PROJECT facts

U.S. DEPARTMENT OF ENERGY
OFFICE OF FOSSIL ENERGY
NATIONAL ENERGY TECHNOLOGY LABORATORY

Innovations for Existing Plants

10/2008

REUSE OF PRODUCED WATER FROM CO_2 ENHANCED OIL RECOVERY, COAL-BED METHANE, AND MINE POOL WATER BY COAL-BASED POWER PLANTS: PROMIS/PROJECT NO.: DE-NT0005343

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Background

Coal-fired power plants are the second largest users of freshwater in the United States. In Illinois, the thermoelectric power sector accounts for approximately 84 percent of the estimated 14 billion gallons per day of freshwater withdrawals and one-third of the state's 1 billion gallons per day of freshwater consumption. Illinois electric power generation capacity is projected to expand 30 percent by 2030, increasing water consumption by 55 to 160 percent. Increasing public resistance to the withdrawal or consumption of freshwater for industrial purposes suggests that the use of non-traditional water sources in power plants may help meet the expected increase in water demand.

In the majority of oil and gas reservoirs, only 20 to 40 percent of the total amount of the original oil in place can be recovered by standard extraction methods. Enhanced oil recovery (EOR) involves the injection of water and carbon dioxide (CO_2) into depleted oil fields to extract up to 10 percent of the remaining oil. EOR using CO_2 that has been captured from coal-fired power plants is being viewed as an economically attractive option for maintaining and expanding Illinois' power production capacity in an environmentally acceptable manner. A recent study indicates that 23 to 37 major reservoirs (depending on the assumed oil price and CO_2 cost scenarios) are economically favorable for CO_2-EOR in the Illinois Basin. However, about 10 barrels of water are produced for each barrel of crude oil recovered via EOR; this water is treated and re-used for further EOR, but it is eventually released to the environment. Power plant use of the water produced by CO_2-EOR may be an environmentally-sustainable alternative for "closing the CO_2-water loop," but the technical and economic viability of this scenario has not been fully explored.

Coalbed methane (CBM) operations have been found to produce water volumes ranging from 0.03 (San Juan, New Mexico) to 2.75 (Powder River, Montana) bbl per thousand cubic feet of recovered methane. Currently, CBM is produced from ~150 boreholes into coal seams in Illinois, but no data are available on water production from CBM in the Illinois Basin. Similarly, potential water storage in the void spaces of abandoned underground coal mines in Illinois is more than 1 trillion gallons, and a mine in White County produces about 450,000 gallons per day. Although several Eastern power plants already use mine water for cooling purposes, and several studies on power plant use of mine water in the Appalachian region have been performed, no comparable assessment has been made thus far for the Illinois Basin.

Description

As part of the U.S. Department of Energy's (DOE) Innovations for Existing Plants (IEP) Program, this project will evaluate the quantity and quality of produced water from CO_2-EOR operation, CBM recovery, and active and abandoned underground coal mines. It will also estimate cooling/process water demand for coal-based power plants in the Illinois Basin, identify suitable technologies and costs for treating the produced water to different quality levels, and optimize the cost of a pipeline distribution network for transporting the water from its source(s) to the power plants for reuse.

PARTNERS

Illinois State Geological Survey

PERIOD OF PERFORMANCE

10/01/08 to 09/30/10

COST

Total Project Value
$1,183,058

DOE/Non-DOE Share
$830,031 / $353,027

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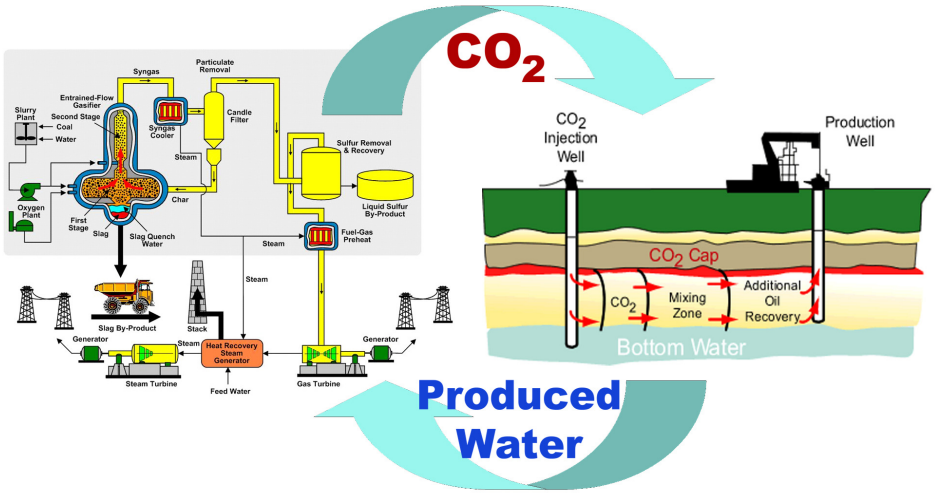
Primary Project Goals

The project will focus on evaluating the quantity and quality of produced water from these sources, identifying suitable technologies for treating the produced water to different quality levels, estimating cooling/process water demand for coal-based power plants in the Illinois Basin, estimating the cost of treated water, and optimizing the cost of pipeline distribution network for water transportation.



Power Plant Reuse of Water Produced of CO_2 - EOR Operations

Benefits

It is likely that the coal-based power generation industry will face restrictions for water use because of the limited availability of water resources and the increasing demand for water in the domestic, agricultural, and industrial sectors. Utilization of the non-traditional water sources to be studied in this project represents an innovative solution to supplement/replace freshwater needs of the coal-based power plants.

Planned Activities

- Search U.S. Geological Survey (USGS) and U.S. Environmental Protection Agency (EPA) databases to obtain historic data of produced water from coal mines in Illinois.
- Collect water samples from CO_2-EOR wells, CBM wells, and active and/or abandoned coal mines in the Illinois Basin and characterize their physical and chemical properties.
- Evaluate various conventional treatment scenarios (e.g., a combination of coagulation, filtration, and adsorption) and innovative water treatment concepts that are currently being developed at the University of Illinois's Center of Advanced Materials for Purification of Water with Systems (WaterCAMPWS) to assess the required treatment options to reuse the produced water as cooling or process water for power plants.
- Conduct a series of conventional water treatment experiments based on the water quality assessment to evaluate the treatability of the produced water samples.
- Calculate the cost to treat produced water from the selected sources based on the data collected, literature information, and standard chemical engineering cost estimation procedures.
- Estimate the cost of pipeline transport for produced water to power plants, including transport to and from any water treatment facilities.
- Conduct a techno-economic assessment of the extent to which the non-traditional waters can meet the future (by 2030) cooling/process water demand by pulverized coal (PC) and Integrated Gasification Combined Cycle (IGCC) power plants in the Illinois Basin, given the estimated costs of produced water treatment and transportation.