Utility-Scale Solar Power

Responsible Water Resource Management

Overview

Some utility-scale solar power plant technologies, specifically parabolic trough and power tower, need water to generate electricity efficiently and cost-effectively. Solar power plants, whether concentrating solar power (CSP) or photovoltaic systems (PV), offer pollution-free electricity generation with impacts on local water sources that are comparable to and often less than traditional fossil fuel generation. [For more information, see the SEIA fact sheet on CSP Technologies.]

Utility-Scale Solar Power Plants and Water Processes

Water use requirements for solar power plants depend on the technology and weather and climate conditions at the site.

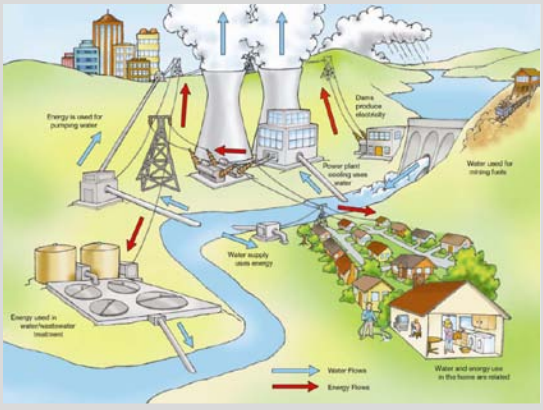
In general, all solar power technologies use a modest amount of water (approximately 20 gallons per megawatt hour, or gal/MWh[1]) for cleaning solar collection and reflection surfaces like mirrors, heliostats, panels, troughs, and dishes. For comparison, a typical family uses about 20,000 gallons of water each year, more than the amount of water needed per MW of photovoltaic generation capacity.

In all thermal power plants, whether fossil, nuclear, or solar, heat is used to boil water into steam, which runs a steam turbine to generate electricity. The exhaust steam from the generator must be cooled prior to being heated again and turned back into steam.

This cooling can be done with water (wet cooling) or air (dry cooling), or a combination of both (hybrid cooling). Water cooling is the most efficient. PV, concentrating PV, and dish-engine solar plants are not thermal cycle plants and therefore do not require water for cooling.

CSP plants using parabolic trough and power tower technologies must use some form of cooling.

Source: U.S. Department of Energy



Source: Sandia National Laboratories

Comparative Cooling System Performance[2]

COOLING SYSTEM	WATER USE	ANNUAL ENERGY OUTPUT	CAPITAL COSTS
Wet	100%	100%	100%
Hybrid	40%	95.4%	103%
Dry	5%	92.5%	104%

Wet Cooling

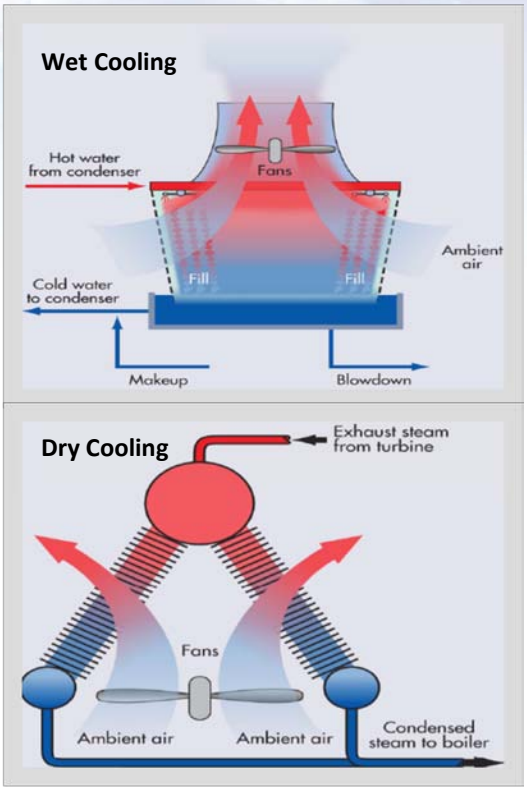
Heat is dissipated from the power plant through evaporation, most often via a cooling tower. Wet cooling is the most common cooling method for power plants, as it is the most efficient and cheapest cooling method available. All CSP systems currently in operation use wet cooling. Parabolic trough and power tower solar plants consume about the same amount of water as a coal-fired or nuclear power plant (500 to 800 gal/MWh).[3]

