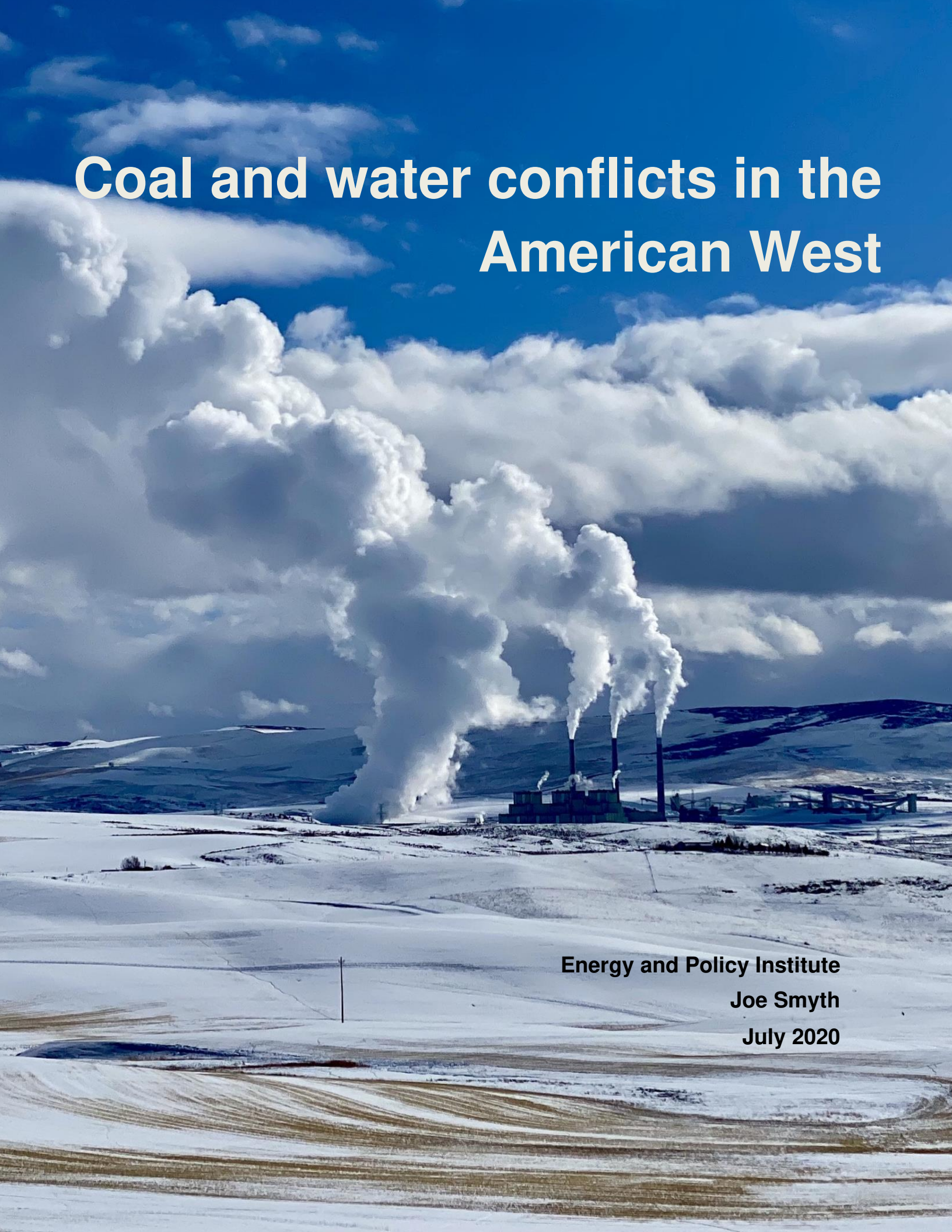
Coal and water conflicts in the American West



Energy and Policy Institute

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Executive summary

Burning coal to generate electricity consumes large quantities of water, which exposes the electric utilities that operate coal plants to water supply risks. Large coal plants consume millions of gallons of water each day, which can also lead to legal disputes and conflicts with other water users, increased costs when water supplies are disrupted, and other challenges. Those water conflicts and risks are magnified in the American West, where water supplies are already scarce and increasingly threatened by persistent drought and hotter temperatures driven by climate change.

