APPENDIX B: CARBON DIOXIDE CAPTURE TECHNOLOGY SHEETS

R&D COLLABORATIONS

PARTNERSHIP FOR CO_2 CAPTURE

Primary Project Goals

The University of North Dakota Energy and Environmental Research Center (UNDEERC) is conducting pilot-scale testing to demonstrate and evaluate a range of carbon dioxide (CO_2) capture technologies to develop key technical and economic information that can be used to examine the feasibility of capture technologies as a function of fuel type and system configuration.

Technical Goals

- Integrate a high-efficiency flexible capture system with existing pilot-scale combustion and emission control systems to evaluate the performance of several capture techniques and technologies in flue gas streams derived from selected fossil fuels, biomass, and blends.
- Conduct testing of oxy-combustion for selected fuels and blends in one or more of UNDEERC's existing pilot-scale units.
- Evaluate the performance of emerging CO_2 capture technologies under development.
- Perform systems engineering modeling to examine efficient and cost-effective integration of CO_2 capture technologies in existing and new systems.

Technical Content

UNDEERC is constructing two pilot-scale systems with the intention of performing experiments on several advanced CO_2 capture technologies and comparing them to one another, as well as to monoethanolamine (MEA), which is considered to be the current state-of-the-art technology.

Baseline testing will be conducted using MEA to gather information to characterize each of the units. The results obtained by using MEA in the CO_2 absorption system will be used as a standard by which all other solvents will be compared. Data to be collected includes CO_2 removal, CO_2 purity, required regeneration heat, and effects of sulfur oxide (SO_x), nitrogen oxide (NO_x), particulate matter, and trace metals.

Figure 1: UNDEERC Post-Combustion CO_2 Capture Test Facility

Technology Maturity:
Pilot-scale

Project Focus:
Partnership for CO_2 Capture

Participant:
UNDEERC

Project Number:
NT43291-02.5

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Partners:
None

Performance Period:
6/30/08 – 8/31/11

Baseline testing of the oxy-combustion system will follow similar procedures as the absorption system. The data collected will be used to identify potential challenges concerning this technology. These challenges include effects of mercury (Hg) capture, flame stability, fouling, slagging, and heat-transfer issues.

Once CO_2 capture technologies have been selected, testing will begin. Some of the technologies under consideration include other solvents [monodiethanolamine (MDEA), tailored amines, designer amines, ammonia, and potassium bicarbonate), membranes (metal membranes and carbozyme], and solid sorbents (zeolites, metal-organic frameworks, solid amines, and C-Quest). In addition to testing these technologies, different fuels will be used to evaluate their impact on the performance of the fabricated test units. Factors to be examined will include the effects of SO_x, NO_x, and other gas components; effects of ash deposition along with corrosion of refractory; and alloy components.

UNDEERC has completed the construction of the oxy-combustion system and has begun shakedown testing of the units.UNDEERC has also completed an Aspen model of the solvent absorption and stripping column (SASC) system.

Technology Advantages

UNDEERC will be capable of providing experimental data for a variety of advanced CO_2 capture technologies and oxy-combustion systems. This information will not only provide needed information for further advancement, but will provide a clear comparison of various approaches.

R&D Challenges

Retrieving enough information on existing technologies to make appropriate selections for testing.

Results To Date/Accomplishments

- Completed design and construction of the post-combustion test system.
- Evaluated four solvents in the post-combustion test system: three advanced solvents and MEA
- Completed the oxy-combustion retrofit.
- Conducted two phases of testing with the oxy-combustion system
- Modeled the combustion test facility (CTF) system in Aspen with and without the oxygen-fired retrofit modifications.

Next Steps

- Perform additional experiments on promising technologies.
- Conduct systems engineering analyses to evaluate technology integration opportunities for CO_2 capture systems.

Final test results will not be available until the August 2011 project completion date.

Available Reports/Technical Papers/Presentations

Chen, S.G.; Lu, Y.; Rostam-Abadi, M. *Carbon Dioxide Capture and Transportation Options in the Illinois Basin*; Topical Report Oct 1, 2003–Sept 30, 2004 for U.S. Department of Energy Contract No. DE-FC26-03NT41994.

Metz, B.; Davidson, O.; Coninik, H.; Loos, M.; Meyer, L. *IPCC Special Report Carbon Dioxide Capture and Storage Technical Summary*; ISBN 92-9169-119-4, Sept 2005.Narula, R.; Wen, H.; Himes, K. Economics of Greenhouse Gas Reduction – The Power Generating Technology Options. Presented at the World Energy Congress, Buenos Aires, Brazil, October 2001.

U.S. Environmental Protection Agency. Greenhouse Gas Inventory Sector Analysis. www.yosemite.epa.gov (accessed June 2006).