NETL Water-Energy Workshop
Water Management for Fossil Energy Systems
August 20 2014, Baltimore, Maryland

Breakout Session B

Facilitator: Barbara Carney Recorder: Mark Philbrick

Each of the sessions provided a review of areas where R&D funds can best be utilized over the near term. The order of discussion was based on prioritization of the categories to be used by each of the Brainstorming Groups. Each group participant received two red stickers. Participants used these to vote for their area of greatest interest for prioritizing discussion among the categories listed below. This ensured that sufficient time would be available to capture discussion on the areas of greatest interest to that group.

The following were the number of votes given for prioritizing topics at the beginning of the session:

1. **Cooling Systems:** **Total Votes = 1**
    a. *(Wet and Dry)*
    b. *Incremental & Step Change Improvements*
2. **Water Treatment and Reuse:** **Total Votes = 5**
    a. *Economic Pathways for Zero Liquid Discharge*
3. **Process Efficiency and Heat Utilization:** **Total Votes = 4**
    a. *Pathways for produce more power per unit of water withdrawn, consumed, and treated*
4. **Data, Modeling and Analysis:** **Total Votes = 4**
    a. *Tools to enable regional and plant level decision making*
5. **Other topics** **Total Votes = 0**

The group consisted of Engineers, Consultants, Product Manufacturers, EPRI, and Utility representatives.

Cooling Systems:

- Although this topic only got one vote, the vote was from the Utility representative, which is who this workshop was targeting, so we began with this topic, which is closely related to Process Efficiency and Heat Utilization.
- The High Efficiency System currently being tested at Southern Company's Plant Barry is of utmost interest to the Utility representative. This air-to-air heat exchanger reduced FGD water use by 30% and removes the visible water plume from the plant stack. The heat is being integrated into the carbon capture process at Plant Barry. Probably all FGD units should have some type of heat recovery installed.
- Dry cooling is a problem in hot, humid areas. It doesn't work well and is expensive. EPRI is concentrated on dry cooling solutions. Load limiting on power plants due to elevated water discharge is a problem in the summer. Heat waves match peak demand times for electricity

generation. EPRI has tested one configuration of hybrid cooling at the Water Research Center using a refrigerant which tracks water cost verses energy cost and implements the higher energy solution when water is at a premium. Hybrid cooling tested thus far has just scratched the surface of this promising compromise on water/energy usage. Many other iterations of hybrid cooling are available and need to be tested.

- Nitrogen and phosphorous are constituents of concern in grey water. Microbiological fouling accounts for about 70% of cooling tower/condenser fouling. Comparing fill types to evaluate resistance to biofouling is important. Utilities try to avoid the use of biocides to control this fouling. Southern Company has a test cooling tower where different types of fill are tested, and the fouled fill is removed with a crane and weighed. All new fill material undergoes this testing prior to use in cooling towers.
- There is currently no market for water. The value of saving water at a power plant is not quantifiable. There are perverse incentives for constant pump usage. A market-based system for water usage may look very different from the one we have now. Alternative generation and storage may be more desirable if water has more value, for instance flow batteries, fuel cells, ancillary services, storing heat in geothermal systems, and alternative methods of energy storage. In 20-30 years, water may not be free.
- The cooling tower is the biggest loss of water and more research should be focused on this. There may be other ways to retrofit cooling towers for water recapture besides the conventional desiccant, membranes, or heat exchangers; for example silver iodide or some other untested method.
- DOE does not generally fund processes that are only incremental improvements over existing technology. There is a strong incentive to only try new and novel approaches. If widely deployed, incremental improvements can have a big impact on water usage. A portfolio approach to research and development is needed.

Water Treatment and Reuse:

- Fracking water from Marcellus and Utica shale wells is often cited as a large water use. In West Virginia and Pennsylvania there is a total of about 5,000 wells installed per year. About 80% of the produced water and flowback from fracking is reused. The total for all wells is not really a large amount of water and not a big issue.
- The newly constructed Kemper plant (IGCC) will use 60% grey water for cooling.
- Power plant water balance investigations as a baseline for improved water use is important.
- Silica removal to avoid scaling is important in some areas. Higher cycles of concentration in cooling systems can sometimes be utilized if silica levels are kept low. Calcium, iron, and sulfate are also of concern. Water quality issues are very regional in nature, and constituents of concern can be totally different within a short distance.
- Zero Liquid Discharge (ZLD) may change how things are done. Specific goals are needed, i.e. recoverable and valuable minerals, to make this option more efficient. There is some question on how much of a plant's capital cost should be devoted to ZLD. Dust suppression and ash

conditioning are one use for degraded water, deep well injection is another. The impact of ZLD on energy use needs to be quantified.

- West Virginia University and other partners have a research project for geological CO_2 storage in the saline Ordos Basin in China. Brines are withdrawn in advance of CO_2 injection, treated with Reverse Osmosis for power plant processes, and reinjected with CO_2. Los Alamos National Lab (LANL) is developing a PENS computer model to assist in this process.

Process Efficiency and Heat Utilization

- Process efficiency and heat utilization are of the utmost importance. In addition to water savings, better efficiency will be critical in the new Clean Air Act Section 111(d), which regulates carbon emissions from power plants. Intelligent use of waste heat is a good topic for research. The efficiency of the overall power generation is critical. The newly constructed Kemper plant (IGCC) will use coal drying to improve efficiency (not sure if waste heat is used for this).

Data, Modeling and Analysis

- There are many great models developed but they give bad analysis due to lack of data. Data needed is conductivity, trace elements (for tracking), and changes in the hydrograph; a salinity balance and nutrient balance is needed. Integrated data sets with agricultural withdrawals and returns verses the hydrograph is needed. Nutrient loading is an issue and more data is needed. University of Minnesota is doing one such study for the upper Mississippi water shed. Groundwater data is also needed. The US Geological Survey collects some of this data, but it is not enough.
- Water quality can evolve within regions. Monitoring concentration levels is important for TMDL (total maximum daily load). NPDES discharge limits are based on TMDL limits, and less fragmented data sets are needed. Additional sample sets are needed but funding is an issue. Industry consortiums can be a good source of funding; the data required is not that expensive to obtain and good data allows identification of the source of a problem. Links need to be created with people who have sampling data. Also, NPDES data is collected monthly but is not released to the public; it would be useful to have this.
- Problems with brackish groundwater are particularly acute. There is a poor understanding of consequences of extraction and a larger risk analysis framework is needed. Rice University is developing a comprehensive brine model to predict how brine, oil, and gas from deep wells react with everything on the way to the surface.

Other Topics

- A Product Manufacturer was present that is interested in replacing water with CO_2. CO_2 could be used for fracking, a working fluid in power plants (i.e. supercritical CO_2 for power generation), and for enhanced geothermal systems.

Attendees:

Carney, Barbara (Facilitator)	USDOE - NETL
Hendren, Zachary	RTI International
Maley, Susan	USDOE - NETL
Rogers, Ryan	3-M Co.
Blythe, Gary	URS Corporation
Mcling, Travis	INL
Philbrick, Mark	Department of Energy
Sullivan Graham, Jeri	Los Alamos National Lab
Wang, Gary	Lockheed Martin
Willersdorf, William	Veolia
Wilson, Steve	Southern Company
Ziemkiewicz, Paul	West Virginia University
Miller, Michael	EPRI