Summary of Carbon Dioxide Capture and Geologic Storage Options

Capture and Separation of Waste Carbon Dioxide from Power Production and Industrial Processes	Transportation	Storage	
		Resource Recovery and Reuse	Other Geologic Storage
• Chemical absorption with liquid amine solution • Oxygen-fired combustion • Pre-combustion decarbonization (e.g., through gasification)	• Carbon dioxide pipeline • Shipping • Trucking[a]	• Enhanced oil, gas, and coalbed methane recovery • Food processing and carbonation, and synthesis of chemicals	• Deep saline formations • Deep, unmineable coal seams • Depleted oil and gas reservoirs • Shales
Sample Applications			
A new 600 MW IGCC plant could capture up to 90 percent of carbon dioxide emissions. Additional energy expenditures would reduce the total captured carbon dioxide to 85 percent of what would be emitted without the project.[b]	A 300-km pipeline transports carbon dioxide from a North Dakota gasification plant to the Weyburn oil field in Saskatchewan.	Carbon dioxide is injected under pressure into a geologic formation to enhance fuel extraction. More than 70 EOR projects worldwide, mostly in U.S., 10 percent of which rely on waste carbon dioxide.[c]	Since 1996, Statoil has avoided Norway's carbon tax by sequestering carbon dioxide in a sandstone aquifer below the North Sea. About 1 MMTC is stored a year, equivalent to 3 percent of Norway's total annual carbon dioxide emissions.

Estimated Cost of Carbon Dioxide Emissions Avoided (Dollars per Metric Ton)			
Power Plant Technology[d]	**Transportation Options[e]**	**Resource Recovery Options[e]**	**Other Storage Options[e]**
IGCC: 19.5	100 km via pipeline: 1-3	NA[f]	Sample storage sites:[g] 4-19
Ultra-supercritical PC: 42.4	500 km via tanker: 2		
NGCC: 60.4	Trucking: NA		

IGCC = integrated gasification combined cycle; NA = not available; NGCC = natural gas combined cycle; PC = pulverized coal.

[a]A.F.B. Wildenborg and L.G.H. van der Meer, "The Use of Oil, Gas and Coal Fields as CO_2 Sinks." Paper presented at IPCC Workshop on Carbon Capture and Storage (Regina, Canada, November 18-21, 2002), web site www.nrcan.gc.ca/es/etb/cetc/combustion/co2network/pdfs/ipcc_geological_storage2.pdf.

[b]Science Applications International Corporation, calculations based on data from K. Thambimuthu, J. Davison, and M. Gupta, "CO_2 Capture and Reuse." Paper presented at IPCC Workshop on Carbon Capture and Storage (Regina, Canada, November 18-21, 2002), web site http://www.nrcan.gc.ca/es/etb/cetc/combustion/co2network/pdfs/ipcc_co2cap_reuse.pdf.

[c]U.S. Department of Energy, Office of Fossil Energy, National Energy Technology Laboratory, *Carbon Sequestration Technology Roadmap and Program Plan* (Washington, DC, March 12, 2003), web site www.fe.doe.gov/programs/sequestration/publications/program_plans/03/.

[d]Electric Power Research Institute, *Updated Cost and Performance Estimates for Fossil Fuel Power Plants with CO_2 Removal*, Interim report (Palo Alto, CA, December 2002), web site www.netl.doe.gov/coalpower/gasification/pubs/pdf/1004483.pdf.

[e]International Energy Agency (IEA), *Solutions for the 21st Century: Zero Emissions Technologies for Fossil Fuels* (Paris, France, May 2002), web site www.iea.org/impagr/zets/strategy/strategic_layout.pdf.

[f]No estimates are available on the added cost benefits of resource enhancement and the impact on total injection and storage cost.

[g]Due to the wide variation in storage types and site parameters, cost estimates for carbon dioxide storage are based on site-specific data and are not distinguished by storage type.

Source: National Energy Technology Laboratory, *Greenhouse Gas Accounting Issues for Carbon Capture and Geologic Storage Projects* (Pittsburgh, PA, February 2003), p. 2.