PROTECTING THE LIFELINE OF THE WEST

How Climate and Clean Energy Policies Can Safeguard Water

EDF
ENVIRONMENTAL DEFENSE FUND®
Finding the ways that work

WESTERN RESOURCE ADVOCATES

This report was a collaborative effort by Western Resource Advocates and Environmental Defense Fund. Lead authorship and editing by Stacy Tellinghuisen (Western Resource Advocates) with co-author Jana Milford. The report benefitted from tremendous guidance and advice from Vickie Patton and Jennifer Pitt (Environmental Defense Fund) and Bart Miller, John Nielsen, Anita Schwartz, and Nicole Theerasatiankul (Western Resource Advocates). We also wish to thank reviewers Robert Wilkinson, Craig Cox, Amy Hardberger, and Douglas Kenney.

The report was funded by grants from the The William and Flora Hewlett Foundation, the Compton Foundation, Inc., and an anonymous foundation.

Western Resource Advocates
Western Resource Advocates' mission is to protect the West's land, air, and water.

Our lawyers, scientists and economists:

1) advance clean energy to reduce pollution and global climate change;

2) promote urban water conservation and river restoration; and

3) defend special public lands from evergy development and unauthorized off-road vehicle travel.

We collaborate with other conservation groups, hunters and fishermen, ranchers, American Indians, and others to ensure a sustainable future for the West.

Environmental Defense Fund
Environmental Defense Fund, a leading national nonprofit organization, represents more than 700,000 members. Since 1967, Environmental Defense Fund has linked science, economics, law and innovative private-sector partnerships to create breakthrough solutions to the most serious environmental problems.

Design by Bee Spring Designs

Appendix A | Sources for Water Use Estimates for Energy Generation

Typical water use for electricity generation.

Fuel/Plant	Water consumption (gal/MWh)	Cooling system	Source
Coal, steam	541	Wet recirculating	*Energy Information Administration. 2002. Form 767, Steam-Electric Plant Operation and Design Report, Cooling System Information.*
Nuclear	609	Wet recirculating	*Ibid.*
Oil/gas, steam	662	Wet recirculating	*Ibid.*
Combustion turbine*	0–100	-	
Combined cycle	180	Wet recirculating	*Electric Power Research Institute. 2002. Water and Sustainability (Volume 3): U.S. Water Consumption for Power Production – The Next Half Century. Report prepared by Bevilacqua-Knight, Inc. Report 1006786.* *Clean Air Task Force and the Land and Water Fund of the Rockies. 2003. The Last Straw: Water Use by Power Plants in the Arid West. http://www.westernresourceadvocates.org/media/pdf/laststraw2009.pdf*
Coal, IGCC	365	Wet recirculating	*National Energy Technology Laboratory. 2007. Cost and Performance Baseline for Fossil Energy Plants: Volume 1: Bituminous Coal and Natural Gas to Electricity Final Report (Revision 1, August 2007). http://www.netl.doe.gov/energy-analyses/pubs/Bituminous Baseline_Final Report.pdf.*
Coal, IGCC, with CCS	500	Wet recirculating	*Ibid.*
Coal, PC, with CCS	1,438	Wet recirculating	*Ibid.*
Natural gas, combined cycle, with CCS	583	Wet recirculating	*Ibid.*
Solar CSP	760	Wet recirculating	*Stoddard, L., J. Abiecunas, and R. O'Connell. 2006. Economic, Energy, and Environmental Benefits of Concentrating Solar Power in California. Overland Park, KS: Black & Veatch.*
Solar CSP, dry cooling	78	Dry cooling (or dish with Stirling engine)	*Kelly, B. 2005. Nexant Parabolic Trough Solar Power Plant Systems Analysis, Task 2: Comparison of Wet and Dry Rankine Cycle Heat Rejection. A report for NREL, SR-550-40163. http://www.nrel.gov/csp/troughnet/pdfs/40163.pdf.*
Solar photovoltaics	0		*Clean Air Task Force and the Land and Water Fund of the Rockies. 2003. The Last Straw: Water Use by Power Plants in the Arid West. http://www.westernresourceadvocates.org/media/pdf/laststraw2009.pdf.*
Wind	0		*Ibid.*
Geothermal, binary	0	Dry cooling	*Kagel, Alyssa, Diana Bates, and Karl Gawell. 2007. A Guide to Geothermal Energy and the Environment., Washington, D.C.: Geothermal Energy Association. Washington, D.C. http://www.geo-energy.org/publications/reports/Environmental Guide.pdf.*
Geothermal, binary	74–368†	Hybrid cooling	*Data provided by Charles Kutscher. 2008. Empire Energy Geothermal Power Plant, Empire, NV: Evaporative Cooling Analysis for Condenser Intake Air. Golden, CO: National Energy Renewable Laboratory. Published as Kutscher, Charles and David Costenaro. 2002. Assessment of Evaporative Cooling Enhancement Methods for Air-Cooled Geothermal Power Plants. Golden, CO: National Renewable Energy Laboratory. NREL/CP-550-32394.*
Geothermal, binary	~1,700, variable	Wet recirculating‡	*Kozubal, Eric and Charles Kutscher. 2003. Analysis of a Water-Cooled Condenser in Series with an Air-Cooled Condenser for a Proposed 1-MW Geothermal Power Plant. Geothermal Resources Council Transactions, Vol. 27.*

* Combustion turbines do not require water for cooling. They may require water for other on-site processes.

† Range of values reflects four different hybrid cooling systems, tested at the Empire Energy Geothermal Plant in Empire, NV. We use an average value (117 gal/MWh).

‡ Geothermal plants can use geothermal fluids for their cooling water needs. Water use in wet-cooled geothermal plants varies substantially, depending on the temperature of the geothermal resource; high temperature resources have lower water use per unit of energy generated.