How it Works: Water for Electricity

The United States uses many different technologies to produce electricity. It is important to understand the different impacts these technologies have on water resources.

Contents:

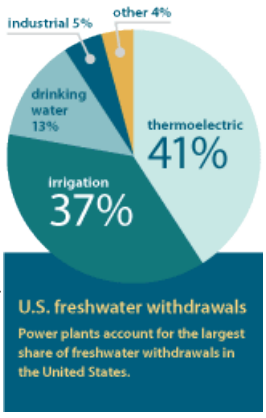
Sequoyah Nuclear Plant in Tennessee. Photo source: TVA

Water's Many Roles in Electricity

Water is involved at many points in the process of producing electricity:

Electricity Generation – More than 90 percent of U.S. power plants require cooling, a traditionally water-intensive process. These types of power plants are called thermoelectric because they use a heat source to produce steam for generating electricity. Hydroelectric power plants use water in a different way, converting the energy in falling water into electricity by passing it through turbines.
Fuel Extraction and Production – Water is a critical resource for the drilling and mining of natural gas, coal, oil, and uranium. In many cases, fuel extraction also produces wastewater, as with natural gas and oil wells and coal slurry ponds.
Fuel Refining and Processing – Oil, uranium, and natural gas all require refining before they can be used as fuels – a process that uses substantial amounts of water.
Fuel Transportation – Water is used to transport coal through slurries -- pipelines of finely ground coal mixed with water -- and to test energy pipelines for leaks.[1]
Emissions Control – Many thermoelectric power plants emit sulfur, mercury, particulates, carbon dioxide, and other pollutants, and require pollution control technologies. These technologies also require significant amounts of water to operate.

Generating Electricity Requires Substantial Amounts of Water



Water use in power plants has two components: withdrawal and consumption. Water withdrawal is the act of removing water from a local water source; the withdrawn water may or may not get returned to its source or made available for use elsewhere. Water consumption is the use of water in a power plant in a way such that the water is not returned, usually because it is lost to evaporation.

Some power plants use cooling systems that draw water from a lake, river, aquifer, or ocean to cool steam and then return virtually all of it – although at higher temperatures – to the source. Such systems have high withdrawal but low consumption. Coal and nuclear plants, for example, may draw 20 to 60 gallons of water for every kilowatt-hour of electricity they produce, depending on how they are cooled.[2] Largely because of older power plants using this approach, electric power generation is responsible for more than 40 percent of freshwater withdrawals in the United States -- an average of 143 billion gallons per day in 2009 -- primarily for cooling.[4] Water withdrawal by power plants can become a major challenge during times of drought or other water stress, when water is simply not available in the required volumes or at the required temperatures. Drawing vast volumes of cooling

water through systems of pumps and pipes can also trap and kill fish, insect larvae, and other organisms.

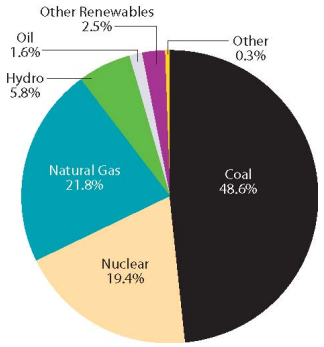
Power plants using other cooling systems can withdraw only a fraction of that amount, but tend to consume far more of it. Power plant water consumption becomes a large problem in water constrained regions where competition among users is high. Hydropower plants withdraw large amounts of water to run through their turbines, while the lakes they rely on also consume water quickly by evaporation; however, dammed lakes are used for multiple purposes, such as agricultural irrigation, flood control, and recreation. Hydropower does not account for all of this water usage.

Electricity Can Also Impact Water Quality

Producing electricity can have significant implications for water quality. For example:

Water used to cool electricity-generating steam exits the power plant at substantially higher temperatures – an average of 17ºF hotter at coal plants in summer.[5] This "thermal pollution" can harm local aquatic ecosystems, especially during the summer months when species are at or near their heat tolerance thresholds.
Minerals unearthed during fuel mining and drilling can contaminate groundwater, which in turn affects drinking water and local ecosystems.
Coal mining and combustion create wastes with dangerous toxins such as mercury, lead, and arsenic; and improper storage or disposal of those wastes can contaminate water supplies. Moreover, coal combustion can create acid rain, increasing the acidity of lakes and streams and harm aquatic ecosystems.

U.S. Electricity by Energy Source



Source: Energy Information Administration, 2008.

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[1] Department of Energy (DOE), 2006. Energy Demands on Water Resources: Report to Congress on the Interdependency of Energy and Water.
[2] DOE, 2006.
[3] U.S. Geological Survey (USGS), 2009. Estimated Use of Water in the United States in 2005. U.S. Geological Survey Circular 1344.
[5] Median summer peak temperature increases. NETL, 2007. NETL coal power plant database.

Last Revised: 10/05/10

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