Water Required for Energy Generation in Colorado Is Declining

WESTERN RESOURCE ADVOCATES

BACKGROUND BRIEF

Recent clean energy policies have reduced Colorado's energy-related water demands

Summary

New energy policies in Colorado are resulting in less water needed for the energy generation sector. In 2011, coal- and natural-gas-fired power plants in the State of Colorado consumed approximately 64,000 acre-feet (AF) of water. With state policies promoting energy efficiency and renewable energy, and retiring the state's most carbon- and water-intensive power plants, Colorado's energy sector likely will use even less water in the future. The trend in energy-related water use is an important consideration in evaluating Colorado's future water demands, particularly for creating a new State Water Plan. Furthermore, new policies to promote water-efficient forms of energy generation can lead to additional future water savings, reducing the "gap" between future water demands and supplies in Colorado.

Water Embedded in Electricity Generation Varies Significantly Between Conventional Power Plants and Clean Energy Sources

The water required for electricity generation varies considerably, depending on the fuel source, generation technology, and cooling technology employed at a thermoelectric power plant. In Colorado, power plants consume approximately 64,000 AF of water today (Table 1). Most of the water consumed to generate electricity is used to cool and condense steam in a thermoelectric power plant.

Typical Western steam plants (such as coal and nuclear plants) employ wet-recirculating cooling systems. These systems recirculate water in a cooling tower, usually until it is fully consumed. A combined cycle gas plant often has two gas turbines and one steam turbine; the water intensity of electricity produced at a combined cycle gas plant is, on average, one-third as much as the water intensity of a conventional coal or nuclear plant. Newer thermal plants may use alternative cooling technologies; in recent years, combined cycle gas plants in the region have adopted dry cooling, which consumes 10% as much water as conventional wet cooling. The Comanche Unit 3, a 750-megawatt coal unit that began operations in 2010, adopted a hybrid wet-dry cooling system, which reduces water use at the unit by approximately 50%.

Water use for renewable technologies varies, though most renewable energy in Colorado uses little or no water. Wind and solar photovoltaic facilities use no water; concentrating solar power plants have variable levels of water use, depending on the generation technology and cooling technology. Figure 1 illustrates comparative levels of water use for different technologies on a *life cycle basis*—that is, the water embedded in the construction of the facility, fuel mining (if applicable), and electricity generation.*

Colorado's energy sector likely will use even less water in the future, thanks to state energy policies promoting energy efficiency, renewable energy, and retiring the state's most carbon- and water-intensive power plants.

* Figure from Meldrum, J., S. Nettles-Anderson, G. Heath, and J. Macknick. 2013. "Life Cycle Water Use for Electricity Generation: A Review and Harmonization of Literature Estimates." *Environmental Research Letters* 8:(1)1–18.

Clean Energy Policies Are Reducing Colorado's Energy-Related Water Demands

Several recent policies and trends in the energy sector have reduced Colorado's energy-related water demands and likely will continue reducing the sector's water needs in the future. For example:

- **Colorado energy policies have retired water-intensive plants**. The Clean Air–Clean Jobs Act, passed by the Colorado Legislature in 2010, established a path for Xcel Energy and Black Hills Electric to retire several older coal-fired units and replace them with natural gas capacity and other cleaner resources. Because combined cycle gas plants are more water efficient than coal-fired steam plants, this shift will reduce total annual water needs for power plants in the state by over 5,000 AF by 2018.

- **Major Colorado utilities' new plants will use less water**. Xcel Energy and Colorado's other major electricity utilities have no plans to develop new, water-intensive coal- or nuclear-steam plants, according to the integrated resource plans that utilities file with the Colorado Public Utilities Commission and other entities. Xcel Energy serves approximately 60% of the state's electricity load; the utility's future resource plans focus on increasing generation from renewable energy sources (primarily wind) and new combined cycle gas plants. This is driven by numerous factors, including the price of natural gas and the price of renewable energy resources. Across the state, the "baseline" or "reference case" energy scenarios reported in the most recent publicly available resource plans of the major utilities indicate that carbon dioxide emissions in the state will decline. Because carbon-intensive plants are generally more water-intensive, the reduction in carbon dioxide emissions also translates into water use reductions.

