July 16, 2009

A Study of Carbon Dioxide Capture Technologies and Costs Associated with Lignite-Based Electrical Generating Stations

Contractor: The Shaw Group (Stone & Webster, Inc.)

Subcontractor: N/A

Objective: Complete a study showing the most promising CO_2 capture systems applicable to the existing fleet of North Dakota lignite-fueled electrical power generating stations in North Dakota. The capture technologies will be based on the current fleet configuration, the unique characteristics of lignite, and the evaluated potential of the systems to be field tested at the subject stations within 5 years. Units to be evaluated include: MRY 1&2, Coyote, LOS 1&2, CCS 1&2, Heskett 1&2.

Cost: $462,000 NDIC

Duration: August 1, 2009 – March 31, 2010 (8 months)

Scope of Work (Summary):

Task 1 – Characterization of the Existing Fleet of Lignite-Fueled Generating Stations

- Issue data requests to the plant contacts, compile information & hold kick-off meeting in Bismarck
- Assess data, prepare preliminary characterization of each plants attributes & needs with respect to CO_2 capture technology
- On-site plant visits: site configuration constraints, resource availability (water, steam, auxiliary power, cooling capacity, other)

Task 2 – Identification of CO_2 capture Technology Systems

- Identify most promising potential CO_2 capture technology systems, including multi-pollutant systems
- Assess the stage of development for each CO_2 capture technology with potential for field testing within 5 years:
  - Ready for demonstration
  - Near-commercial
  - First-of-a-kind commercial, or
  - Commercially demonstrated on power plants other than North Dakota lignite-fueled plants
- Finalize plant-specific application(s) for each generating unit

Task 3 – Describe each CO_2 capture Technology Systems

- Provide a description of the leading one, two or three technologies and any additional equipment necessary to integrate each CO_2 capture technology into each plant. Scope of retrofit considerations:
  - Description of flue gas pre-treatment required
  - Consideration of multiple trains, bypass requirements for CO_2 capture, recovery & compression
  - Modifications to the existing flue gas system to accommodate pre-treatment and to connect flue gas to and from the CO_2

capture absorber, e.g., ductwork modifications and additions, fan upgrades or booster fans
    - Preliminary design & sizing of equipment for CO_2 capture by technology supplier; pretreatment, compression & balance of plant
    - Estimate of parasitic power consumption & generation loss for CO_2 capture & other requirements
    - Evaluate constructability issues & degree of difficulty of retrofit
- For each plant & applicable technology, the following will be prepared:
    - Overall process flow diagram with stream balance
    - Motor load list to estimate auxiliary power requirement for retrofit
    - Major equipment list
    - Site plan showing location of additional pretreatment equipment, CO_2 capture & compression equipment

Task 4 – Technical Performance, Costs and Concerns

- Shaw will be working with each leading CO_2 capture technology developer regarding design, performance and cost information to retrofit existing lignite-fueled power plants in ND
- Specifications will be prepared including:
    - Process flow diagram & plot plan
    - Energy and material balance
    - Catalyst and chemicals summary (where applicable)
    - Proprietary solvent/adsorbent/absorbent chemical cost
    - Sizing of equipment
    - Budgetary cost for major equipment & installation
    - Licensing/royalty fees (if applicable)
    - Special maintenance/replacement requirements
- Design and performance information for both 50% & 90% CO_2 removal
    - Flue gas flow, temperature & composition
    - Solvent make up rate
    - Steam requirements
    - Cooling water flow
    - Electricity consumption
    - Flue gas pretreatment
    - Flue gas emissions
    - Space requirements
    - Net power plant output with CO_2 capture & compression

Task 5 – Recommend Most Promising Systems

- A scale of ranking the CO_2 capture technology systems will be prepared
- Project economics and uncertainties (risks and concerns) will be the basis
- Recommendations for additional work regarding follow-up topics for further study and demonstration will be provided

Task 6 – Project Management & Deliverables

- A kick-off meeting in Bismarck, 2 quarterly reports, draft final report, final report and oral presentation in Bismarck describing study findings