Carbon Capture and Sequestration: The Key to Coal's Future?

Experts have identified the capture and long-term storage of carbon dioxide (CO_2), primarily from coal combustion, as a "critical enabling technology" that will make continued use of coal possible in a carbon-constrained world.[1] Unless the U.S. develops the capacity to capture and sequester carbon, however, continued investment in coal-fired power plants will undermine efforts to address global warming.

Carbon capture and storage (CCS) also offers the U.S. the opportunity to develop new technologies needed by other coal-dependent countries, such as China and India. By encouraging U.S. companies to develop CCS technology, it may be possible to take advantage of commercial opportunities to export this technology. The European Union is already doing so, having committed to launch up to 12 large-scale CCS demonstration projects by 2015 and possibly collaborating with China on at least one such project.[2] The EU aims to have CCS technology commercially available in 10 to 15 years.[3]

Carbon Capture and Sequestration: What We Know

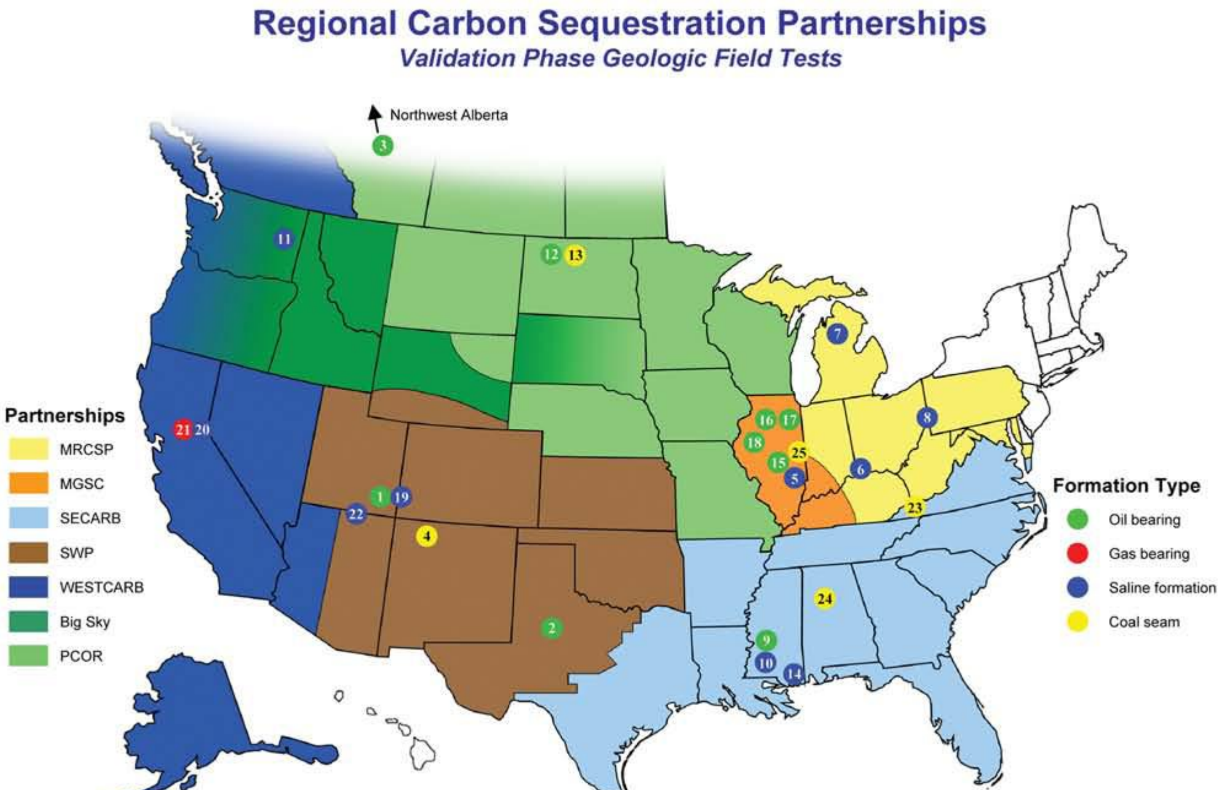
Geologic storage begins with capturing CO_2 from its source (*e.g.*, power plants, refineries, chemical plants) and converting it under high temperatures and pressure to a "supercritical fluid," a stage between a gas and a liquid. The CO_2 then needs to be piped to the storage site. In order to remain stable in geological storage, it must be injected a minimum of 2,500 feet below the ground.[4]