Several utilities have recently announced plans to close coal plants that they operate in order to reduce costs and meet the expectations of their customers, regulators, and investors for a cleaner power supply. Those closures will free up large quantities of water, creating potential economic and environmental benefits while also raising questions among communities, utilities, and regulators over the fate of that newly available water.

Still, many coal plants in the Western U.S. do not yet have clear closure plans, and the utilities that operate them will continue to face water supply risks and conflicts.

Recent reports by Moody's Investors Service and BlackRock have highlighted the growing risks of climate change impacts to electric utilities and the power plants they operate, including water supply risks and drought. Major electric utilities also acknowledge those risks; in filings with the Securities and Exchange Commission, the largest electric utilities and coal plant operators in the Western United States - including Xcel Energy, PNM, Arizona Public Service Company, Pacificorp, Talen Energy, and Tri-State Generation and Transmission Association - reported that drought in the region could disrupt water supplies consumed by their coal plants. Utilities that don't disclose risks in SEC filings, like Basin Electric and Arizona G&T Cooperatives, have nevertheless faced water supply challenges at their coal plants.

Some parties propose keeping coal plants online by installing infrastructure to capture their carbon emissions. Carbon capture infrastructure nearly doubles the water consumption of a coal plant, significantly increasing the water supply risks for companies that pursue carbon capture instead of closing coal plants.

This report explores the water supply risks facing coal plants in the American West, and the conflicts and legal disputes over water that have already arisen between communities and the utilities that operate coal plants. We show how much water each coal plant in the Western U.S. consumed in recent years, and estimate how much more water each will consume until its closure. And we discuss key water supply risks facing particular coal plants in the American West, based on documents filed with the SEC and state utility regulators, annual reports, local news articles, and correspondence with utilities in the region. Those include legal disputes over water rights between Native American communities and utilities, increased water needs of a carbon capture proposal in New Mexico, groundwater consumption by coal plants in Arizona, the impacts of drought on coal plants in Colorado, Montana, and Wyoming, and more.

Cumulatively, 30 coal plants in Arizona, New Mexico, Colorado, Utah, Nevada, Montana, and Wyoming consumed 370,555,000,000 gallons of water between 2014 and 2018, according to data published by the Energy Information Agency (EIA). On average, that amounts to more than 76 billion gallons of water each year, or 208 million gallons each day. Coal capacity owned by Pacificorp consumed over 102 billion gallons of water between 2014 and 2018, 27% of the total and the most of any utility in the region.

Combining coal unit water consumption data with coal unit closure dates (announced as of July 2020) shows that coal plants in the Western U.S. could consume 886 billion gallons of water between 2020 and 2040. That figure could be reduced as more utilities announce additional coal plant closures, close coal units before their scheduled retirement dates, and operate coal plants less often.

Most coal plants in the Western U.S. consume surface water, including from the Colorado River, Yellowstone River, Green River, San Juan River, Laramie River, North Platte River, Arkansas River, Yampa River, San Miguel River, Cottonwood Creek, Sevier River, Huntington Creek, Hams Fork River, and the Bighorn River.

Nine coal plants consume groundwater, including in Arizona, Colorado, New Mexico, and Nevada, a practice that is rare outside of the Southwest. Two coal plants in Colorado consume reclaimed municipal water, which reduces but does not eliminate water supply risks. Three coal plants in Wyoming use dry cooling systems instead of water-cooled systems, which reduces water consumption but increases costs and air pollution.

