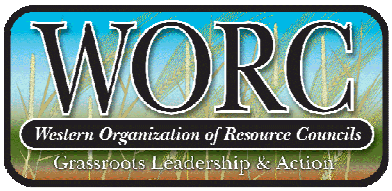
Bound to Fail:

The Costs and Risks of Capturing and Sequestering Carbon from Coal-fired Power Plants

Western Organization of Resource Councils
February 2010
By Anna Lucas
alucas@worc.org



Coal is a carbon dioxide-intensive fossil fuel, emitting about 3 pounds of CO2 for every pound of coal burned. Carbon capture and sequestration (or storage) is a risky endeavor that would ensure our dependence on coal production for decades to come. To properly sequester the carbon dioxide, appropriate geological formations under earth's surface need to be identified and used to store this toxic gas indefinitely. These spaces could be in your backyard, under your home, ranch, or family farm.

Summary

Coal-fired power plants are the nation's largest emitter of carbon dioxide, the main contributor to climate change, so carbon emissions from coal plants must be curbed substantially if we hope to have a chance of avoiding the worst of these consequences. Commercial-scale carbon capture and sequestration (CCS) is at the center of the debate on how to reduce carbon pollution in the United States. This proposed technology would, according to its proponents, enable our continued dependence on fossil fuels like coal to provide our nation's electricity, and at the same time reduce carbon emissions. Despite the considerable amount of money, research and analysis that has been invested in CCS, however, it has yet to be demonstrated through a commercial-scale, fully integrated project that converts coal into electricity, gas or liquid fuel, captures carbon, and sequesters it.

There are some significant and fundamental challenges to making such a project a reality, however, which have reduced the initial enthusiasm and financial backing from both the private and public sectors. Experts disagree on the cost, how long it will take for this technology to be available for commercial and wide-scale use, although most agree it will not take place for at least a decade, and it is not clear what other possibilities could arise from investing in and depending on an unproven and untested technology. CCS would require an enormous new infrastructure to capture, process, and transport large quantities of carbon dioxide. Additionally, there are serious concerns about the ability of carbon dioxide remaining safely underground and not contaminate aquifers or leak back into the atmosphere. Moreover, CCS would increase the cost of building and operating coal plants while at the same time actually reducing power output.

Because investors have been unwilling to invest in such an untested, unproven and risky technology, widespread deployment of CCS will only occur with substantial political and financial guarantees from taxpayers. As Congress considers funneling more taxpayer dollars into CCS research and deployment, it must pay more than lip service to these substantive concerns and consider whether CCS is the best investment for the limited taxpayer funds available as we move to reduce our dependence on fossil fuels.

How Would CCS Work?

Carbon capture and sequestration is a proposed process in which carbon dioxide that would have been emitted into the atmosphere from coal-fired power plants would be captured at the plants' exhaust systems, and stored (or sequestered) underground forever to prevent it from leaking into the atmosphere.

The three distinct parts to this concept are carbon capture, transport, and storage (which include measurement, monitoring, and verification). After capture, carbon dioxide gas would be compressed into a dense liquid and transported by pipeline to an injection well such as a depleted oil and gas field. Once injected, if the process works as planned, the CO2 would be isolated from drinking water supplies and prevented from release into the atmosphere by a confining zone that would include a dense layer of rock that would act as a seal and additional trapping mechanism. It is hoped that, although sequestered CO2 underground could seep into the pore space in the surrounding rock, it would not escape to the surface and enter the atmosphere.

Problems with Carbon Capture and Sequestration

1. **Cost -** the United States government has already invested millions of taxpayer dollars in the attempt to prove this technology, with little to show for it. Capturing and sequestering carbon dioxide from coal-fired power plants is an extremely expensive option for cleaning up the earth's atmosphere. Every dollar spent on CCS technology is a dollar not spent on clean and renewable energy technologies.
2. **Monitoring and verification -** supposing that the carbon pumped underground remains there, strict monitoring and enforcement would need to be performed indefinitely to ensure the carbon dioxide doesn't escape into the atmosphere, putting communities and families' health at risk, and defeating the purpose of keeping it out of the air. An act of nature such as an earthquake could jeopardize the entire operation of the stored carbon dioxide, and then the entire investment would be lost.
3. **Long term liability on the taxpayer -** if coal companies are not held responsible for the long term risks associated with pumping carbon dioxide under people's property, in the end, the average citizen will end up bearing the costs of carbon dioxide leakage into the air and water contamination.
4. **CCS increases the lifecycle costs of coal production -** coal production has problems other than the release of massive amounts of carbon dioxide into the atmosphere. Workers in the coal mines and their health and safety will continue to be at risk. By-products of coal production such as fly ash, mercury, sulfur dioxide, and nitrogen oxide will continue to be emitted by coal-fired power plants. Mountaintop removal, strip mining on mountains and pollution of aquifers are all side-effects of coal production that are not addressed with the proposed CCS technology.