- **Proposed federal regulations are promoting less carbon-intensive power, which translates to less water-intensive energy**. Federal regulations may further reduce the amount of water used by the energy sector in the future. In June of 2014,

the Environmental Protection Agency released draft regulations for greenhouse gas emissions from existing power plants. These regulations will reduce greenhouse gas emissions from the existing fleet of power plants; the rule allows states significant flexibility in implementation, but will likely reduce future electricity generation at the most carbon-intensive and water-intensive thermoelectric power plants. Reducing electricity generation at a power plant would lessen the amount of water used at a plant, further reducing the state's future water-energy needs.

Given these factors, the statewide trend for water demands for electricity generation in Colorado will remain flat or decline in the future.

FIGURE Nº 1 WATER USE FOR ENERGY GENERATION VARIES BY FUEL SOURCE AND TECHNOLOGY.

Water used for electricity generation varies, depending on the fuel source and technology employed. The water used for renewable energy sources adopted in Colorado, including wind and solar photovoltaics, is minimal. Conventional coal, nuclear, and wet-cooled concentrating solar power use the largest amounts of water on a per-megawatt hour basis. The "life cycle" reflects the full lifespan of an energy generating facility (i.e., a power plant, wind turbine, or solar panel), including construction, fuel mining or drilling, and electricity generation. Figure adapted from Meldrum et al, 2013 (Figure 4).