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Introduction

When the CEO of a coal-heavy utility announced plans to close coal plants in Colorado and New Mexico, he spoke about the importance of developing a community transition plan, the cost savings of new wind and solar projects - and the enormous amount of water that will be "liberated" after the coal plants close.

At a January 2020 press conference announcing the coal plant closures, Tri-State Generation and Transmission Association CEO Duane Highley said:

As you might imagine, water is pretty important, and the moment we announced this plan we have had numerous outreach from folks that have interest in reuse of that water or rights to that water. That will be work of our board going forward to figure out how exactly that gets dealt with. I'll say it presents an enormous opportunity for all of us, as we think about it. When you look at a typical coal facility it uses an enormous volume of water, and the fact that that will be liberated, available for other reuse, is going to be significant.

Coal plants consume large amounts of water, so closures will make significant amounts of water newly available for other uses. That is particularly important in the arid Western United States, especially as communities in the region navigate an historic "megadrought" made worse by climate change. In addition to reduced rain and snow, warmer temperatures are also driving a "longer-term trend toward greater aridification" of the region, by increasing evaporation, drying soils, and accelerating snow melt. Those hotter and drier conditions, along with overuse, mean that western states will be forced to reduce water diversions from the Colorado River for the first time this year.

With several coal plants scheduled to close over the next decade, the cumulative water savings will be significant. Eric Kuhn, the former general manager of the Colorado River Water Conservation District, pointed to the Bureau of Reclamation's Consumptive Uses and Losses Report showing that power plants in the Upper Colorado River Basin used 162,000 acre-feet of water (52.8 billion gallons) per year on average, from 1991-2018. In a March 2020 article, Could water from retiring coal plants help solve the Upper Colorado River Basin's "demand management" problem?, Kuhn noted:

160,000 acre-feet of consumptive use per year is actually a lot of water... Water efficient cities such as Las Vegas or Phoenix could serve more than 1.5 million people with this amount of water. It's over half of Nevada's use from Lake Mead and close to half of the average annual use of the upper states of New Mexico and Wyoming.

But many coal plants in the Western U.S. are not scheduled to close anytime soon. A review by the Los Angeles Times in February 2020 found that "a handful of western utilities continue to operate coal plants with no plans to decommission them, defying economic and political headwinds." That will lead to increased water supply risks for those coal plants, as well as

conflicts over water between the utilities that own and operate those coal plants, and the communities, tribes, farmers, and others that depend on water in an increasingly arid region.

In fact, water supply risks and conflict are already impacting some coal plants and utilities in the region. Xcel Energy subsidiary Southwestern Public Service, which sells power to customers in New Mexico and Texas, plans to close its Tolk coal plant in the Texas panhandle because it doesn't expect to be able to continue to pump groundwater from the depleted Ogallala Aquifer. Other coal plant operators in western states have faced legal disputes over their access to water, increased costs for alternative water supplies during droughts, and other water supply risks. Drought conditions have also sometimes forced communities to curtail their water use from rivers, even as coal plants continued to consume millions of gallons of water each day from the same sources.

Electric utilities use enormous amounts of water to operate coal plants

Nationally, electric utilities withdraw tens of billions of gallons of water each day to generate electricity at coal plants.

U.S. Geological Survey data show that thermoelectric power plants account for 48% of all fresh surface-water withdrawals, the largest of any category. And coal plants accounted for 67% of all thermoelectric power plants' total water withdrawals in 2008, according to "Freshwater Use by U.S. Power Plants," a report of the Energy and Water in a Warming World Initiative (EW3).

However, it's important to distinguish between water *withdrawals* and water *consumption*, which vary based on the types of cooling systems used at power plants. Some coal plants in the U.S. use "once-through" cooling systems, which withdraw very large quantities of water, but consume only a small portion of that water, while the rest is returned (at higher temperatures) to the body of water from which it was withdrawn. Once-through cooling systems accounted for about 75% of water withdrawals by power plants, according to a May 2018 study published in *Environmental Science and Technology* by the American Chemical Society, "Water Use in the United States Energy System: A National Assessment and Unit Process Inventory of Water Consumption and Withdrawals."

