Power Plant Water Consumption

GAO Energy-Water Nexus: \*PP= Power Plant

* In 2000 39% of US freshwater use was from PP
* PP use water to cool steam and for generating electricity
* Discusses ways to reduce water and their drawbacks
* Discusses the consideration of water use when proposing to build a PP
* Discusses the usefulness of federal water data to experts and state regulators
* Their recommendations:
  + Use advance cooling technologies
  + Use alternative water sources
  + Reinstating collection of data on PP water consumption
  + distributing data on use of alternative water sources
* Using advance air cooling tech to cool all or some steam cuts back on firewater use but can lead to increased energy use leading to energy production penalties or higher cost of operations
* Using effluent to cool but can have adverse effects on cooling equipment of regulatory compliance issues
* GAO found that depending on states the laws and requirements are different
* For states that have strict water consumption use in general already of plans of action to minimize freshwater consumption by PP
* While other states have no policies regarding PP water use and some do not require state permits for water use
* USGS collect water use data through stream flow gauges, groundwater surveys, and monitoring stations
* DOE and EIA do not systematically collect info on advanced cooling tech and others are incomplete
* USGS stopped data distribution on water consumption by PP and now only provide info on water withdrawals
* Incomplete data make it difficult for analyzers to conduct full analyses on industry trends
* Simple cycle PP normally use a turbine/jet engine to spin a generator and heat is let off into the surrounding
* Combine cycle PP take the heat generated from the turbines to heat water that spins a generator and cooling water is used to cool steam
* Combine cycle uses less cooling water than steam plants
* Steam PP uses fossil fuel boil water to spin the turbine and uses cooling water to cool steam so the cycle continues
* **\*\*\*** Water is monitored in three categories: Withdrawal, Consumption, and Discharge
  + Withdrawal- when water is removed from the ground or diverted from a surface souce
  + Consumption- when the water is no longer available to return to a water source, such as when is has evaporated
  + Discharge-when the water is returned to the original or new source
* Most water is discharged by PP but at higher temps it will evaporate
* The amount discharged depends on the cooling tech used, plant economics, and environmental regulations
* The decision to build a PP is independently by the developer or the state public utility commission
* Developers must obtain approval from a number of state and local officials, generally by obtaining preconstruction and operating permits, before they can proceed with building their plant in a particular location
* This is done to balance the benefits of the plants (jobs & energy) with the impacts to communities and environments nearby
* Regulations on the electricity industry’s water use involves both federal and state laws
* State responsible for managing the allocation and use of freshwater supplies and ensuring discharge meets regulation standards
* Federal responsible for water use on federal lands or interstate commerce and water discharged permits
* Zero-liquid discharge- PP has no discharge outside their boundaries
* 4 cooling methods:
  + Once through- water pulled from a body of water then discharged immediately after use. Almost no consumption but warm water is discharged. Can affect the habitat and cause more evaporation
  + Wet recirculating system- warm cooled water is sent to a water tower or pond to cool. Less fresh water use but higher water consumption from evaporation. Blowout happens to rid solids (doesn’t say where blowout goes). Water withdrawal for replacing water lost
  + Dry cooling- uses fans to blow air on steam pipes to condense steam. But water could be used for other plant purposes like pollution control. Another topic not covered.
  + Hybrid- can use either wet or dry independently or simultaneously

Review of Operational Water Consumption:

* 2005 41% freshwater withdrawal from thermoelectric power operations
* Energy sources reviewed concentrating solar power (CSP), solar photovoltaic (PV), wind, biopower, geothermal, hydroelectric, nuclear, natural gas, and coal technologies
* CSP use water for steam cycle processes to clean mirrors/heliostats and for cooling if cooling tower is used
* PV use it for occasional panel cleaning
* Wind Energy use very little for cleaning
* Biopower facilities use water for steam cycle processing and cooling
* Also talks about gap in federal data base
* Also talks about dry air cooling and using other sources of water, along with their drawbacks
* Focused study on cooling operation
* Focused on withdrawal and consumption not discharge
* Withdrawal and consumption usually reported at annual averages but may change up to 16% because of diurnal and seasonal variations in temperatures, wind speeds, and humidity levels
* Age of equipment and efficiency of thermal process can effect water consumption
* Graphs on page 7-10
* \*\*\* Operational water consumption and withdrawal measured in gallons/MWh
* Renewable water consumption and withdrawal graphs page 12-14
* Better data needs to be recorded for more accurate analysis of cooling techniques but they are ranked in this order
  + Water withdrawal- Dry < Wet < Hybrid < Once through
  + Water Consumption- Dry< Once through < Hybrid < Wet

Freshwater use by US PP

* Outages can happen during heat waves because water is scarce
* USGS report every 5 years on national water use
  + PP- withdrawal, where they withdrawal, and if its freshwater or saline
  + Sources information from state regulatory officials, PP operators, and EIA
* EIA collects data on withdrawal, consumption, and discharge for plants rate over 100MW yearly
* State allocates water use with two doctrines:
  + Riparian doctrine mainly in the east- landowners may withdrawal any water flowing past the land for any reasonable purpose. All landowners have equal rights to use water. A permit is required and tracked but in states with no water scarcity it is not closely tracked.
  + Appropriation doctrine mainly west-water rights are not linked with land ownership. Water right can be bought or sold and users get an allotted amound of water to withdrawal. Seniority has priority. If not used permit can be terminated. If there is a water shortage then junior holders could lose all rights while senior holder can continue to use all of their allotted water.
* Groundwater works the same as surface but can have some differences
  + Some states allow landowners to use as much as they want
  + While others allow you to use as much but with a reasonable cause
* Page 20 cooling water estimate in gallons/MWh by plant type table
* Using air to cool will lessen the output of a PP- more energy to cool and less efficient PP
* Dry cooling systems have high cost and produce more noise
* Page 34 has a table of 7 states that have been contacted with the laws and permits needed
* States rely on federal data but federal data is incomplete so it has limits
* EIA does not collect data on advanced cool tech