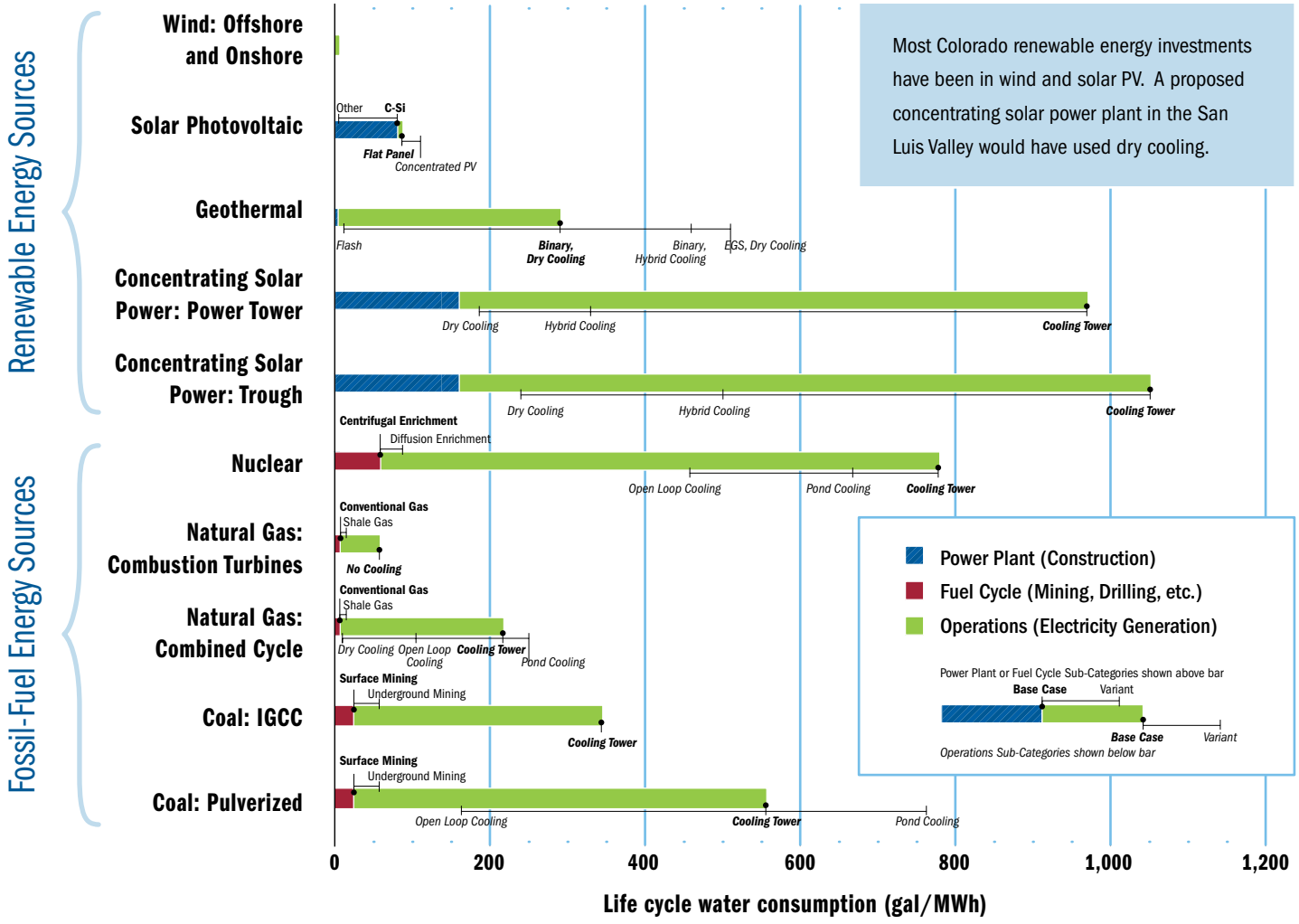


TABLE Nº 1 THE WATER USED BY POWER PLANTS IS DECLINING DUE TO CLEAN ENERGY POLICIES.

Power plants in Colorado consumed approximately 64,000 AF/year in 2012. Clean energy policies, such as in Colorado's Clean Air–Clean Jobs Act and Renewable Energy Standard, have saved water in the state and will continue to reduce the energy sector's water needs in the future. The water use—and water savings—are in river basins throughout the state.

