CARBON CAPTURE AND STORAGE—A VIABLE TECHNOLOGY FOR THE ABATEMENT OF GREENHOUSE GAS EMISSIONS?

Dominick J. Graziano

In 1742, when Benjamin Franklin invented the Franklin Stove (which provided more heat while burning less fuel than other fire places), the concentration of CO_2 in the atmosphere was approximately 290 parts per million (ppm). By 1960, the concentration of CO_2 in the Earth's atmosphere had risen to 315 ppm, it increased to 350 ppm by 1988 and is 370 ppm today. *See*, SPENCER WEART, THE DISCOVERY OF GLOBAL WARMING 203 (Harvard 2004). We are currently increasing the concentration of CO_2 in the atmosphere at a rate of about 2 ppm per year. Some scientific reports suggest that we must prevent atmospheric CO_2 concentrations from reaching 450 ppm if we are to avoid "catastrophic" climate impacts.

Despite dire warnings from scientists and a steady stream of scientific reports detailing the potential global impacts from continued climate change caused by the buildup of greenhouse gases (GHGs), the use of carbon emitting fossil fuels is likely to continue well into the future, and is likely to rise along with the growing economies of India and China. *See*, The "Assessment Reports" issued by the United Nations Intergovernmental Panel on Climate Change (IPPC) available at www.ipcc.ch; and reports issued by the Pew Center on Global Climate Change, available at www.pewclimate.org. Recently, periodicals as varied as Foreign Affairs, Scientific American, and The Financial Times have published articles discussing the feasibility of carbon capture and storage (CCS) as a possible bridge technology while the world weans itself off of fossil fuels and towards renewable sources of energy. FOREIGN AFF., Nov./Dec. 2004; SCI. AM., July 2005; FIN. TIMES, Aug. 23, 2005.

On Sept. 25, 2005, the IPCC, which is made up of over 2000 experts from over 100 countries, issued its long awaited "Summary Special Report on Carbon Dioxide Capture and Storage" (Special Report), available at www.ipcc.ch. At the time of this writing, only the "summary report for policy makers" was available for review. Nonetheless, it outlines critical issues associated with implementing CCS technology, including economic costs, safety and environmental risks, its potential for ameliorating climate change and related issues.

The Special Report defines CCS as "a process consisting of separation of CO_2 from industrial and energy related sources, transport to a storage location, and long term isolation from the atmosphere." It affirms CCS as a viable GHG mitigation option that could be implemented along with energy efficiency improvements, the use of less carbon intensive fuels, increased use of nuclear power, renewable energy sources, and creating and nurturing biological sinks. It also acknowledges that widespread adoption of CCS will depend upon technological maturity and cost, as well as its overall potential for diffusion and transfer to developing countries.

The Special Report underscores the IPCC's Third Assessment Report's (TAR) acknowledgement that effective reduction of GHGs must be approached with the understanding that until the middle of this century the primary source of energy will continue to be fossil fuels. CCS can serve as a "bridge" to the future while use of renewable energy sources, coupled with increased energy efficiency, is encouraged along with reduced reliance on the use of fossil fuels. *See*, Socolow, *Can You Bury Global Warming?*, SCI. AM., July 2005.

It is estimated that as much as 40 percent of CO_2 emissions in the United States can be attributable to large point sources. This makes CCS especially important in the reduction of GHGs since it is primarily applicable to large stationary sources. These facilities include large fossil fuel or biomass energy facilities, natural gas production, synthetic fuel plants and fossil fuel based hydrogen plants. One of the critical issues in implementing CCS is determining whether the locations of these large stationary sources are near potential GHG repositories. The Special Report outlines several storage methods, including storage in geological formations, such as oil and gas fields, unminable coal beds, deep saline formations, ocean storage (including direct release into the water column or onto the deep ocean sea floor) and industrial fixation of CO_2 into inorganic carbonates.

According to the IPCC, technology currently available is capable of capturing about 85-95 percent of the CO_2 processed in a capture plant. However, capturing carbon requires approximately 10-40 percent more energy than a plant with equivalent output that does not capture carbon. The majority of this additional energy is needed for capture and compression. Thus, the net result is 80-90 percent reduction in CO_2 emissions as compared to a power plant not using CCS technology.

There are several different types of CCS technologies currently available, including post combustion capture, precombustion capture and oxyfuel combustion capture. According to the Special Report, all of these are economically feasible under most circumstances.

Transportation mechanisms for captured CO_2 include pipelines for large amounts and trucking facilities for smaller amounts, or ships for overseas disposal destinations. Ideally, the CO_2 would be captured and stored in repositories close to the generating facilities, thus reducing additional energy costs and GHG emissions.

Currently, there are three industrial scale CCS facilities in the world, one in Norway, another in Canada and one in Algeria. The Norway facility has been in use since 1996, resulting in approximately one million tons of CO_2 being stored annually from the offshore gas field, Sleipner West. This project has resulted in the capture of 2 percent of Norway's total GHG emissions. This project offers a real world example on the application and efficacy of carbon capture and storage in geologic formations. To date, there have been no signs of leakage from the Sleipner repository.

