

# Managing the Water Intensity of CO<sub>2</sub> storage: Using the Water, Energy and Carbon Sequestration Simulation Model (WECSSim) for Water Policy Assessments

Jesse D. Roach, Ph.D., Sandia National Laboratories, 505-284-9367, [jdroach@sandia.gov](mailto:jdroach@sandia.gov)  
 Peter H. Kobos, Ph.D., Sandia National Laboratories  
 Geoffrey T. Klise, Sandia National Laboratories  
 Jason E. Heath, Ph.D., Sandia National Laboratories

## Abstract

Capture of carbon dioxide (CO<sub>2</sub>) from thermoelectric power plant exhaust gas is an energetically costly process, and insofar as additional power to offset these losses is generated with additional thermoelectric power, also a water intensive process. This paper explores the water cost of CO<sub>2</sub> capture and storage (CCS) from fossil-fuel power generating stations in the United States.

The Water, Energy and Carbon Sequestration Simulation model (WECSSim) was developed to address coal and natural gas-based power generation stations' ability to capture, transport and store CO<sub>2</sub> in geologic saline formations with the potential to extract and treat the saline waters present in the saline formation to offset a portion of the new CCS driven water demand (Kobos et al., In Press). WECSSim was developed in a system-dynamics computer simulation software called Powersim Studio, and will be available for public download and use at <http://carbonmanagement.sandia.gov> by the summer of 2014. The modeling framework includes submodules that define characteristics of the power plant, the make-up power, the geological storage formations, options for resident water extraction and treatment, and the costs associated with each step in the CCS chain. WECSSim combines the coal and natural gas-based power generating stations from the Environmental Protection Agency's eGRID database (EPA 2007) with potential deep saline CO<sub>2</sub> storage formations characterized by the National Energy Technology Laboratory's NatCarb database (NETL 2008) to allow for a quantitative assessment of CCS options across the power plant fleet in the United States.

Previous work with WECSSim using marginal abatement costs curves for national scale CCS demonstrated the value of extraction of resident saline water from the perspective of injection efficiency (Roach, Heath, et al., In Press). This paper focuses on the value of extraction and treatment of resident saline water from the perspective of offsetting new water demands associated with CCS. New water demands associated with CCS vary widely depending on make-up power generation and cooling technologies utilized. For example, using cooling towers on a natural gas combined cycle (NGCC) power plant would require a much smaller diversion of water (on the order of 700 gallons/tonne CO<sub>2</sub>) than would once through cooling on a coal fired power plant (over 7000 gal/tonne CO<sub>2</sub>). As a result, depending on the power generation and cooling technologies utilized in generation of make-up power, the added water demands that would be associated with U.S. power plant fleet wide CCS can range from relatively small to impractically large (Roach, et al. 2010). For the more water efficient CCS options, and depending on the salinity of the resident water in the CO<sub>2</sub> storage formation, extracting and treating resident water can offset most or all additional water demands resulting from CCS. However, the economic costs necessary to achieve zero net added water demand may not be justified in all cases. This paper investigates the trade offs between added cost and added water demand associated with large scale CCS in the United States in order to estimate the marginal abatement costs of reducing CO<sub>2</sub> emissions via CCS within the context of regional water supply constraints.

## References

- EPA. *The Emissions & Generation Resource Integrated Database for 2007 (eGRID2007)*. Washington DC: Environmental Protection Agency, 2007.
- Kobos, Peter H., Roach, Jesse D., Geoffrey T. Klise, Jason E. Heath, Thomas A. Dewers, Karen A. Gutierrez, Leonard A. Malczynski, David J. Borns, and Andrea McNemar, *in press*, "The Water, Energy and Carbon Dioxide Sequestration Simulation Model (WECSSim<sup>TM</sup>): A User's Manual."
- NETL. *National Carbon Sequestration Database and Geographic Information System (NatCarb)*. Morgantown, WV: National Energy Technology Laboratory, 2008.

Sandia National Laboratories is a multi-program laboratory managed and operated by Sandia Corporation, a wholly owned subsidiary of Lockheed Martin Corporation, for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000. GHGT-12 Conference. Thanks go to the National Energy Technology Laboratory for supporting the development of WECSSim.

Roach, Jesse D, Jason E Heath, Peter H Kobos, and Geoffrey T Klise. "System-level Benefits of Extracting and Treating Saline Water from Geologic Formations during National-Scale Carbon Capture & Storage." *International Journal of Greenhouse Gas Control*, In Press.

Roach, Jesse D, Peter H Kobos, Geoffrey T Klise, Jim L Krumhansl, and Andrea McNemar. "New Demands, New Supplies: A National Look at the Water Balance of Carbon Dioxide Capture and Sequestration." *American Geophysical Union, Fall Meeting 2010, abstract #H21A-1021*. San Francisco, 2010.