Center for American Progress

Carbon Capture & Sequestration 101

Several recent congressional hearings on the challenges associated with rapid deployment of carbon capture and storage technologies indicate CCS is at the center of the debate on how to reduce U.S. CO_2 emissions. Carbon capture and storage technologies are essential to allow the continued use of coal to generate electricity while we substantially reduce emissions of greenhouse gases to combat global warming. While the technologies are complex, the overall value of introducing them into the U.S. and global economies is undeniable.

Technology currently exists to capture CO_2 emissions from coal-fired plants and to sequester that CO_2 in underground geologic formations. But widespread deployment of CCS systems will not happen on its own. Congress needs to put in place a new policy framework which includes large-scale research-and-development and demonstration projects, CO_2 emission performance standards for new coal power plants, financial incentives to invest in CCS, and new rules governing the design and operation of geologic repositories. That's why it is important to briefly review why carbon capture and sequestration is necessary in reducing CO_2 emissions and why Congress must act now to make sure this technology is deployed as soon as possible.

The Need to Capture Coal Plant Emissions

There are many ways to meet growing consumer energy demand, including increased energy efficiency and greater reliance on renewable energy sources. Historically, a substantial portion of U.S. electricity has been generated by burning coal, which is an abundant domestic fuel. The Department of Energy has predicted that 145 gigawatts of new power from coal-fired power plants will be built by 2030. If these plants are built without emissions controls, they will result in additional CO_2 emissions of 790 million metric tons per year. This will add significantly to total U.S. CO_2 emissions and greatly magnify the challenge of combating global warming. CCS is the only known technology that would enable new coal plants to be built without an unacceptable increase in CO_2 emissions.

What Is CCS?

In CCS operations, CO_2 is separated from the fuel and captured either before or after the combustion of coal. It is then compressed to a super critical liquid, transported by pipeline to an injection well and then pumped underground to depths sufficient to maintain critical temperatures and pressures. The CO_2 seeps into the pore spaces in the surrounding rock and its escape to the surface is blocked by a caprock, or overlaying impermeable layer.

Energy companies boast extensive experience sequestering CO_2 by injecting it into oil fields to enhance oil recovery. Experts are optimistic this practice can be replicated in saline aquifers and other geologic formations that are likely to constitute the main storage reservoirs for CO_2 emitted from coal power plants. Underground storage capacity in the United States is believed to be ample and widespread, and long-term leakage of CO_2 from properly permitted and monitored storage reservoirs is expected to be negligible.

Carbon Capture Technologies

A new coal-based generation technology known as Integrated Gasification Combined Cycle Process offers promise as a pathway to capture CO_2 before combustion at coal plants and sequester it downstream. IGCC plants are able to capture emissions more cost-effectively than methods currently used at more conventional plants—such as supercritical pulverized coal—because they do not rely on direct combustion and instead convert coal feedstocks using gasification. The current carbon capture rate for IGCC plants is believed to be around 85 percent.

Efforts are underway to develop capture technologies for traditional pulverized coal power plants. At these plants, CO_2 would need to be captured from flue gases after combustion through a chilled ammonia or amine stripping process. CO_2 capture at conventional plants is likely to be more costly than at IGCC plants but has advantages, particularly in the retrofit of existing plants.

Barriers to Widespread Deployment

Plants with CCS currently cost more to build and are less efficient than conventional plants. Also, because there is a lack of working models and experience with these technologies, there is skepticism of their reliability and efficiency. Even cost-competitive new technologies are usually not adopted rapidly, particularly in a conservative industry such as the utility sector, where the new technology is different from the conventional technology. In addition, new power plants are not likely to capture and sequester their CO_2 emissions in the current regulatory environment since add-on capture technology will reduce efficiency and lower electricity output, resulting in increases in the cost of electricity to consumers.

A New Policy Framework to Stimulate Adoption of CCS Systems

Ensuring the timely and widespread deployment of CCS technology requires a new policy framework encompassing the following:

- Requiring all new coal power plants to meet an "emission performance" standard that limits CO_2 emissions to levels achievable with CCS systems
- Establishing a greenhouse gas cap-and-trade program
- Providing subsidies to plant developers that offset the cost differential between conventional plants and those with CCS

- Targeting regulatory and R&D efforts to implementing CCS technology as effectively as possible

The adoption of an emission performance standard for all new coal-fired electricity plants is the best policy tool to achieve accelerated adoption of CCS technologies. This emission performance standard would require, in effect, that new coal capacity be built to meet a CO_2 emissions standard achievable with the best available CCS technology.

An emission performance standard for new coal plants should be accompanied by a carbon cap-and-trade program for existing power plants, with the cap starting at 100 percent of emissions and progressively declining over time. A declining cap would encourage greater efficiencies in operating existing plants and incentivize the retirement of higher emitting existing plants.

If legislation requiring an emission performance standard for new coal plants is enacted, then Congress should simultaneously take steps to offset the additional costs of installing CCS systems and provide relief from electricity price increases. This would prevent disproportionate costs from falling upon consumers who live in regions heavily dependent on coal for power generation.

Once the nation commits to a rapid timetable for requiring an emission performance standard at coal plants, then all of our regulatory and R&D efforts should be focused on implementing CCS technology as effectively as possible. These efforts would include enhanced R&D for capture technologies, large-scale experience with sequestration for a range of geologic formations, a national inventory of potential storage reservoirs, and a new regulatory framework for evaluating sequestration sites and allocating liability for long-term CO_2 storage.

The Potential of CCS

Widespread CCS deployment—in combination with other policies to reduce CO_2 emissions and diversify energy sources—could be invaluable in meeting our emission reduction goals for greenhouse gases and would encourage the export of CCS technology around the world, particularly to developing nations such as China and India, many of which are depending on low-cost coal to fuel economic growth. The Bush administration's discontinuation of FutureGen, a power plant employing IGCC, set the process back, as it would have been the world's first functioning power plant to demonstrate the feasibility of CCS technology. To take the reins on this emerging technology, we must start now with an aggressive program of proper legislation, demonstration projects, and funding backed by political will.