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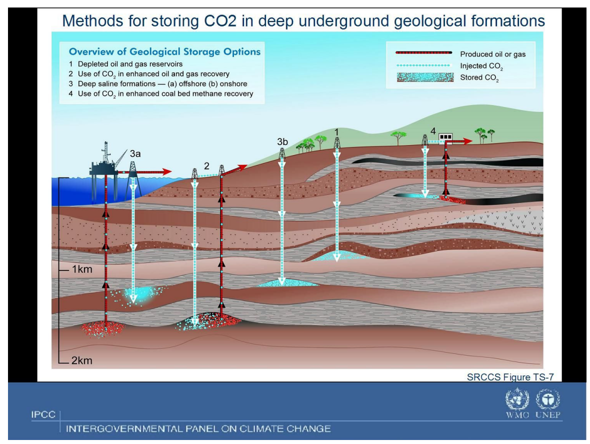
The Basics of Carbon Capture and Sequestration

Carbon sequestration is the process of storing carbon underground to curb the accumulation of carbon dioxide in the atmosphere. Although the earth naturally stores carbon in forests, oceans, and soil, these carbon sinks are unable to accommodate the excessive and increasing amounts of carbon dioxide humans continue to emit. As a result, researchers have begun to explore ways of enhancing the absorption of natural carbon sinks, as well as ways to artificially store carbon dioxide underground.

Currently, 70% of America's commercial electricity comes from fossil fuels[1] that when combusted generate 40% of our annual carbon dioxide emissions.[2] Supporters of carbon sequestration view carbon capture and storage technology as a solution to these emissions. Although estimates of geologic storage capacity of carbon dioxide can range to upward of 3.6 trillion metric tons,[3] CCS technology is immature and currently unreliable. Many uncertainties persist that render this method insufficient for addressing the urgent need to reduce global warming pollution in the next decade. Before embracing carbon sequestration on a national level, research and development must be conclusive that sequestration is reliably permanent and will not harm communities and the environment.



Geological Sequestration

Sequestering carbon in geologic formations requires an additional 10-40% of energy to power electricity plants with the necessary technology.[4] There are three primary options for geo-sequestration:

1) <u>Depleted Oil and Gas Reservoirs</u> – Oil companies already pump approximately 33 million metric tons of carbon dioxide into reservoirs every year to recover depleted supplies of oil and gas in a process known as "enhanced oil recovery."[5] In this process, additional sales of oil can offset the costly process of depositing the carbon dioxide into the reservoirs.[6] A major drawback, however, is that the interaction between carbon dioxide and minerals can yield unexpected results: this interaction might improve the permanence of the storage, but it could also increase the permeability of physical barriers and allow the carbon dioxide to leak through the earth's surface. In addition, the drilling and disturbance of these reservoirs can affect their ability to store gases long-term.[7]

2) Unmineable <u>Coal Beds</u> – Coal seams currently unsuitable for mining are another option for carbon sequestration due to their pores and seams that are often filled with methane, another global warming gas.[8] In theory, this methane can be displaced and extracted by injecting carbon dioxide into the seams and subsequently sold to offset injection costs.[9] However, the feasibility depends on the permeability of the coal bed, and little is known about the leakage potential of these seams.[10]

3) <u>Saline Formations</u> – Saline formations are deep layers of porous rock that are saturated with brine, or water that is saturated with salt and other minerals. These formations have the largest potential capacity worldwide and are more common than oil and gas reservoirs. More research is needed to determine the viability of specific formations: at this point, little is known about the potential leakage of CO_2 back into the atmosphere or into drinking water, and no product can be sold to offset the costs of storage.[11]

In addition to underground storage of pressurized carbon dioxide, some scientists have begun to experiment with a process known as mineral sequestration or mineral carbonation. Mineral sequestration involves trapping carbon by facilitating reactions between carbon dioxide and minerals to formulate carbonates (a type of salt), which can be stored permanently.[12] This method could potentially offer a substantially more stable and long term storage option than the geological alternatives because the solid form would not leak into the atmosphere. However, this process is costly,[13] requiring 60-180% more energy to facilitate the technology as compared to a conventional power plant.[14] Mineral carbonation also requires extensive amounts of minerals, and would lead to similar damages as those caused by large-scale surface mines, including land-clearing, habitat degradation, and harmful impacts to air and water quality.[15]

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Environmental and Health Consequences of Carbon Storage

The risks associated with carbon capture and storage are both local and global in nature. During transport and after storage, there is a potential for a sudden and large release of CO_2 into the air caused either by slow leakage or an abrupt leak from a failure at the site.[16] Either scenario could pose as a health hazard if it collects in large quantities. In addition to the potentially disastrous consequences to global warming, effects on human health range from immediate death resulting from asphyxiation to long-term effects from prolonged exposure to high levels of CO2 [17] Stored carbon dioxide can also contaminate drinking water, kill subsoil plants and animals, and cause small seismic events.[18] Detailed information about the full potentials for risk may only be known once the technology has been more widely deployed.