Today, oil and gas companies inject CO_2 into depleted oil and gas fields in order to maximize production, a process called "Enhanced Oil Recovery" (EOR). This practice validates the potential successes of carbon sequestration technology, but EOR is conducted on a much smaller scale than will be required to capture emissions from coal-fired power plants. Nor does EOR ensure that CO_2 emissions remain underground indefinitely.

From Promise to Solution

Despite our current knowledge, much more research, testing, and demonstration are needed before commercial-scale CCS can be widely deployed. The U.S. must work to comprehensively identify and certify places where the geology is suitable to store carbon safely for very long periods. Sequestering a significant portion of our CO_2 emissions will require the use of a variety of geologic formations. Therefore, the U.S. needs to conduct large-scale demonstration projects in diverse locations. The Department of Energy has begun this process through their Regional Carbon Sequestration Partnership (RCSP) program, which currently includes seven partnerships located across the United States, including overlapping work with Canada.[5] Through these various networks, DOE regional officials have begun field tests to assess the ability of specific formations to safely and permanently store CO_2. One example is a recently initiated field test in the Michigan Basin to sequester up to 10,000 metric tons of CO_2 into a saline formation in the range of 3,200 feet underground.[6]

Figure 1 – Department of Energy Regional Carbon Sequestration Partnerships: Region and Formation type[7].



In addition to field testing through the RCSP, DOE plans to begin a demonstration project sequestering CO_2 in a saline formation in 2016,[8] although some argue that is not soon enough. Despite progress, commercialization of CCS technology is still projected to be years away, and the department's 2007 sequestration roadmap emphasizes that "commercialization is not likely absent emission regulations, incentives, or government funding."[9] FutureGen, a separate DOE initiative that was launched in 2003, was on track to construct a clean-coal power plant in Illinois with CCS capabilities that would produced both electricity and hydrogen fuel, until government funding for the project was cut in early 2008. FutureGen power plants would also have incorporated integrated gasification and combined cycle (IGCC) technology, which is capable of turning coal into gaseous form and removing pollutants like CO_2. Some experts in the field believe that the planned plant, which was further along than any other such project in the world to integrate IGCC with 90% carbon capture, should still move ahead, and that cancelling the FutureGen plant will only delay advancement of critical clean-coal technology.[10]

As recommended by a 2007 study from M.I.T., *The Future of Coal*, policymakers should consider the following guidelines for implementing carbon sequestration measures:

- Urgency: In order for carbon sequestration and storage to reduce emissions in time to avoid the worst impacts of climate change, the U.S. needs to act quickly to gain understanding and experience with key components of the technology.

- Robustness: The M.I.T. report recommends funding 3–5 demonstration projects at a cost of $13 to $28 million each annually. Based on this calculation, the government should plan to invest $100 to $225 million over the lifetime of each demonstration project.[11]
- Large-scale: If significant amounts of CO_2 emissions are to be sequestered from specific sources, experience with large capacity sites will be essential. The M.I.T. study recommends that the demonstration projects store 1 million tons/year for a minimum of five years, but notes that storage volumes may depend on specific geologies.[12]
- Monitoring, measuring and verification (MMV): In order to ensure long term sequestration, initial demonstration projects must focus on monitoring, measuring, and verification of stored carbon to effectively analyze the risks involved with sequestration. Analysis should continue after injection; therefore, demonstration projects should continue for a significant number of years, from inception to completion of the test.[13] Additionally, with any CCS project, risks to public health, the environment, and human safety must also be evaluated and considered.
- Variety: Demonstration projects should be held in a variety of geologies, including saline formations, depleted oil and gas fields, and deep coal seams. It is particularly important to gain experience sequestering carbon dioxide in saline formations, because of their great storage potential.[14] Demonstration sites should be near large-scale existing or planned coal-fired power plants, as these will be key storage areas in the future. The U.S. may also want to consider cooperating on international sites, which can encourage developing nations to take further steps to help stabilize climate.

