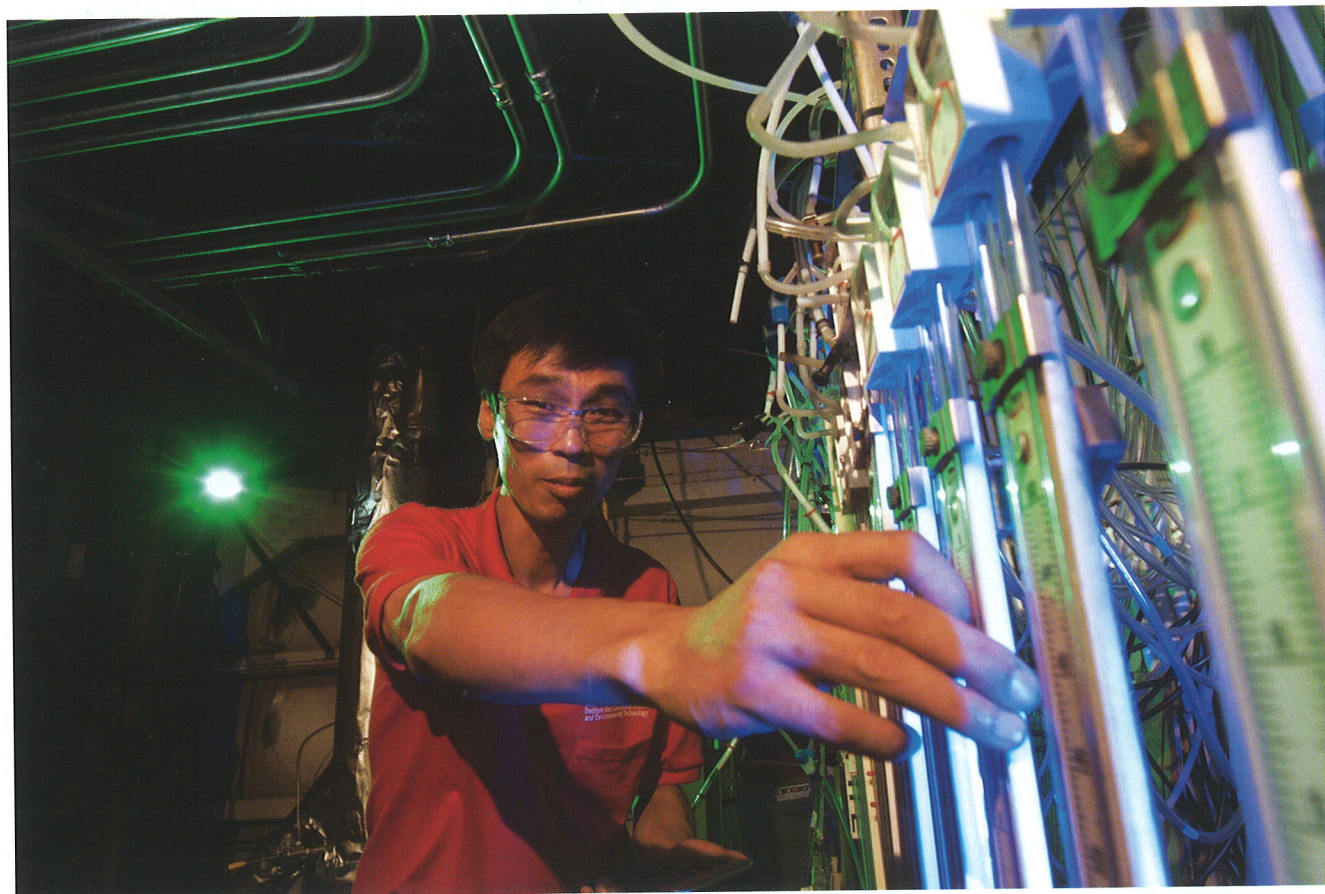
Dr. Cao, who has a Ph.D. in chemical engineering from the

Institute of Coal Chemistry (at the Chinese Academy of Science in Beijing), knows his talents could be put to use in the private sector. Large chemical and energy-producing companies regularly contact him about his research and consulting services. But for the last nine years, ICSET has provided him with a favorable environment and the freedom to pursue research and research-related education. "I love to explore new things," he says with a smile. "My mind cannot keep on one thing, and research is what I want to do." Because of his professional expertise and dedicated work, he has moved up from research assistant to research associate, lab manager,

assistant director for research and development, and finally to his current position of associate director.