According to the Special Report, CO_2 can be injected into saline formations or oil or gas fields at depths below 800 meters, resulting in physical and geochemical trapping mechanisms (a cap rock), preventing migration to the surface. Other possible geological repositories include coal bed storage at shallower depths, which relies upon CO_2 being absorbed by the surrounding coal. One of the potential drawbacks of this repository is the inherent permeability of the coal bed.

The Special Report notes, and it is important to point out, that CO_2 storage could be used along with enhanced oil recovery (EOR), a longstanding oil field technology. EOR involves the injection of CO_2 into petroleum beds which forces the oil to the surface. Appropriate technology could be used to then cap or secure the CO_2 once its efficacy has been exhausted.

Another possible technology involves injecting and dissolving CO_2 into the hot water column of the ocean through a fixed pipeline or moving ship. Another option would be depositing CO_2 through a fixed pipeline, or an offshore platform, to the seafloor at depths below 3,000 meters. According to the Special Report, CO_2 would form a "lake" thus delaying the CO_2's dissolution into the surrounding environment. This type of disposal offers certain legal impediments, such as international treaties, and the technology is far behind other available technology due to insufficient research and practical application. *See,* McGuire, Surviving Armageddon— Solutions for a Threatened Planet Ch. 4 (Oxford University Press 2005), for a discussion on deep ocean disposal and other innovative technologies for dealing with GHGs.

The most viable and effective use of CCS would be for large point sources that are near major industrial and urban areas. The Special Report notes that by 2050, as much as 40 percent of global fossil fuel CO_2 emissions could be captured, including 30-60 percent of electricity generation and 30-40 percent of industrial CO_2 emissions. Unfortunately, there is still limited information regarding whether these sources are near potential storage sites. Proximity to repositories is a key economic ingredient for large scale implementation of CCS in the power generating industry.

The Special Report also contains an analysis of the costs for CCS. Based upon 2002 conditions, the IPCC estimates that adoption of CCS would result in one to five cents per kilowatt hour of increased electricity generation costs. The Special Report is careful to note that these costs depend on the fuel and the specific technology in use, as well as the location of the facility. These costs can be reduced where benefits such as EOR are implemented along with the CCS system. One of the key missing ingredients in determining these costs is the possible effect of government incentives for implementing CCS systems. CCS costs could be reduced based upon research and technological developments and economies of scale, but the Special Report does not specifically address government incentives. The Special Report also does not address the possibility of implementing a broad based carbon trading system in conjunction with CCS, which could also be a factor in reducing costs.

The Special Report notes that the lack of a clear legal framework and public acceptance is likely to result in CCS having a lower economic potential than other mitigation options. According to the Special Report, the health, safety and environmental risks associated with CCS are expected to be similar to, or lower than, those currently posed by hydrocarbon pipelines. While a sudden and large release of CO_2 might present significant risks to human health and safety, the likelihood of these events is low based on past experience. Moreover, siting facilities would likely take into account large population areas to reduce these risks even further. Drawing on the experience of hydrocarbon storage and transport would serve as a good knowledge base for developing CCS systems with reduced risks to human health and the environment. Thus, the IPCC concludes that a properly selected and managed geological repository will likely result in a retention factor exceeding 99 percent for over 100 years, and 99 percent over 1,000 years.

The promise of CCS is unlikely to be realized on a significant scale until a legal and regulatory framework in the United States, as well as other countries, is adopted. There are statutory and regulatory analogues in the United States such as the Underground Injection Control Program (UIC) that could be modified to incorporate CCS, and allow for permitting such facilities. Now that the Special Report has been issued, it is up to governments to consider the potential offered by CCS in reducing GHGs.

Dominick J. Graziano is a shareholder in the Tampa, Florida, law firm of Bush Graziano & Rice, P.A., where he practices primarily in the areas of environmental and toxic tort litigation. He can be reached at (813) 228-7000 or dgraziano@ bgrtriallaw.com.

SMART BUILDINGS: CAPTURING THE OPPORTUNITIES FOR ENERGY SAVINGS IN COMMERCIAL REAL ESTATE

Michael J. Zimmer

Introduction

In the United States, commercial real estate as an industry is an enormous consumer of energy using more energy in that sector than any other country in the world, except for China. Commercial properties include office buildings, university campuses, shopping malls, retail establishments, apartment buildings, hospitals, museums, theaters, restaurants and more. Almost 40 percent of U.S. energy and 70 percent of all U.S. electricity is consumed in commercial property. At a time of rising energy prices and shrinking profit margins for property holders as interest rates rise and the real estate market cools, property owners need to examine ways of lowering their electricity expenditures. In 2002, the 4.8 million commercial and government buildings spent $26 billion on energy. Current national commercial electricity prices average more than $2.00 per square foot per year annually and can approach $2.50 per square foot in capacity constrained areas like Boston, New York, California and southwestern Connecticut.

National energy legislation (H.R.6) enacted on Aug. 8, 2005, recognizes the important challenge of finding ways to lower electricity and fuel expenditures. For the first time energy efficiency and sustainability provisions almost equal the fossil fuel and electricity supply provisions of national energy policy. Though traditionally viewed as a fixed cost, electricity expenditures can be managed and reduced in a number of ways. Some of these include: