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Carbon Sequestration: Silver Bullet or Black Hole?

If coal is part of the energy future of a carbon-constrained world, new technologies need to capture CO2. What works? This is a summary of a panel discussion at the 2008 national conference of the Society of Environmental Journalists. Panelists included Jeff Johnson, Chemical and Engineering News, senior correspondent; Sarah Forbes, World Resources Institute, senior associate; CCS specialist Thomas Feeley, U.S. Department of Energy, National Energy Technology Lab technology manager; Bruce Braine, American Electric Power, vice president, strategic policy analyst.

Half of U.S. electricity and more than a third of the nation's CO2 emissions come from coal-fired power plants. Coal is the cheapest source of energy in America — constitutes 48 percent of U.S. energy. It's estimated to serve 54 percent by 2030 if we continue with business as usual.

Three alternatives to business as usual:

1. Reduce carbon intensity
2. improve efficiency
3. capture and sequester carbon

Three ways to capture carbon:

1. Post-combustion
   - After coal's burned, collect, compress, inject through pipes into the Earth, in drained natural gas fields or in saline aquifers.
   - An estimated 75 percent of the cost would come in gathering it.
   - Existing plants can be retrofitted with additional box before the smoke stack

2. Pre-combustion
   - Done through Integrated Gasification Combined Cycle plants (IGCC), which oxidizes the fuel in a gasifier before combustion. This process produces "syngas" which is made of carbon oxides and hydrogen.
   - Existing plants cannot be retrofitted to use IGCC

3. Oxyfuel combustion
   - Burns coal in pure oxygen, instead of open air.
   - Flue gases re-circulated through the combustion chamber to cool reaction.
   - Emission stream is almost pure CO2 and water vapor.

World Resources Institute released guidelines on Carbon Capture and Storage (CCS) in October 2008 for demonstrating and deploying CCS technologies. The group concluded that CCS will most likely be needed to achieve the CO2 emissions reduction required to stabilize and reduce

greenhouse gases. The guidelines were developed with input from more than 80 people from academic, government, business and environmental backgrounds. They address the impact on ecosystems, human health and safety and on underground sources of drinking water and other natural resources.
Keys to good projects, according to WRI:

• Finding site with sufficient cap rock. Overlies storage foundation that keeps CO2 from permeating. It can't have artificial passages.

• Needs to have injectivity; has to have enough capacity CCS could apply to oil and natural gas power plants

National Energy Technology Lab is the only U.S. Department of Energy lab dedicated to fossil energy. They focus on the capture side. Their goals include:

• By 2020 have available for commercial deployment technologies;
• Achieving 90 percent CO2 capture;
• 99 percent storage permanence;
• fewer than 10 percent increase in cost of electricity.

Current CCS Projects

There are a few fairly large sequestration projects happening. MIT's report, The Future of Coal. Large-volume sequestration tests by the DOE are scheduled to begin in 2008 to demonstrate permanent CO2 storage; upwards of a million tons of CO2 will be injected into geologic formations

• There will be monitoring, mitigation and verification on leaks, etc. Post-combustion — adding another box before the smoke stack — and oxygen combustion can be used on existing plants.

Cost

"Implementing CCS today would be technically and economically prohibitive … nearly doubling the cost of electricity," according to the DOE.

WRI says the cost will go down as technology is installed: with each doubling capacity, there should be decrease in cost percentage.

CCS will result in 30-80 percent increase in cost of electricity, according to the DOE.
• 5-30 percent parasitic energy loss
• 35-110 percent increase in capital cost
• primary cost today is the energy lost to operate a post-combustion device: about 32 percent of power output of plant needed to operate CC system.
• A lot of the energy goes to compressing the CO2

Questions:

How sure can we be that the CO2 will stay trapped in the Earth?

Risk of leakage is high during injection – after twice the length of the injection period the risk goes down, declining further as long as it's in there. Based on geologic trapping mechanisms, every site is going to be different, according to WRI.
WRI points to the Statoil project in North Sea. They've been injecting since 1996: "CO2 has and will remain permanently trapped in formation they've injected it into."
Storage becomes more secure over time.
Still, questions about leakage will remain as long as there are no long-term studies
Health and environmental effects are other questions.

Is there enough capacity to store America's carbon?
The U.S. has several hundred years of CO2 storage capacity, according to the DOE
Jeff Johnson, senior correspondent for *Chemical and Engineering News*, said most gas and oil fields are so "junked up," it would be difficult to keep the CO2 in the ground.

(Reported by Andrew Norman, MSU Knight Center for Environmental Journalism)