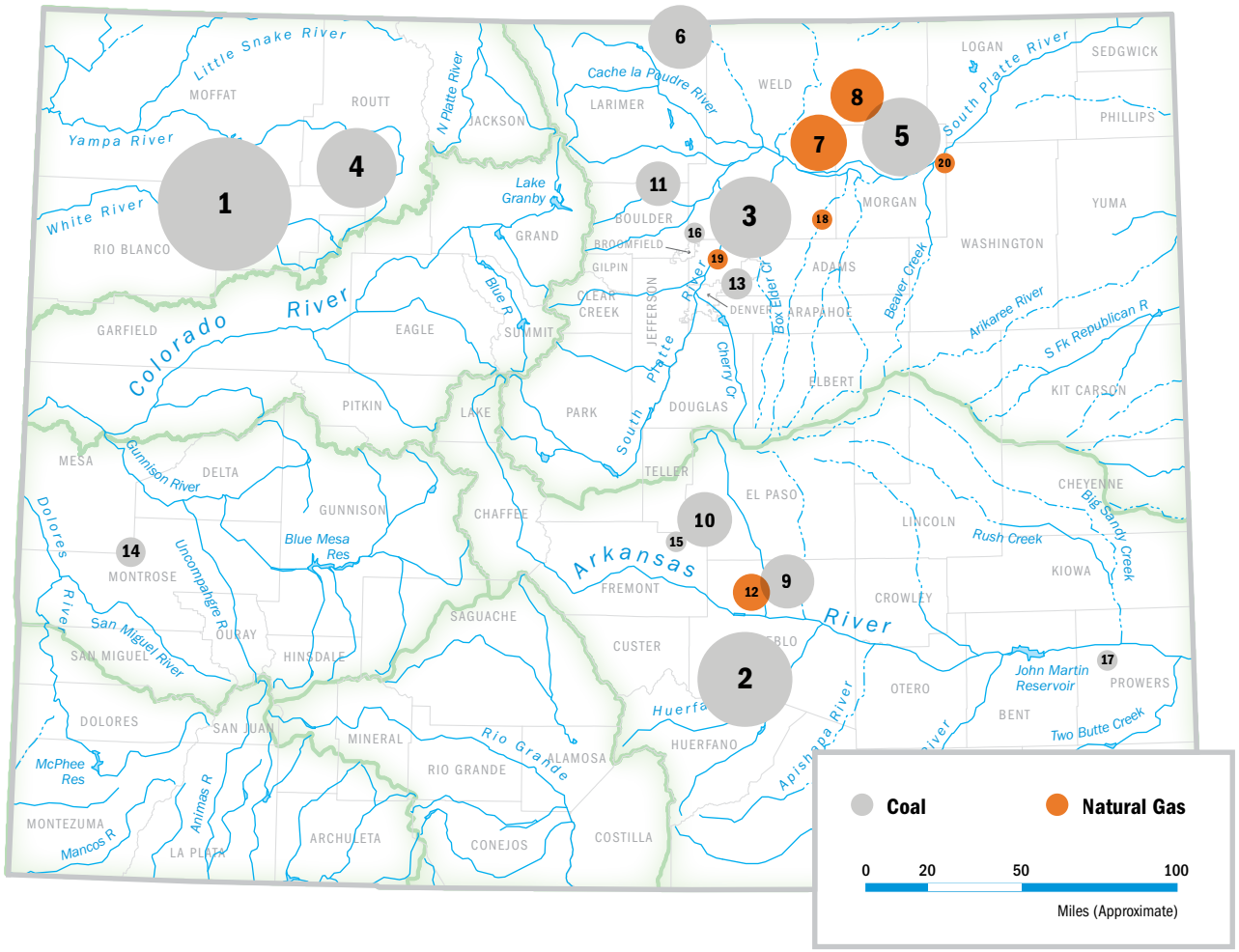
Ref. #	Plant	Basin	Primary Fuel Source	Water Use (AF/year)	Estimated Water Savings from Clean Energy Policies (AF/year)	Notes
1	Craig Station	Yampa	coal	16,400		
2	Comanche Generating Station	Arkansas	coal	8,200		
3	Cherokee Generating Station	South Platte	coal	6,300	6,300*	Cherokee 1, 2, and 3 will be closed by 2015; Cherokee 4 will be fuel-switched to natural gas by 2017. * A portion of the water savings will be displaced by generation at a new combined cycle gas plant at the Cherokee site.
4	Hayden Generating Station	Yampa	coal	5,900		
5	Pawnee Generating Station	South Platte	coal	5,700		
6	Rawhide Energy Station	South Platte	coal	3,700		
7	Fort St. Vrain Generating Station	South Platte	natural gas	3,000		
8	Rocky Mountain Energy Center	South Platte	natural gas	2,900		
9	Ray D. Nixon Power Plant	Arkansas	coal	2,800		
10	Martin Drake Power Plant	Arkansas	coal	2,700		
11	Valmont Generating Station	South Platte	coal	1,900	1,900	Valmont will be closed in 2017 as part of the Clean Air–Clean Jobs Act.
12	Front Range Power Plant	Arkansas	natural gas	1,300		
13	Arapahoe Plant	South Platte	coal	1,000	1,000	Arapahoe Units 3 and 4 were retired in 2013 as part of the Clean Air–Clean Jobs Act.
14	Nucla Station	Colorado	coal	800		
15	W.N. Clark Station	Arkansas	coal	400	400	W.N. Clark was retired in 2014 as part of the Clean Air–Clean Jobs Act.
16	Colorado Energy Nations	South Platte	coal	300		
17	Lamar Power Plant	Arkansas	coal	200		
18	J.M. Shafer Generating Station	South Platte	natural gas	200		
19	Arapahoe Combustion Turbines	South Platte	natural gas	100		
20	Brush Generation Facility	South Platte	natural gas	100		
	Existing Renewable Energy				5,600	
Total 2012 Water Use and Expected Savings from Clean Energy Policies				**63,900**	**15,200**	
Additional Water Savings from Planned New Renewable Energy Development (in 2030)					7,200	
Additional Water Savings from Planned Energy Efficiency (in 2030)					4,200	

