Testimony of

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before the

Subcommittee on Energy
Committee on Science, Space, and Technology
U.S. House of Representatives

Hearing on The Future of Coal: Utilizing America's Abundant Energy Resources

July 25, 2013

Carbon Capture, Utilization and Storage

Madam Chairman, Rep. Swalwell, and members of the Subcommittee, thank you for the opportunity to testify on carbon capture, utilization, and storage. My name is Judi Greenwald, and I am Vice President for Technology and Innovation at the Center for Climate and Energy Solutions (C2ES – formerly known as the Pew Center on Global Climate Change).

My testimony today will focus on the most important climate and energy solution that no one knows about. I will emphasize two main points:

- Carbon capture and storage (CCS) is a critical technology for solving climate change, while allowing continued reliance on fossil fuels.

- Carbon dioxide enhanced oil recovery (CO_2-EOR) can advance CCS, while boosting domestic oil production and generating net federal revenue.

C2ES is an independent, nonprofit, nonpartisan organization dedicated to advancing practical and effective policies and actions to address our global climate change and energy challenges. We perform multifaceted research and analysis of the scientific, technological, economic, and policy aspects of these issues. Our work is informed by our Business Environmental Leadership Council (BELC), a group of 34 major companies, most in the Fortune 500, that work with C2ES on climate change and energy risks, challenges, and solutions. The views I am expressing, however, are those of C2ES alone.

C2ES has been analyzing CCS for over a decade and has recently focused on how CO_2-EOR can advance CCS. With the Great Plains Institute, C2ES co-convenes the National Enhanced Oil Recovery Initiative, or NEORI, a coalition of businesses, environmental NGOs, labor representatives, and state officials advocating for incentives to use captured CO_2 in EOR. You

can find more information on NEORI at www.neori.org. I would like to submit NEORI's CO_2-EOR analysis and consensus recommendations for the record. In addition, C2ES serves as the advisor and facilitator to the Sequestration Working Group of the North America 2050 Initiative, a collaborative of states and provinces exploring options for CCS regulations and incentives. C2ES recently completed a summary of state-level regulations and incentives that can be found at www.na2050.org/sequestration.[1]

C2ES also has authored research and publications related to CCS and CO_2-EOR. For example, C2ES developed a comprehensive framework for calculating CO_2 emissions from CCS based on input from experts in industry, academia, and the environmental community.[2] C2ES also publishes a CCS Climate TechBook,[3] a brief report that explains in layman's terms how CCS technology works, why its development is needed to address climate change, and how it might be advanced.

CCS is a critically important technology

The United States and the rest of the world are getting 80 percent of our energy from coal, oil and gas, and our dependence on, and overall use of, these fossil fuels globally is growing rapidly. Under a business-as-usual scenario, the Energy Information Administration expects fossil fuels will continue to provide more than 65 percent of U.S. electricity in 2040 – with 35 percent coming from coal-fired generation. Globally, coal consumption is expected to increase nearly 60 percent over the next two decades, led by developing countries like China and India, which together will comprise 62 percent of the total global coal demand in 2035. This poses an enormous challenge, because the CO_2 emissions from the combustion of these fossil fuels are the major contributor to global climate change. While we can and should become more energy-efficient and shift our energy mix toward inherently zero-emitting sources like nuclear power and renewables, it will be difficult to do that fast enough and at a reasonable enough cost to avoid the worst climate impacts.

Hence the critical need for CCS, a suite of technologies that captures CO_2 and stores it deep underground in geological formations. CCS can capture up to 90 percent of emissions from stationary sources, such as power plants and industrial facilities, thereby allowing coal and natural gas to remain part of our energy mix. The International Energy Agency (IEA) and others have demonstrated through detailed technology and economic scenario analyses that CCS is likely an essential component of an affordable and effective response to global climate change. In fact, IEA estimates that CCS could provide one-sixth of the requisite GHG emissions reductions by 2050.

What is needed to advance CCS?