His profession was established for him long ago by family circumstances, says Dr. Cao. "My parents and their colleagues were all engineers or professors in chemistry and chemical engineering. When I was a child, I would always watch and learn in their labs. I naturally followed them into the areas which had fascinated me for so long." He adds, "Some of my father's colleagues later became my Ph.D. advisors."

When he first arrived at ICSET, Cao immersed himself in the lab's research projects involving mercury emissions. In the years he has been



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with WKU, says Cao, energy scientists have learned to measure mercury emissions from coal-burning that had not been fully studied before. "Lots of things are getting into the air from burning coal, some we don't even know about yet. It's very tough to do measurements on trace metals such as mercury, but the technology is improving every year," he says.

Over the past ten years, Dr. Cao and his colleagues have serviced more than 150 of the 1000 United States coal-fired power plants. In fact, he says, "several top electricity-generating companies work with our lab, including AEP, Southern Company, Duke Energy, and TVA." After analyzing their systems, ICSET researchers provide these companies with ideas for reducing and controlling mercury emissions.

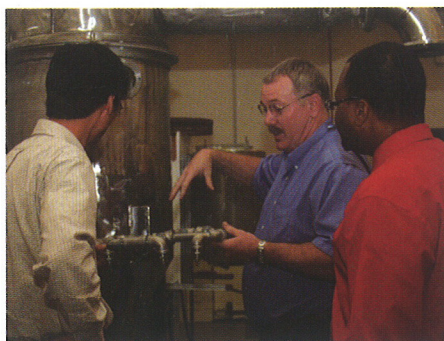
Since 2003, Cao has been leading research on the development of chemical-looping combustion technology, which is different from the conventional combustion process in that it uses oxygen from metal oxide oxygen carriers, not air, for fuel combustion. Thus, there is no energy penalty or reduction in power-plant efficiency.

This research has been funded by the federal and state governments, as well as industrial partners. The overall project will make a vital contribution to the scientific, technical, and institutional knowledge necessary to develop commercially feasible carbon-capture technologies, which can reduce overall electricity costs. Cao believes this technology has the capacity to extend itself into new areas such as hydrogen production and oxygen production, which are critical for the development of green energy.

Another exciting green technology being developed at ICSET is turning carbon dioxide into ammonium bicarbonate, an economical and environmentally

acceptable carbon fertilizer. After this compound is assimilated and metabolized in crops, a considerable amount of the carbon is absorbed by the plants, which leads to increased biomass production. Meanwhile, the majority of the unused carbon source percolates into the soil to form carbonate salts.

At ICSET, Dr. Cao also works with WKU undergraduates and graduate students to improve their research skills and capabilities. "Education



"If we share this knowledge [sustainable green energy], everybody benefits."

and training activities help develop future scientists and engineers, who will then possess the skills required for implementing and deploying carbon capture and sequestration technologies," he says. Dr. Pan and Dr. Cao have been selected by the United States Department of Energy (DOE) National Energy Technology Laboratory (NETL) to conduct fundamental research projects on the aforementioned chemical-looping combustion with students throughout the United States.

Another highly competitive program, Research Experience for Undergraduates (REU), allows students to work closely with WKU faculty members on research to determine levels of toxic PCBs (polychlorinated biphenyl

compounds) in the Green River where it runs through Bowling Green.

Over the years, Dr. Cao has worked with many visiting scholars and student interns from other countries, who then return to their homelands to spread the knowledge they have gained. Dr. Cao says, "It is exciting to work with those people and to exchange multidisciplinary experiences."

For Cao, carbon emissions are the energy problem of today. In the future, he says, he wants to look at the interface between coal-based energy and other renewable energy resources such as biomass (mostly plant material) and solar energy. "In the area of clean energy technology, I have many ideas," he says. "I want to research turning biomass into biodiesel fuel." As a co-principal investigator with Dr. Pan, he has already received a \$500,000 grant from the U.S. Department of Energy to begin studying this process. "Right now, the raw resource for biodiesel production is not 100% green [i.e. from biomass]. Half of it still comes from coal," he explains. With the funds, Cao wants to develop a new process to create biodiesel production that uses a 100% biomass supply.

Cao welcomes emails and calls from other universities, government agencies and corporate representatives, because each contact might lead to another research project being implemented. "I will soon finish with a project funded by the biggest gas company in Canada," says Cao. "They emailed me after reading the published results from ICSET projects." The technology developed here at WKU might someday help the governments of the world develop sustainable green energy and offset the warming effects of coal combustion, he says. "If we share this knowledge, everybody benefits." ■