Significant Opportunities for Reducing the Water Used for Energy

The interdependency of energy and water highlights additional opportunities to advance policies that can reduce Colorado's future energy-related water demands. Policies that reduce the energy sector's future water needs can "free up" water for other sectors in the state—including municipal, agricultural, recreational, and environmental needs. Water managers can work with energy utilities, the Colorado Energy Office, state legislators, and other decision-makers to advance clean energy policies.

FIGURE Nº 2 COLORADO'S THERMOELECTRIC POWER PLANTS USE WATER IN ALMOST EVERY RIVER BASIN.

Power plants in the state use water in almost every river basin, with energy from these plants serving customers across the state. Circles are located approximately where power plants are located; the size of circles corresponds to the estimated annual water use of the plant. The number in each circle can be used to identify the plant in the list in Table 1.



Data sources: (1) Electricity generation data from U.S. Department of Energy, Energy Information Administration. 2011. 2010 EIA-923 Monthly Time Series File Boiler Fuel Consumption/Generating Unit Net Generation Sources: EIA-923 Schedules 3A and 5A, and EIA-860. (2) Water intensity data sources summarized in Western Resource Advocates. 2012. *A Powerful Thirst: Managing the Electricity Sector's Water Needs and the Risk of Drought*, Table 1. Boulder, Colo.

Smart policies that drive both water and energy savings include:

- ✓ Advancing energy efficiency, renewable energy, and other clean energy policies that also reduce future water needs for energy beyond the reductions already likely to occur. Energy efficiency uses no water. Renewable energy in Colorado is primarily from wind and solar photovoltaics, and uses no water.
- ✓ Promoting small and distributed generation, such as in-conduit hydropower (which can be installed in municipal water supply systems and agricultural ditch systems), to meet a portion of future energy needs. Such generation does not consume water supplies.
- ✓ Supporting cities' adoption of new efficient standards for indoor appliances and landscaping ordinances for new developments to reduce the water and energy used by customers, as well as the energy used "upstream" of the customer to pump, treat, and distribute potable supplies.

With the energy policies in place today, Colorado's electricity sector will likely see flat or declining water needs in the future.

Colorado has shown strong leadership in advancing clean energy policies. While the air quality benefits of these policies have long been evident, they have also led to important water supply benefits. In fact, with the energy policies in place today, Colorado's electricity sector will likely see flat or declining water needs in the future. Given this trend, the Colorado Water Plan and Basin Implementation Plans should accurately assess the future water use for energy generation, and note the water benefits of advancing additional clean energy and energy-efficiency policies.

The amount of energy needed to provide water is also significant.

An estimated 13% of our nation's energy use is embedded in water use,* a figure that may be even higher in some Western states where long-distance water transfers consume large amounts of energy. The amount of energy embedded in water use depends on the source and quality of water. For example, groundwater pumped from deep aquifers, surface water pumped over long distances, and lower-quality water (requiring more treatment) all require more significant amounts of energy than local, high-quality surface water. On the customer's end, heating water in homes and businesses generally requires the most significant amounts of energy.

Programs that increase water efficiency, such as leak detection, innovative financing mechanisms for water conservation (similar to Energy Performance Contracting and ClimateSmart loan programs), and agricultural efficiency programs, may provide valuable energy and water savings.

* Sanders, K. and M. Webber. 2012. "Evaluating the Energy Consumed for Water Use in the United States." *Environmental Research Letters* 7(3):1–11.

WESTERN RESOURCE ADVOCATES

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

Western Resource Advocates

2260 Baseline Road, Suite 200
Boulder, CO 80302
Tel: (303) 444-1188 Fax: (720) 786-8054

www.westernresourceadvocates.org

© Copyright September 2014