Carbon Dioxide Sequestration

Industrial-scale processes are available for separating carbon dioxide from the post-combustion flue gas of a steam-electric power plant or from the synthesis gas fuel of a coal gasification power plant. The separated carbon dioxide can be compressed and transported by pipeline for injection into suitable geologic formations for permanent storage ("sequestration").

Commercialization of coal-fired gasification power plants (Appendix I) is expected to boost the prospects for carbon dioxide separation and sequestration because the lower cost of carbon dioxide separation from the relatively low volume of pressurized synthesis gas fuel of a gasification plant compared to the cost of partitioning carbon dioxide from the much greater volume of steam-electric plant flue gas. Carbon dioxide can be separated using the sorbent processes currently used to remove sulfur compounds from the synthesis gas of existing gasification plants used for chemical production. Selective regenerative sorbent technology is capable of separating up to 90 percent of the carbon dioxide content of raw synthesis gas. The carbon dioxide would than be compressed to its high-density supercritical phase for pipeline transport to sequestration sites.

This process is in commercial operation at the Great Plains Synfuels Plant in central North Dakota. Here, carbon dioxide is separated, compressed and transported 205 miles by pipeline to Weyburn, Saskachewan where it is injected for enhanced oil recovery. Solvent-based regenerative processes are energy-intensive and would lower the thermal efficiency of coal gasification power plants. Selective separation membrane technology would reduce the energy requirements of carbon dioxide separation. Research, mostly at the theoretical or laboratory stage is underway for the development of selective separation membrane technology suitable for withstanding the operating conditions of a coal gasification power plant.

Among the sequestration alternatives being considered are depleted or depleting oil and gas reservoirs, unmineable coal seams, salt domes, deep saline aquifers and deep ocean disposal. Proven technology is available for injection of carbon dioxide into oil or gas-bearing formations. An advantage of sequestration involving enhanced recovery of gas, oil or coalbed methane is the byproduct value of the recovered oil or gas. Moreover, coal is often found in the general vicinity of oil or gas-bearing formations, which could reduce carbon dioxide transportation cost. Saline formations suitable for sequestration are widespread, and could also use existing injection technology, though there would be no byproduct value. Because the primary objective of existing carbon dioxide injection operations has been enhanced oil or gas recovery rather than carbon dioxide storage, additional development of monitoring capability and processes for verifying the integrity of geologic carbon dioxide disposal sites is needed.

Preliminary assessment of the costs of carbon dioxide transportation and storage range from $1.00 to over $16/tonCO2 for a power plant located near suitable depleted oil or gas reservoirs or saline aquifers (Table K-1)[1]. These estimates do not include the possible byproduct value of

---

[1] Heddle, Gemma, et al. The Economics of Carbon Dioxide Storage (MIT LFEE 2003-003 RP). MIT Laboratory for Energy and the Environment. August 2003.

enhanced oil or gas recovery. The report from which the values of Table K-1 were obtained also examined the cost of ocean disposal of carbon dioxide. These estimates were omitted from Table K-1 because the feasibility of ocean disposal appears to be speculative at this time.

Deep saline aquifers and bedded salt formations potentially suited for carbon dioxide sequestration are present in eastern Montana. The US DOE has provided matching funds to establish several Regional Carbon Sequestration Partnerships. These include the Northern Rockies and Great Plains partnership, led by Montana State University. This group will identify carbon dioxide sources and promising geologic and terrestrial storage sites in Montana, Idaho and South Dakota. The West Coast Regional partnership, led by the California Energy Commission will pursue similar objectives in the West Coast states, Arizona and Nevada.

Table K-1: Estimated costs for transporting & storing 7389 tonnes (8146 Tons) carbon dioxide per day ($/TonCO2, year 2000$)[2]

Depleted gas reservoir		
Base	Compression to 152 bar (2204 psi) at IGCC plant; 100km (62 mi) 12" (nominal) pipeline to injection site; 5000 ft injection wells. No recompression.	$4.10
Low cost	Compression to 152 bar (2204 psi) at IGCC plant adjacent to injection site; 2000 ft injection wells. No recompression.	$1.00
High cost	Compression to 152 bar (2204 psi) at IGCC plant; 300km (186 mi) 13.8" (min.) pipeline to injection site; 10,000 ft injection wells. No recompression.	$16.30
Depleted oil reservoir		
Base	Compression to 152 bar (2204 psi) at IGCC plant; 100km (62 mi) 12" (nominal) pipeline to injection site; 5100 ft injection wells. No recompression.	$3.20
Low cost	Compression to 152 bar (2204 psi) at IGCC plant adjacent to injection site; 5000 ft injection wells. No recompression.	$1.00
High cost	Compression to 152 bar (2204 psi) at IGCC plant; 300km (186 mi) 13.8" (min.) pipeline to injection site; 7000 ft injection wells. No recompression.	$9.40
Saline aquifer		
Base	Compression to 152 bar (2204 psi) at IGCC plant; 100km (62 mi) 12" (nominal) pipeline to injection site; 4100 ft injection wells. No recompression.	$2.50
Low cost	Compression to 152 bar (2204 psi) at IGCC plant adjacent to injection site; 2300 ft injection wells. No recompression.	$1.00
High cost	Compression to 152 bar (2204 psi) at IGCC plant; 300km (186 mi) 13.8" (min.) pipeline to injection site; 5600 ft injection wells. No recompression.	$9.80

2 Estimates exclude separation costs and possible byproduct credit from enhanced gas or oil recovery.