CCS has been established and commercialized for the capture of CO_2 from some industrial processes such as natural gas processing, chemical, fertilizer and ethanol production, and the

[1] http://na2050.org/wp-content/uploads/2013/07/NA2050_State_Policy_Actions_to_Overcome_Barriers_to_CCS_and_CO2-EOR.pdf
[2] http://www.c2es.org/publications/greenhouse-gas-accounting-framework-carbon-capture-and-storage-projects
[3] http://www.c2es.org/technology/factsheet/CCS

gasification of coal. The use of man-made CO_2 in EOR has been practiced for several decades. However, CCS in other contexts – for example, coal- and natural gas-powered electricity generation – is a relatively expensive technology that is just reaching maturity. Further R&D is important, but the key challenge for CCS is to get a sufficient number of commercial-scale projects up and running to demonstrate the emerging technologies at scale and bring down their costs. The first large-scale commercial CCS power projects are under construction. Yet, it is still unclear whether more commercial-scale CCS projects will be built after these initial projects are completed. After the collapse of climate legislation in the United States in 2010, a number of CCS projects were cancelled.

CCS is being increasingly thought of as carbon capture utilization and storage, or CCUS. Instead of seeing CO_2 as a waste, utilizing and selling captured CO_2, primarily for EOR, improves the economics of CCS projects and is an important market driver. Almost all of the existing or planned CO_2 capture projects in the United States have been developed with the intention of marketing captured CO_2 for use in EOR. Still, in many cases, additional drivers are needed. Those projects operating or underway today are being financed though some combination of U.S. Department of Energy (DOE) grants, utility cost recovery from ratepayers, private finance, sales of CO_2 for EOR, other revenue streams from chemical production, and existing tax credits.

DOE's role in CCS development has been and will remain critical. DOE is working with the private sector on the leading innovative CCS projects in the United States today. This collaboration is beginning to yield results. In late 2012, the DOE-supported Air Products' Port Arthur CCS project, where CO_2 is captured from refinery-based hydrogen production and sent for use in EOR, began operations. Through its Industrial Carbon Capture and Storage (ICCS) Program and with funding from the American Recovery and Reinvestment Act of 2009 (ARRA), DOE agreed to fund $284 million of the Port Arthur project's $430 million total investment cost. The Port Arthur project is expected to capture up to 1 million tons of CO_2 per year and enable EOR production of 1.6 million to 3.1 million barrels of domestic oil a year in East Texas.

DOE is also working on applying CCS to the power sector. Southern Company's coal-fueled Kemper County energy facility in Mississippi is now under construction and will be the first commercial-scale CCS power project in the United States. DOE selected the Kemper project to receive more than $290 million through its Clean Coal Power Initiative (CCPI). A later round of the CCPI made possible through ARRA funding selected three additional coal-fired CCS power projects for funding. They are Summit Power's Texas Clean Energy Project (TCEP), NRG Energy's Washington Parish Project, and SCS Energy's Hydrogen Energy California project. TCEP is nearing financial close and, when completed, will capture 90 percent of its emissions and supply approximately 2.5 million tons of CO_2 for use in EOR.

Given the high costs and uncertainties of CCS investment for the private sector and the urgent need for CCS, it is extremely important that the federal government continue to support CCS research, development, demonstration, and deployment. Beyond DOE's pivotal role, other forms of federal financial support, such as tax credits, should be reformed and expanded. States too can play a key role in advancing CCS through incentives and well-informed regulation.

Background on CO_2-EOR

CO_2-EOR is a means of commercial oil production that could play a key role in the development of CCS and in increasing our domestic energy security. CO_2-EOR has the potential to increase American oil production by tens of billions of barrels, while displacing imported oil and safely storing billions of tons of CO_2 underground.

How does CO_2-EOR work? Even after conventional primary and secondary oil recovery, most of the oil in a typical oil field is left in the ground. When injected deep underground, CO_2 can make it possible to recover more oil and extend an oil field's life. The best available evidence indicates that by using best EOR industry practice and existing rules governing underground injection, the overwhelming majority of the injected CO_2 remains underground, incidentally and safely storing CO_2. Commercial injection of CO_2 for EOR is regulated under EPA's Underground Injection Control Program, and under current federal greenhouse gas reporting rules for air emissions, EOR operators may document this incidental CO_2 storage through additional monitoring, reporting, and verification requirements to qualify as geologic sequestration. There is a range of views as to what additional state or federal rules are needed to ensure that CO_2 is stored permanently.