Infrastructure and Costs Required

Infrastructure

If coal continues to provide half of our country's electricity, the amount of carbon dioxide that is needed to be sequestered will be enormous. The processes needed to capture CO2, turn the gas into a liquid, transport it, and inject it back underground consume large amounts of energy, which would use up to a quarter or more of the output of a CCS-fitted coal-fired power plant.

The scope of a commercial-scale CCS project would be massive and energy intensive, and would require building new infrastructure made up of pipes, pumps, and transmission lines to transport and inject the carbon dioxide in liquid form underground. Estimates from the International Energy Agency forecast that for CCS to have a significant impact in the slowing of global warming there must be 6,000 CCS projects each storing a million tons of carbon dioxide per year in operation by the year 2050.[1] The United States Geological Survey has determined that the distances between the largest existing sources of CO2 and potential storage sites (in oil and gas fields) would require the development of a processing and transportation infrastructure larger than that of the entire existing US natural gas and petroleum industry. [2]

High Costs

In addition, according to many estimates, plants with CCS will need to be at least a third bigger than conventional plants to generate the same amount of net power because of the energy required to sequester the carbon. The captured carbon dioxide has to be compressed to 100 times the atmospheric pressure, transferred to an underground storage reservoir and then pumped in the ground. All of this requires large amounts of energy, requiring a CCS-fitted coal plant to burn 30% more coal to generate the same amount of usable electricity.

Associated Risks

Leakage

A major concern is whether leakage of stored CO2 will undermine the viability of the CCS technology. Leakage through the transportation pipeline is a real possibility, as is leakage from trapped CO2 underground, which would pose a local danger since high concentrations of this gas can be fatal. Additionally, CO2 could also migrate while underground and contaminate freshwater aquifers[3]. Finally, there is a possibility that injecting massive quantities of CO2 into the ground could trigger earthquakes. Due to the fact that sequestration of carbon dioxide carries a risk that, once injected it could migrate, contaminate freshwater aquifers or be released into the atmosphere, strict site-selection criteria are crucial.

Contamination of Water Supplies

If carbon dioxide is injected into or near underground aquifers, it will turn into carbonic acid. The acidification of the gas could harm water quality by increasing the leaching of contaminants such as arsenic, lead, and mercury. As surface water becomes increasingly scarce, communities across the Western United States are more and more dependent on aquifers for drinking water. If these same geologic formations are storing carbon dioxide, this could dangerously compromise the quality of the drinking water.

Who Owns the Pore Space?

Both a coal-fired power plant and the associated storage site (or sites) will require a long-term commitment after the site closes, during which the site will need to be closely monitored to ensure that the injected CO2 does not escape into the atmosphere.

---

[1] *International Energy Agency. Prospects for CO2 Capture and Storage http://www.iea.org/textbase/nppdf/free/2004/prospects.pdf*

[2] *MIT. 2007. The future of coal: Options for a carbon-constrained world. Cambridge, MA. ix. Online at http://web.mit.edu/coal/.*

[3] *IPCC 2005, Section 5.7.4.2.*

Since there are so many unknowns with the potential damages cited above , ownership of the pore space and mineral rights, and liability if something goes wrong, require a clear decision on who is accountable to ensure long term stewardship and responsibility.

Several states have already developed a legal framework in which the state would assume responsibility for long-term stewardship once a CCS project has been completed. However, some CO2 injections could use pore space in more than one state if the formation lies below several different states. This concern and others must be taken into account when differing legal frameworks among states exist.

A further complication is the difference in property law across the country. In many states, the federal government retains the subsurface rights to the land, creating a "split estate" where a surface owner does not have rights to the minerals and space below the surface. In other states, the mineral rights, or multiple shares in mineral rights have been sold to private parties other than the surface owner. Depending on the location, it may be impractical, impossible, or very costly for utilities to acquire title to hundreds of thousands of acres of land and subsurface rights to store carbon dioxide.

Minimizing the risks of CCS will require developing and enforcing strict standards and protocols on site selection, project design, operation, and long term monitoring. Additionally, any protocol or procedure in place that may limit industry liability should ensure that the enormous potential risk and cost burden does not fall on the American taxpayer.

