Virginia City Hybrid Energy Center
Response to Data Request
Vivian Thomson, Vice Chair, Virginia Air Pollution Control Board

Question (Page No. 7):

The National Energy Technology Laboratory indicates that the $/tonne of CO_2 avoided for pulverized coal technologies operating with carbon capture is approximately $50/tonne, or two times that for IGCC plants operating with carbon capture ($24/tonne CO_2 avoided) (National Energy Technology Laboratory 2007). What is the estimated $/tonne of CO_2 avoided for circulating fluidized bed technology with carbon capture?

Response:

The cost estimates for carbon capture from a circulating fluidized bed boiler today are similar to that of a PC unit. Both PC and CFB units, will utilize a combustion or post-combustion carbon capture process. The difference between CO_2 emissions from new generation IGCC and from CFB/PC installations is that there is a more concentrated CO_2 exhaust stream from IGCC than CFB/PC, thus allowing for a more efficient capture of CO_2. However, collection of CO_2 from IGCC installations has not been demonstrated in practice at a commercial level.

As the National Energy Technology Laboratory website points out, "because CO_2 is present at much higher concentrations in syngas than in post-combustion flue gas, CO_2 capture should be less expensive for pre-combustion capture than for post-combustion capture. Currently, however, there are few gasification plants in full-scale operation, and capital costs are higher than for conventional pulverized coal plants."[1]

The National Association of Regulatory Commissioners: "Clean Coal Generation Technologies Review for New Power Plants Assessment," March 2008, reported that between technologies "numerous elements may affect these costs, and over the long term there is no clear leader in the technologies [PC,SCPC,CFB,IGCC] considered here". "Different technologies may have cost advantages depending on factors such as the impact of coal rank on projected cost and efficiency, the recent escalation in actual equipment costs, and the lack of demonstration of CO2 capture on commercial power plants."[2]

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[1] **http://www.netl.doe.gov/technologies/carbon_seq/FAQs/tech-status.html#**

[2] http://www.naruc.org/Publications/CoalGenerationTechnologies.pdfm

To a practical extent, carbon capture technologies are still being developed. DOE, as well as the global community engaged on this topic, is pursuing research programs on three types of capture technologies with equal commitment and vigor **(http://www.fossil.energy.gov/news/techlines/2006/06061Sequestration_Research_Grants.html):**

- "Pre-combustion, in which fuel is gasified to form a mixture of hydrogen and CO2, called synthesis gas or "syngas," and CO2 is captured from the syngas before it is combusted.
- Post-combustion, which involves capturing CO2 from flue gas after fuel has been combusted in air.
- Oxycombustion, in which fuel is combusted in pure or nearly pure oxygen rather than air, producing an exhaust mixture of CO2 and water that can easily be processed to produce pure CO2."

Some of the issues and challenges on these technologies were summarized in a presentation by AEP, which is below as Figure 1.[3]

Dominion Virginia Power has been very involved in monitoring carbon capture technologies including combustion (OxyFuel) and post-combustion processes (chilled ammonia process, amine absorption, or algae bioreactor systems). The rate of research progress on capture R&D, as well as on storage, is summarized in Figure 2. This information was compiled for the 2005 special report of the Intergovernmental Panel on Climate Change entitled "Carbon Dioxide Capture and Storage."

The report and similar studies by a number of other agencies and organizations have concluded that Pre- and Post-combustion capture methods for generation facilities are progressing with similar pace. The table also addresses, amongst other parameters, the state of development of CO_2 storage options. Sequestration in coal seams, with Enhanced Coal Bed Methane, the method currently pursued by the Virginia Center for Coal and Energy Research, is given a "Demonstration Phase" maturity.

The process of post-combustion capture using chilled ammonia as the solvent, funded amongst others by EPRI, Alstom , Statoil, DOE, and others, will be demonstrated at two AEP facilities, the Mountaineer Plant in West Virginia and the Northeastern Plant in Oklahoma as demonstrated in Figure 3 below. [1] According the presentation, "the first carbon capture project, at the Mountaineer plant in West Virginia is expected to complete its product validation phase in 2009" and "the second, at the Northeastern plant in Oklahoma, will begin commercial operations in 2012."

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[3] B. Braine (a), AEP and Climate Legislation, Presentation at Sanford C. Bernstein 2007 Carbon Symposium, October 9, 2007.

According to the developers and AEP, this method of post combustion has the potential to be deployed with a power reduction to the generation facility (parasitic load) of 10% with an associate coast of electricity of about 25% to achieve CO2 capture.[4] Finally, the same article projects that pre- and post combustion capture will be fairly competitive in 15-20 years, and fuel specific issues are likely to drive the choice.

In conclusion, post-combustion capture, a method proposed for the CFB Dominion Facility in Wise County, offers excellent promise. As indicated above, a number of post-combustion technologies are under development. Post-combustion capture using chilled ammonia as the solvent, has now moved to the demonstration stage, and is an excellent candidate for carbon capture. Economic and technical criteria (including parasitic load requirements) for this particular method are encouraging, and the commercialization validation is within reach, by 2012.

[4] *The Challenge of Carbon Capture*, EPRI Journal, Spring 2007

Figure 1: AEP and Climate Legislation, Presentation at Sanford C. Bernstein 2007 Carbon Symposium

Figure 2: IPCC 2005 Report, “Carbon Dioxide Capture and Storage”

Figure 3: Post Combustion Capture at AEP Facilities