Dry Cooling

Heat from the condenser is rejected using fans and ambient air. A significant temperature difference between the outside air and the exhaust steam is needed for an adequate heat exchange, limiting performance on hot summer days. Dry cooling systems have greater capital costs in comparison to wet cooling, but significantly reduce total water consumption (see chart above).

Hybrid Cooling

The hybrid approach involves constructing both a wet and a dry cooling system. These systems can either operate in parallel or switch from dry cooling to wet cooling during the hottest hours of the day. Hybrid systems conserve less water than dry cooling but are more expensive than either alone.



Source: Electric Power Research Institute

Utility-Scale Solar Power and Agriculture: Water Use in Context

- The newest CSP plant in the United States, the Nevada Solar One parabolic trough plant, consumes 850 gallons of water per MWh on a 360-acre site near Las Vegas, or about 300,000 gallons per acre per year. In comparison, agriculture in Nevada requires almost 1.2 million gallons of water per acre per year – nearly four times the consumption of the solar power plant. [4]
- The Department of Energy compared the costs and benefits of the chief crop of the Imperial Valley area of California, alfalfa, to the benefits of potential parabolic trough solar plants. Researchers found the solar plant would use approximately 25 percent of the water required for a similar parcel of land growing alfalfa. Additionally, the USP plant was estimated to generate more revenue for the community, and create more and higher-wage jobs.[5]

About the Solar Energy Industries Association

Established in 1974, the Solar Energy Industries Association® is the national trade association of the U.S. solar energy industry. Through advocacy and education, SEIA and its 1,000 member companies are building a strong solar industry to power America. As the voice of the industry, SEIA works to make solar a mainstream and significant energy source by expanding markets, removing market barriers, strengthening the industry and educating the public on the benefits of solar energy.

For a referenced version of this factsheet and more information, please visit www.seia.org.

[1] "Concentrating Solar Power Commercial Application Study: Reducing Water Consumption of Concentrating Solar Power Electricity Generation." Report to Congress. U.S. Department of Energy. Accessed 24 July 2009.
http://www.nrel.gov/csp/pdfs/csp_water_study.pdf

[2] "FPLE – Beacon Solar Energy Project Dry Cooling Evaluation." February 2008. WorleyParsons Group, Inc. Accessed online 30 July 2009.
http://www.energy.ca.gov/sitingcases/beacon/documents/applicant/2008-02-01_DRY_COOLING_EVALUATION_TN-49597.PDF

[3] Cooling water required for a wet-cooled tower is comparable to wet-cooled coal and nuclear plants (approximately 500 gal/MWh). See DOE "Concentrating Solar Power Commercial Application Study." When factoring in water use for scrubbing, ash handling, etc., coal and nuclear plants are comparable to wet-cooled parabolic trough systems (between 700 and 800 gal/MWh). See Zammit, Kent. "Water Use & Conservation in the Utility Industry." Presentation to Georgia State University Center for Ethics and Corporate Responsibility. July 2008. Electric Power Research Institute. Accessed online 30 July 2009.
http://robinson.gsu.edu/resources/files/ethics/summer_seminar_series/kent_zammit.pdf

[4] In Nevada, 3.65 average acre-feet of water per acre of land x 32,5851.4 acre feet to gallons = 1,189,358 gallons of water per year. See "Estimated Use of Water in the United States in 2000" and "Irrigation Water Use." U.S. Geological Survey. Accessed online 30 July 2009.
http://pubs.usgs.gov/circ/2004/circ1268/htdocs/table07.html
and http://ga.water.usgs.gov/edu/wuir.html

[5] "Parabolic Trough FAQs." National Renewable Energy Laboratory. Accessed online 30 July 2009.
http://www.nrel.gov/csp/troughnet/faqs.html