The United States has been a global leader in CO_2-EOR for 40 years. We currently obtain six percent of our domestic oil production through this method. While most CO_2-EOR activity occurs in the Permian Basin of Texas, there are also projects in the Gulf Coast, the Rocky Mountains, Oklahoma, and even Michigan. Estimates of the potential for CO_2-EOR to increase oil production and store CO_2 have been increasing in recent years. According to the National Energy Technology Lab, using existing techniques, CO_2-EOR could double or triple U.S. oil reserves and store 10 to 20 billion tons of CO_2, which is equivalent to between five and 10 years of emissions from all U.S. coal-fired power plants. More advanced techniques could yield much higher oil production and CO_2 storage.

The key role of CO_2-EOR in advancing CCS

For those CO_2 capture technologies that have not reached full commercialization, especially in electric power generation, selling captured CO_2 for use in EOR can provide a revenue stream that helps reduce the financial risks and uncertainty of investing in emerging technology. About 75 percent of the CO_2 used in EOR currently comes from naturally occurring CO_2 reservoirs. The rest comes from man-made CO_2 sources. Somewhat oddly, the EOR market lacks sufficient CO_2. By expanding carbon capture from man-made sources, we can increase domestic oil production, promote economic development, create jobs, reduce CO_2 emissions, and drive innovation in CCS technology.

It is because of these multiple benefits that we have been able to bring together the National Enhanced Oil Recovery Initiative, or NEORI, a diverse coalition favoring the reform and expansion of existing tax incentives to use captured CO_2 in EOR. Among the members of NEORI are Arch Coal, Summit Power, Tenaska, the Natural Resources Defense Council, AFL-CIO, and The Wyoming Outdoor Council. Some of NEORI's participants are primarily interested in job creation, others in increasing domestic oil production, and others in protecting the environment. But all agree that advancing the capture of man-made CO_2 for use in EOR

makes sense. NEORI has been briefing members on both sides of the aisle in both houses of Congress on its proposals.

EOR operators in some regions are willing to pay upwards of $30 per ton for CO_2. At the same time, industrial facilities and power plants are emitting billions of tons of CO_2 into the atmosphere as a waste. CO_2-EOR therefore offers the opportunity to transform this waste into a marketable commodity and transform an environmental problem into an energy production solution.

In a few cases, revenue from selling CO_2 for enhanced oil recovery is sufficient to pay for CO_2 capture and transport. Thanks to the efforts of the private sector and DOE, many CO_2 capture technologies are already commercially proven, and only a modest incentive is needed to help close the gap between the market price of CO_2 and the costs to capture and transport it. In the case of emerging technologies, however, companies need a larger incentive to help shoulder the additional financial and operational risk of deploying new, pioneering capture projects for the first few times at a commercial scale.

By combining private EOR operators' willingness to pay for CO_2 with a tax incentive, society leverages its public investment. Perhaps most importantly, according to our analysis, such tax incentives would more than pay for themselves by driving increased domestic oil production and associated taxable oil revenues. Increased CO_2-EOR production will generate federal revenue that more than pays for the cost of new incentives within a 10-year timeframe. Under existing tax treatment, CO_2-EOR directly yields revenues from three main sources: corporate income taxes, individual income taxes on royalties from production on private land, and royalties from production on federal land. Our analysis indicates that federal revenues from incremental CO_2-EOR production would exceed the fiscal cost of new incentives by more than $100 billion over 40 years.

Conclusion

CCS is a critical technology for reconciling our continued dependence on fossil fuels with the imperative to protect the global climate. Our best hope at the moment for CCS advancement is carbon capture, *utilization*, and storage, or CCUS. The best example of CO_2 utilization we know of is enhanced oil recovery (CO_2-EOR). Solving our climate and energy problems will require a portfolio of technologies, and all must be pursued vigorously. But we are focusing here today on CO_2-EOR, because it is the most important climate and energy solution that no one knows about.