Sierra Club Position

While carbon sequestration is a potentially important tool for meeting our energy needs without worsening global warming, the calculations for net reductions of carbon dioxide from CCS must account for the additional energy requirements—and increased carbon dioxide emissions— necessary to power CCS systems. Additionally, the retention capabilities of geologic formations are uncertain at best, and the U.S. currently lacks any regulation or monitoring system to track the effectiveness of long-term storage. Current scientific studies have only projected the permanence of these storage options on a timeline of up to 1,000 years – after which we have no idea if the ground can contain the stored carbon.[19]

If U.S. global warming policy depends on this technology to remove huge quantities of greenhouse gas emissions from the atmosphere and the carbon dioxide leaks from its storage sites, the net result could completely negate our efforts to curb global warming. Further, geologic sequestration does not reduce the significant environmental impact that results from current destructive coal mining practices such as mountaintop removal.

As a nation, we should not unwisely depend on geologic sequestration to solve all of our problems. Nor should we wait until sequestration is commercially available and cost-effective before moving to make deep cuts in carbon emissions with reliable tools like energy efficiency and renewable energy. Under almost any scenario, coal-fired electricity with captured and stored CO2 will be an expensive and energy-intensive proposition. As a nation, we should focus our resources on seizing the cheapest, cleanest, quickest, most reliable methods to displace carbon emissions while meeting our energy needs.

Further Reading on Carbon Sequestration:

Policy Implications: Report on the Policy Implications of Carbon Sequestration (http://www.ipcc.ch/activity/ccsspm.pdf)
Methods: Analysis of the methods used in Carbon Sequestration by the IEA (http://www.ieagreen.org.uk/putcback.pdf)
In the News: News articles pertaining to carbon sequestration complied by Stanford University (http://pangea.stanford.edu/~mhesse/NewsLinks.html)

[1] Energy Information Administration, "Net Generation by Energy Source by Type of Producer," Electric Power Annual, October 22, 2007. <http://www.eia.doe.gov/cneaf/electricity/epa/epat1p1.html>
[2] US EPA, "Draft Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2006," February 2008. Table ES-2. http://www.epa.gov/climatechange/emissions/usinventoryreport.html
[3] Department of Energy, National Energy Technology Laboratory, *Carbon Sequestration Atlas of the United States and Canada.* Estimate includes geologic storage capacity in Canada as well as the United States.
[4] IPCC Special Report: *Carbon Dioxide Capture and Storage.* http://arch.rivm.nl/env/int/ipcc/pages_media/SRCCS-final/SRCCS_SummaryforPolicymakers.pdf page 4
[5] International Energy Agency Greenhouse Gas R&D Programme. *Depleted Oil and Gas Fields for CO_2 Storage.* <http://www.ieagreen.org.uk/7.pdf> (Accessed 2/4/08).
[6] *Ibid*
[7] National Energy Technology Laboratory. *Carbon Sequestration: FAQ Information Portal.* <http://www.netl.doe.gov/technologies/carbon_seq/FAQs/concerns.html> (Accessed 2/4/08)
[8] International EnergyAgency Greenhouse Gas R&D Programme. *Storing CO_2 in Unminable Coal Seams..* <http://www.ieagreen.org.uk/8.pdf> (Accessed 2/4/08).
[9] *Ibid*
[10] Department of Energy. (April 2007). *Geologic Sequestration Research.* <http://www.fossil.energy.gov/programs/sequestration/geologic/>
[11] Department of Energy. *Geologic Sequestration Research.* <http://www.fossil.energy.gov/programs/sequestration/geologic/> (Accessed 2/4/08).
[12] National Energy Technology Laboratory. *CO_2 Mineral Sequestration Studies in US.* <http://www.netl.doe.gov/publications/proceedings/01/carbon_seq/6c1.pdf> (Accessed 2/4/08).
[13] *Ibid*
[14] IPCC Special Report: *Carbon Dioxide Capture and Storage.* http://www.ipcc.ch/pdf/special-reports/srccs/srccs_ summary forpolicymakers.pdf page 4
[15] Ibid page 14
[16] IPCC Special Report: *Carbon Dioxide Capture and Storage.* http://www.ipcc.ch/pdf/special-reports/srccs/srccs_ summary forpolicymakers.pdf
[17] Gerard, David. *Environmental Bonds and the Problem of Long-Term Carbon Sequestration* <http://www.epp.cmu.edu/csir/Content/Research/Carbon%20Capture%20and%20Sequestration/Gerard%20Wilson %20Bonding.doc>
[18] IPCC Special Report: *Carbon Dioxide Capture and Storage.* http://www.ipcc.ch/pdf/special-reports/srccs/srccs_ summary forpolicymakers.pdf p. 14
[19] IPCC Special Report: *Carbon Dioxide Capture and Storage.* http://www.ipcc.ch/pdf/special-reports/srccs/srccs_ summary forpolicymakers.pdf p. 14
[20] Photo courtesy of Intergovernmental Panel on Climate Change http://arch.rivm.nl/env/int/ipcc/pages_media/SRCCS-final/graphics/jpg/large/Figure%20TS-07.jpg