



# U.S. Department of Energy

## Categorical Exclusion Determination Form

**Program or Field Office:** Advanced Research Projects Agency - Energy (ARPA-E)

**Project Title:** 25A1455 - CO2 Capture with Enzyme Synthetic Analogue

**Location:** Connecticut

**Proposed Action or Project Description:**

American Recovery and Reinvestment Act:

Coal-fired power plants account for more than half of the ~3.8 billion tons of CO<sub>2</sub> emitted from stationary sources in the US and the relatively dilute concentration of CO<sub>2</sub> in their flue gas makes capture challenging. Currently, the best available capture system employs amine-based chemical scrubbing. The technology is effective in removing CO<sub>2</sub>; however, the cost is prohibitively expensive, estimated to be over \$100B /yr for DOE's goal of 90% capture, and adding ~85% to the cost of electricity. Nature's solution to carbon dioxide management in aerobic organisms is to create and use one of the fastest enzymes known, carbonic anhydrase (CA). However, recent academic research has created "synthetic analogue" molecules for elucidation of CA enzyme mechanisms. The biomimicking analogue could be modified for membrane separation for CO<sub>2</sub> capture, offering potential for much lower affect on cost of electricity. UTRC proposes to develop a synthetic analogue/polymer thin film and evaluate its performance and durability for CO<sub>2</sub> separation in a flue gas environment (TRL2 → TRL3). The synthetic analogue of CA will be applied as a "fixed carrier" to capture and release CO<sub>2</sub> in a novel "facilitated transport" separation membrane. The overall project objective is to design the best membrane and system configuration that can lead to the lowest incremental cost of electricity. UTRC's approach comprises two annual phases with ~~five technical tasks for incorporation of the analogue into this non-composite film active layer, followed by preparation and testing of~~

**Categorical Exclusion(s) Applied:**

X - B3.6 Siting/construction/operation/decommissioning of facilities for bench-scale research, conventional laboratory operations, small-scale research and development and pilot projects

\*-For the complete DOE National Environmental Policy Act regulations regarding categorical exclusions, see Subpart D of 10 CFR10 21 [Click Here](#)

This action would not: threaten a violation of applicable statutory, regulatory, or permit requirements for environment, safety, and health, including DOE and/or Executive Orders; require siting, construction, or major expansion of waste storage, disposal, recovery, or treatment facilities, but may include such categorically excluded facilities; disturb hazardous substances, pollutants, contaminants, or CERCLA-excluded petroleum and natural gas products that pre-exist in the environment such that there would be uncontrolled or unpermitted releases; or adversely affect environmentally sensitive resources (including but not limited to those listed in paragraph B.(4)) of Appendix B to Subpart D of 10 CFR 1021). Furthermore, there are no extraordinary circumstances related to this action that may affect the significance of the environmental effects of the action; this action is not "connected" to other actions with potentially significant impacts, is not related to other proposed actions with cumulatively significant impacts, and is not precluded by 40 CFR 1506.1 or 10 CFR 1021.211.

Based on my review of information conveyed to me and in my possession (or attached) concerning the proposed action, as NEPA Compliance Officer (as authorized under DOE Order 451.1B), I have determined that the proposed action fits within the specified class(es) of action, the other regulatory requirements set forth above are met, and the proposed action is hereby categorically excluded from further NEPA review.

NEPA Compliance Officer: /s/ William J. Bierbower

Digitally signed by William J. Bierbower  
 DN: cn=William J. Bierbower, o, ou,  
 email=william.bierbower@hq.doe.gov, c=US  
 Date: 2009.12.15 15:43:58 -05'00'

Date Determined: 12/15/2009

Comments:

Webmaster:



## 25A1455 - Proposed Action or Project Description (Continued)

five technical tasks for incorporation of the analogue into thin nano-composite film active layer, followed by preparation and testing of resulting separation membrane. A preliminary system model has predicted significant cost improvements over amine systems based on target membrane requirements for selectivity, permanence, and durability. Critical project risks include analogue stability, active layer performance and stability, and membrane durability. Mitigating these risks, the project team will be led by UTRC with strong systems, component and molecular modeling, plus deep membrane evaluation and project management experience. Columbia University Professor G. Parkin, the only developer of CA synthetic analogues, will offer tailored analogue molecule synthesis. UTRC will also team with CM-Tec for polymer synthesis and with WorleyParsons, LLC for review of power plant coupled system performance and cost models. Scale-up of the new selective membrane will involve existing technology (membrane modules, compressors, etc) for rapid deployment at large scale.