

# PROJECT FACTS

UNIVERSITY OF KENTUCKY CENTER FOR APPLIED ENERGY RESEARCH

## PARTICIPANTS

University of Kentucky  
Center for Applied Energy  
Research

2540 Research Park Dr.  
Lexington, KY 40511

## SPONSORS

E-ON US

## CONTACT

Kunlei Liu  
UK CAER  
2540 Research Park Dr.  
Lexington, KY 40511  
Tel: (859) 257-0293  
Fax: (859) 257-0302  
[liu@caer.uky.edu](mailto:liu@caer.uky.edu)



## POWER GENERATION & UTILITY FUELS

### Development of an Integrated CO<sub>2</sub> Capture/Fertilizer By-product Process

It is estimated that an aqueous-ammonia technology can reduce the heat rate of a pulverized coal (PC) combustion power plant equipped for CO<sub>2</sub> capture from 11,896 Btu/kWh (amine capture) to 10,140 Btu/kWh. In addition, capital costs are reduced from \$2,231/kW to \$1,800/kW, partially due to the cascading effect of improved efficiency. The aqueous ammonia process also offers a lower net cost for SO<sub>2</sub> and mercury control, thus offering the economic benefits of a multi-pollutant-control system. Fertilizer by-products could provide net revenue of 0.5 cents/kWh, depending on site-specific markets. Overall, aqueous-ammonia scrubbing can potentially provide a net cost of \$13-14/metric ton of CO<sub>2</sub> captured, which equates to a 18-21% increase in the cost of electricity (COE) compared to a PC unit without CO<sub>2</sub> capture. However, research on ammonia-based systems is at a very early stage. The lack of an efficient method to separate ammonia from the concentrated CO<sub>2</sub> stream following thermal decomposition of the scrubber products represents a major hurdle that must be addressed before ammonia scrubbing can be put into common practice.

The objectives of this project are (1) to mitigate the energy penalty imposed by post-combustion CO<sub>2</sub> capture by the addition of a heat-integrated Ammonia CO<sub>2</sub> scrubber; (2) to develop a novel process for overcoming the ammonia separation hurdle from the concentrated CO<sub>2</sub> stream; and (3) to study the feasibility of applying CO<sub>2</sub> hydrate formation in an ammonium based solution.

Several significant impacts from the proposed investigation are anticipated including: (1) demonstration of a more cost-effective ammonia CO<sub>2</sub>-capture process would significantly improve the economics of, and thus, accelerate a national greenhouse-gas sequestration program; (2) the provision of an option to produce a fertilizer by-product (e.g., ammonium sulfate, ammonium bisulfate, ammonium nitrite, and ammonium bicarbonate); (3) the technology could provide a replacement for limestone-based scrubbing processes for SO<sub>2</sub> control. This would result in additional reductions in CO<sub>2</sub> emissions by eliminating the release of CO<sub>2</sub> from the limestone now being used; and (4) improve power plant reliability by eliminating ash fouling in the regenerative air pre-heater section in those plants that rely on selective catalytic reduction (SCR) for NO<sub>x</sub> control.

After completion of the project, the following unsolved issues will be addressed:

- The NH<sub>3</sub>-H<sub>2</sub>O-CO<sub>2</sub> Three-phase Diagram under Utility Flue Gas Conditions
- Optimized Ammonia CO<sub>2</sub> Scrubber & Stripper Configuration and Operation Parameters
- Ammonia Separation from Concentrated CO<sub>2</sub> steam