Thermoelectric Water Use: Consumption

This EnviroAtlas national map estimates the total water used each day (in millions of gallons per day) for thermoelectric power plants within each 12-digit hydrological unit (HUC) in the contiguous United States. For this map, thermoelectric water demand includes the amount of water used by coal, oil, gas, or nuclear, biomass, solar, and geothermal plants for the generation of energy. Thermoelectric water comes from self-supplied (e.g., private wells or reservoirs) surface and ground water. This map is based on water withdrawn and consumed but not returned to the watershed.

Why is thermoelectric water use important?

Thermoelectric plants account for over forty percent of total fresh water use in the United States. Based on the data used for this map, water use for thermoelectric power plants averages over 200 billion gallons of water daily. Besides power generation, individuals and communities depend on water resources for drinking, household use, recreation, industry, and transportation. Plants and animals also depend on a clean and plentiful water supply. Water is a finite resource. Overuse within a watershed can lead to unintended consequences, such as water shortages, the need for additional treatment, and higher costs for storage and distribution. Maintaining appropriate natural resource usage can help ensure the availability of a stable water supply.

Water demand for thermoelectric use varies throughout the year and across the country depending on factors such as climate, population density, evolving technologies, conservation efforts, cost, and cultural preferences. In thermoelectric power generation, water is mainly used during the cooling of the electrical generating equipment. The hot water cannot be released directly back into the environment and must first be cooled. Because of the large water demand for cooling, thermoelectric plants tend to be sited along rivers and lakes.

Water withdrawal for thermoelectric power production represents the total amount of water removed from the resource, while thermoelectric water consumption refers to the amount of water removed, but not returned to the source waterbody. The amount of water withdrawn from U.S. waterbodies for power generation is second only to that withdrawn for irrigated agriculture. It was estimated in 2005 that about 25 gallons is withdrawn for each kilowatt-hour of electricity produced.[1] The amount of water withdrawn and consumed from nearby waterbodies varies according to

power plant design. "Once-through" or cooling pond systems withdraw large amounts of water but consume relatively little, while recirculating cooling tower systems withdraw 30–50 times less water but consume as much as 75% of the water withdrawn.[1] Consumption of fresh water resources withdrawn for power generation was estimated at 3% of the total water withdrawn (last calculated in 1995) or more than 3 billion gallons per day.[1]

The overuse of water resources can impact ecosystems and ecosystem services (the natural benefits that ecosystems provide). Natural ecosystems such as wetlands, forests, and riparian cover near water bodies help protect the supply and quality of water resources. By storing and filtering rainwater, regulating the speed and volume of water flows, and preventing sediment and contaminants from entering waterbodies, properly functioning natural resources ensure that clean and plentiful water is available for aquatic habitat, drinking, recreation, and power production. Understanding the demand placed on these ecosystems will help ensure their continued ability to provide such services.

How can I use this information?

The map, Thermoelectric Water Use: Consumption, can be used to help evaluate the demand for clean and plentiful water for electrical power production within each 12-digit HUC in the U.S. Another related map, Thermoelectric Water Use: Withdrawal, estimates the amount of water withdrawn from source waterbodies. Understanding water uses is a critical step to identifying potential imbalances and trends in supply and demand. Within EnviroAtlas, this map can be

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used in combination with maps on domestic, agricultural, and industrial water use to visualize which HUCs have relatively high demands placed on their water resources.

These maps can be used in conjunction with the maps and data that illustrate water availability such as the water supply in reservoirs map. Together, these data suggest where demand for water may outpace availability at the watershed scale. These maps may highlight where the ecosystems that protect water resources may experience strain, require protection, or benefit from restoration. In areas with significant imbalances or detrimental trends, additional research may help to understand and alleviate pressure on the water supply. These maps can be used to complement the maps showing stream length, density, and impairments from metals, nutrients, and temperature. By comparing thermoelectric use to stream impairments, users can better assess the extent of stresses to local watersheds.

How were the data for this map created?

The water demand for thermoelectric power plants by 12-digit HUCs was estimated using the US Energy Information Administration (EIA) monthly electric generator inventory, a comprehensive source of almost all electrical power generated in the United States. Thermoelectric plants included those that utilize coal, oil, gas, or nuclear, biomass, solar, and geothermal as a fuel source. The plant name plate capacity generation of energy was multiplied by a water consumption coefficient to estimate total water use by the plant. With the exception of oil, the average water consumption coefficient per kilowatt (MWhr) came from Macknick et al 2012. The oil estimate came from the 2009 report from the National Energy Technology Laboratory titled "Estimating Freshwater Needs to Meet Future Thermoelectric Generation Requirements." Finally, for EnviroAtlas, the applied thermoelectric water use values were then summarized by 12-digit HUC.

What are the limitations of these data?

The data that are reported for thermoelectric water usage in the United States are complex. The calculations are based on available data, which may not accurately represent water usage. For example, available data on reclaimed water during the thermoelectric process was not included in our calculations; therefore total water consumption will be an overestimation, as some of the water used during the cooling process is reused. However, considerable efforts have been made to report the most accurate estimates across these data.

How can I access these data?

EnviroAtlas data can be viewed in the interactive map, accessed through web services, or downloaded. USGS water use data is available from the USGS water use website.

Where can I get more information?

There are numerous resources on thermoelectric water use and demand; a small selection of these resources is listed below. EPA and USGS have additional resources on their respective websites. Access the metadata for the data layer from the drop down menu on the interactive map table of contents and click again on metadata at the bottom of the metadata summary page for more details. To ask specific questions about this data layer, please contact the EnviroAtlas Team.

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Selected Publications

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