STATEMENT OF

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Thank you, Mr. Chairman and Members of the Committee. I appreciate the opportunity to provide testimony on the U.S. Department of Energy's (DOE's) research program directed at reducing power plant water use as it relates to carbon capture efficiency and optimization.

Of particular concern is the potential implication on freshwater requirements in a future in which carbon dioxide (CO_2) capture technology is required to be installed on coal-based power systems. DOE's National Energy Technology Laboratory (NETL) projects that, in the absence of successful development of new advanced CO_2 capture and water management technologies, implementation of today's CO_2 capture technologies would significantly increase freshwater consumption by fossil-based power plants.

In the absence of climate legislation, the latest Annual Energy Outlook from the Energy Information Administration forecasts that CO_2 emissions from the electric power sector would contribute over 40 percent of the Nation's annual energy-related emissions

of CO_2 (equivalent) by 2030. Coal-based power plants would emit 84 percent of the power sector's emissions under the reference case scenario and, significantly, 95 percent of the cumulative CO_2 emissions from coal-fired plants, through 2030, would stem from existing coal-fired plants (Figures 1-3, Appendix). An additional 15 percent of power generation sector emissions emanate from combustion of natural gas. A carbon control regime that seeks to dramatically limit CO_2 emissions from the power generation energy sector will eventually need to encompass both existing and new coal-fired plants as well as natural gas-fired power plants. The comparative economics of retrofitting existing plants and adding new natural-gas and coal-based plants with carbon capture will come to the forefront.

Energy and water are indeed inextricably linked. Most Americans do not realize that they use more water turning on lights and running appliances each day than they do directly through washing their clothes and watering their lawns. This is because thermoelectric power generation facilities require large volumes of freshwater to operate, ranking just behind agricultural irrigation in terms of total freshwater withdrawal. These thermoelectric plants contribute over 90 percent of the Nation's electricity and, in the process, account for about 40 percent of the Nation's freshwater withdrawal and about 3% of the Nation's freshwater consumption (Figure 4, Appendix).

It is important to distinguish between water withdrawal and consumption. Withdrawal is the removal of water from any water source or reservoir, such as a lake, river, stream, or aquifer for human use; for power plants, the primary purpose of this withdrawal is cooling. Consumption, on the other hand, is that portion of the water withdrawn that is no longer available for use because it has evaporated, transpired, been

incorporated into products and crops, or consumed by humans or livestock. Note that water withdrawal rates are two orders of magnitude greater than consumption (136 billion gallons per day versus 4 billion gallons per day). This illustrates that most water withdrawn in power generation is not consumed, but returned to its source.

By comparison, nuclear power plants consume approximately 40 percent more water, and natural gas combined cycle plants consume approximately 60 percent less water than equivalent contemporary subcritical Pulverized Coal (PC) technology. Moreover, advanced technology coal plants offer the opportunity to significantly reduce the consumptive footprint, with integrated gasification combined cycle technologies – or IGCC – offering the greatest reduction at 40 percent less than that of a subcritical PC (Figures 5-6, Appendix).

Although a number of commercially available cooling technology options – for example hybrid and dry cooling technologies – can reduce or mitigate water consumption for all generating options, they all result in added cost and increased complexity. In areas where water use is constrained, such as the arid Southwest or the currently drought-afflicted Southeast, increases in water consumption need to be met with careful consideration. Water withdrawal permitting requirements give the private sector the incentive it needs to advance existing cooling technology options, with the exception of the uncertainty associated with future requirements for carbon capture.

Using today's technologies, efforts to capture carbon from the existing coal and natural gas plants, or from new fossil plants, would cause increases in water consumption – a big concern for some regions – and may increase the cost of electricity, a concern for all.

Capturing carbon from fossil plants requires the addition of several energy intensive processes, for example processes that use solvents to capture CO_2, require energy to regenerate the solvent so it can be used again. Once the CO_2 is captured, it must be compressed for sequestration or beneficial re-use, with compressors usually having significant operating power requirements. These processes are common to both conventional fossil-based combustion processes as well as to advanced technologies such as IGCC. NETL estimates that the added energy requirements for these processes results in a significant increase in net plant auxiliary load, known as parasitic power, resulting in a decrease in net plant power output of 15 percent to 30 percent. The requirement for additional systems could have significant reliability implications.

NETL analyses indicate that efforts to capture 90 percent of carbon emissions by using current near-commercial carbon capture and storage (CCS) technologies on PC plants would more than double the amount of water consumed per unit of electricity generated. Studies of this consumptive footprint have indicated that IGCC with CCS has a comparative advantage, with water consumption significantly lower than that of post-combustion CCS technologies. Importantly, IGCC with 90 percent CCS can have a consumptive footprint lower than that of a conventional PC power plant without CCS. Furthermore, the greatly reduced carbon footprint of IGCC with CCS and its low-water consumption compared to nuclear power plants may tend to focus future generation technology choices on capital costs related to water consumption as well as on CO_2 emissions.

For instance, advanced coal systems with 90 percent capture emit CO_2 at rates substantially below that of existing and new Natural Gas Combined Cycle (NGCC) units.

A comparable NGCC plant would capture over 65 percent of its emissions in order to release CO_2 at similar rates. The implementation of CCS on natural gas-fired plants would increase water demand in states such as California, where natural gas exceeds 50 percent of in-state generation. The use of today's post-combustion CO_2 mitigation technologies could have substantial economic impacts. IGCC technology would not increase the use of water relative to conventional post-combustion coal power without carbon capture. Ongoing research and development efforts for more cost-effective capture technology, including improved water-efficiency, deserves continued attention and support.

NETL actively collaborates with other parties from industry, academia, state, and other Federal departments and national laboratories in efforts to mitigate the impact of carbon capture on water supply. Such activities have included recent collaborations with the Office of Electricity Delivery and Energy Reliability, and the North American Electric Reliability Corporation in analyzing the potential impact of the Clean Water Act 316(b) legislation on the Nation's power supply and reliability.

NETL funds a significant amount of water-related extramural research, focusing on technologies to reduce carbon capture water use. Activities are further detailed in the Appendix.

NETL actively works with the Environmental Protection Agency on drinking water issues related to CO_2 injection.

Alongside NETL's expertise in power systems, such research and collaboration plays a vital role in understanding the complex interactions among energy, water, and the environment in the United States.

In conclusion, DOE's Existing Plants, Emissions, and Capture Program has a successful track record and a promising future that will ultimately mitigate the impact of carbon capture on water supply.

Mr. Chairman, Members of the Committee, this completes my statement. I would be happy to respond to any questions you may have.