More Investments Needed
While demonstration and assessment of carbon sequestration is an essential next step, it is only one solution for dealing with coal-generated CO_2 emissions. To improve power plant efficiency and reduce pollution, additional investment must be made in Integrated Gasification Combined Cycle (IGCC) technology , advanced coal technologies, and demonstration of other CCS applications for both new and retrofitted power plants.[15]

[1] Massachusetts Institute of Technology, 2007, *The Future of Coal: Options for a Carbon-Constrained World*, p. x, <eb.mit.edu/coal/>.
[2] John Bruton, Ambassador, Head of Delegation of the European Union to the United States, March 29, 2007, "The European Union's Experience in the Use of Economic Instruments, Including Taxation, to Reach Specific Objectives in Energy Policy," Statement to the Senate Finance Committee, p. 12, <www.senate.gov/~finance/hearings/testimony/2007test/032907testjb.pdf>.
[3] Commission of the European Communities, "Sustainable Power Generation from Fossil Fuels: Aiming for Near-Zero Emissions from Coal after 2020," 2007, *Communication from the Commission to the Council and the European Parliament*, p.6-7, <ec.europa.eu/environment/climat/ccs/pdf/com2006_0843_en.pdf>.
[4] U.S. Department of Energy (DOE), National Energy Technology Laboratory (NETL), 2005, *Midwest Regional Carbon Sequestration Partnership Final Report, Phase 1*, "Section 4: CO2 Capture and Geological Storage," p. 48, <www.netl.doe.gov/technologies/carbon_seq/partnerships/phase1/pdfs/MRCSP_Phase_I_Final.pdf>.
[5] DOE NETL, 2008, "Regional Carbon Sequestration Partnerships," <www.netl.doe.gov/technologies/carbon_seq/partnerships/partnerships.html>.
[6] DOE NETL, February 18, 2008, News Release: "Carbon Sequestration Partner Initiates CO_2 Injection into Michigan Basin," <www.netl.doe.gov/publications/press/2008/08005-CO2_Injection_Begins_in_Michigan.html>.
[7] DOE NETL, 2007, Carbon Sequestration Atlas of the United States and Canada, <www.netl.doe.gov/technologies/carbon_seq/refshelf/atlas/ATLAS.pdf>.
[8] DOE NETL, 2007, "Carbon Sequestration: Technology Roadmap and Program Plan," p. 11, <www.netl.doe.gov/technologies/carbon_seq/refshelf/project%20portfolio/2007/2007Roadmap.pdf >.
[9] *Ibid*, p. 14.
[10] FutureGen Alliance, Feb. 7, 2008, Press release: "FutureGen Alliance Board Unanimously Agrees that FutureGen at Mattoon Remains in the Public Interest," <www.futuregenalliance.org/news/releases/pr_02-07-08.stm>. See also: Biello, David, Feb. 6, 2008, "'Clean' Coal Power Plant Canceled--Hydrogen Economy, Too," *Scientific American*, <www.sciam.com/article.cfm?id=clean-coal-power-plant-canceled-hydrogen-economy-too>.
[11] M.I.T., *Op. cit*., p.53.
[12] *Ibid*, pp. 52 and 60.
[13] *Ibid*, pp. 47-50.
[14] *Ibid*, p. 53.
[15] *Ibid*, Chapter 6.

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