Capturing and compressing all of that carbon dioxide requires additional energy and would increase the fuel needs of a coal-fired plant. Therefore, plants with CCS capabilities will need to be at least a third bigger than old, conventional plants to generate the same net amount of power. There is the added expense of building the capture plant and the injection pipelines. Furthermore, if the sequestration site is far from the coal plant, even more energy will be needed to transport the carbon dioxide across large swaths of land.[4]

Even if CCS technology could capture and sequester carbon dioxide from the atmosphere, coal mining and combustion still create by-product hazardous wastes as a by-product that must be treated and properly disposed. Most of this goes into landfills and surface impoundments from which mercury, lead, cadmium, arsenic, and other toxic constituents have been known to leak out and contaminate water supplies.[5] While CCS purports to reduce the amount of carbon pollution, due to the extra coal that is needed to burn, it would actually increase these dangerous pollutants.

Externalizing the cost of coal

Coal companies burden local communities with the external costs of coal mining in the form of health impacts and contaminated water. If the CCS concept is realized, the

Would You Want Carbon Stored Under Your Backyard?

Citizens of Greenville, Ohio, decided the risks outweighed the proposed benefits of having carbon dioxide sequestered under their houses and farms. In August of 2009, Columbus-based research group Battelle's effort to capture 1 million tons of CO2 from an ethanol plant and store it 3,000 feet underground went unrealized after facing opposition from local political leaders and citizens. Citing "business considerations," the company issued a statement announcing they were canceling plans after concerns raised by a citizens' group and mayor that the tests could endanger the county's aquifer, which provides water to the farms that make up most of the county's economic base. Mike Bower, the mayor of Greenville said of Battelle's decision, "Messing with the natural resources of our area didn't seem to be a wise thing from an experimental standpoint."

[4] *Carbon Capture and Storage: Trouble in Store. http://www.economist.com/opinion/displayStory.cfm?story_id=13226661&source=hptextfeature*

[5] *National Research Council (NRC). 2007. Coal: Research and development to support national energy policy. Washington, DC: National Academies Press, 44. Online at http://books.nap.edu/catalog.php?record_id=11977.*

additional risks and uncertainties of the capture and storage technology will be passed onto those living in coal communities. The long term liability of leakage and other impacts will fall to the responsibility of the landowner who has to live with the pumping of CO2 under his or her property. These risks belong with the coal companies instead of placing the burden on those who are already adversely impacted by the coal mining industry.

CCS and Climate Change Legislation

Under proposed legislation, new coal plants would be required to capture and store at least 50% of their CO2 emissions by the year 2025. However, these "new performance standards" would not apply to 43 new coal fired power plant projects already in the process of being permitted or built, which would be grandfathered in and exempt from the new regulations. New coal plants would be subject to new and stringent rules, but since the older plants are not, this creates an incentive for the oldest and dirtiest polluting plants to remain in operation, or even increase in scale. The House-passed American Clean Energy and Security Act in June 2009 would provide billions of taxpayer dollars in the form of government incentives to the coal industry to develop CCS technology. [6]

The portion of Obama's 2011 budget request dedicated to the Department of Energy includes $4.7 billion in clean energy technology investments, including $545 million for advanced coal climate change technologies to focus resources to develop carbon capture technologies.

A Sensible and Just Transition to Clean, Renewable Energy is a Better Future

Coal mining is harmful to a state's economy as well as its environment, causing irreparable damage to surface and ground water, wildlife, and natural ecosystems. Large coal companies profit enormously from coal, but at the severe cost of local communities in which they mine, as counties with surface mining are among the poorest in the nation. When a mining company sets up its operation, landowners and families can be displaced from their homes as large areas of land are needed for the mine site, and there is potential for the loss and destruction of cultural heritage and historically significant areas. Additionally, an American Journal of Public Health study found that people who live in counties where lots of coal is mined are much more likely to suffer from an array of chronic and life-threatening problems due to dust inhalation and the contamination of drinking water sources due to mining operations.

Since CCS is an unproven technology and experts disagree as to how long it will take for it to be available for widespread commercial use and we know we can reduce our dependence on coal today with proven, cost effective technologies, we should stop investing millions of taxpayer dollars to continue our dependence on coal. Simply increasing efficiency and promoting clean and renewable energy such as wind and solar is a more viable and immediate option. CCS requires billions of dollars of taxpayer subsidies to be viable, and every dollar spent on unproven, unreliable CCS technology diverts resources from cleaner, cheaper, and safer alternatives. If we care about climate change, healthy and vibrant communities, and a safe planet for the next generation, coal and sequestering its harmful emittents cannot be part of the new clean energy solution.

However, if coal production is curtailed during the transition to clean and renewable sources of energy, coal communities will face a loss of jobs and revenue. It is imperative that economic development and job re-training be a priority specifically targeted to the communities that will be affected by declining coal production.

---

[6] *American Clean Energy and Security Act of 2009*
http://energycommerce.house.gov/Press_111/20090701/hr2454_house.pdf