In contrast, "recirculating" cooling systems withdraw far less water than once-through systems, but consume much more water because of higher rates of evaporation as water is recirculated in cooling towers or ponds. In the Western U.S., most power plants use recirculating cooling systems because water is more scarce; ironically, that means western power plants also end up consuming more water. Only one of the 30 coal plants assessed in this report, the Dave Johnston plant in Wyoming, uses a once-through cooling system.

In addition to accounting for two-thirds of thermoelectric power plants' total water withdrawals, coal plants also accounted for 65% of all thermoelectric power plants' total water consumption in 2008, according to the EW3 report.

Water withdrawal and consumption data are both important for understanding the water supply risks and conflicts facing power plants. For example, water consumption data is important for understanding how much water a power plant uses that is no longer available for other uses. Water withdrawal data is important for understanding how much water a power plant needs to operate, and so could be forced to stop or reduce operations if that quantity of water is not available.

The Energy Information Agency reports both water withdrawal and water consumption data for power plants, in data tables released each year as well as in a beta version of its electricity browser.

For this report, we compiled EIA water *consumption* data for each coal plant in the Western U.S. We report the amount of water consumed by each coal plant between 2014 and 2018 (the most recent year available), and use those figures to calculate the average annual and daily water consumption during that five-year period. And we estimate how much water each coal plant will consume until the year it is scheduled to close, if it continues to consume water at a similar rate. For coal plants without a closure date, we estimate water consumption until 2040. Water consumption figures for specific coal plants, along with state totals, are reported in the sections below. A table with figures for each coal plant is included at the end of this report.

Importantly, water *consumption* figures reported by the EIA represent only a portion of the water that could become available for other uses when a coal plant closes. Coal plants withdraw more water than they consume, and the water rights associated with a coal plant are likely higher still. In some cases, water rights associated with a coal plant may far exceed how much water that plant consumed, such as if a utility retains water rights sufficient to expand a power plant in the future.

Cumulatively, coal plants currently operating in Arizona, New Mexico, Colorado, Utah, Nevada, Montana, and Wyoming consumed 370,555,000,000 gallons of water during the five year period between 2014 and 2018. That amounts to an average of more than 76 billion gallons of water each year, or 208 million gallons each day.

If those coal plants with closure dates close as scheduled, and coal plants without closure dates continue to operate, coal plants in the Western U.S. will consume an estimated 886 billion gallons of water by 2040.

That estimate is indicative of the amount of water that would be consumed if those coal plants continued to operate at similar levels as from 2014 to 2018, and no more plants are scheduled for closure before 2040. In reality, more coal plants in the Western U.S. will likely face early closures, as more utilities in the region recognize the opportunities to reduce costs and increase

earnings by replacing coal with renewable energy, concerns grow about air and water pollution from burning and mining coal, and state regulators and policymakers enact policies to address climate change. Utilities may also operate coal plants less often, which would reduce their water consumption in the remaining years that they do operate. Finally, utilities may end up closing coal units earlier than their scheduled closure dates.

Financial analysts and government reports warn of drought risks to power plants

Recent reports by Moody's Investors Service and BlackRock have focused on the growing climate risks to electric utilities and power plants, including water supply risks and drought.

In a January 2020 report, Moody's Investors Service looked at the intensifying climate risks facing electric utilities in the U.S., including heat stress, water stress, extreme rainfall and flooding, and hurricanes. The Moody's report emphasized that utilities in the Western U.S. are most exposed to water stress:

The Rocky Mountain states, the Colorado River region and California are most exposed to water stress – that is, the extent to which demand for water outstrips the availability of water based on expected precipitation levels, as shown in Exhibit 4. Thermoelectric power generation is the largest US consumer of freshwater. For electric utilities, water stress is generally credit negative because of the critical role that water plays in the economy and in cooling power plants.

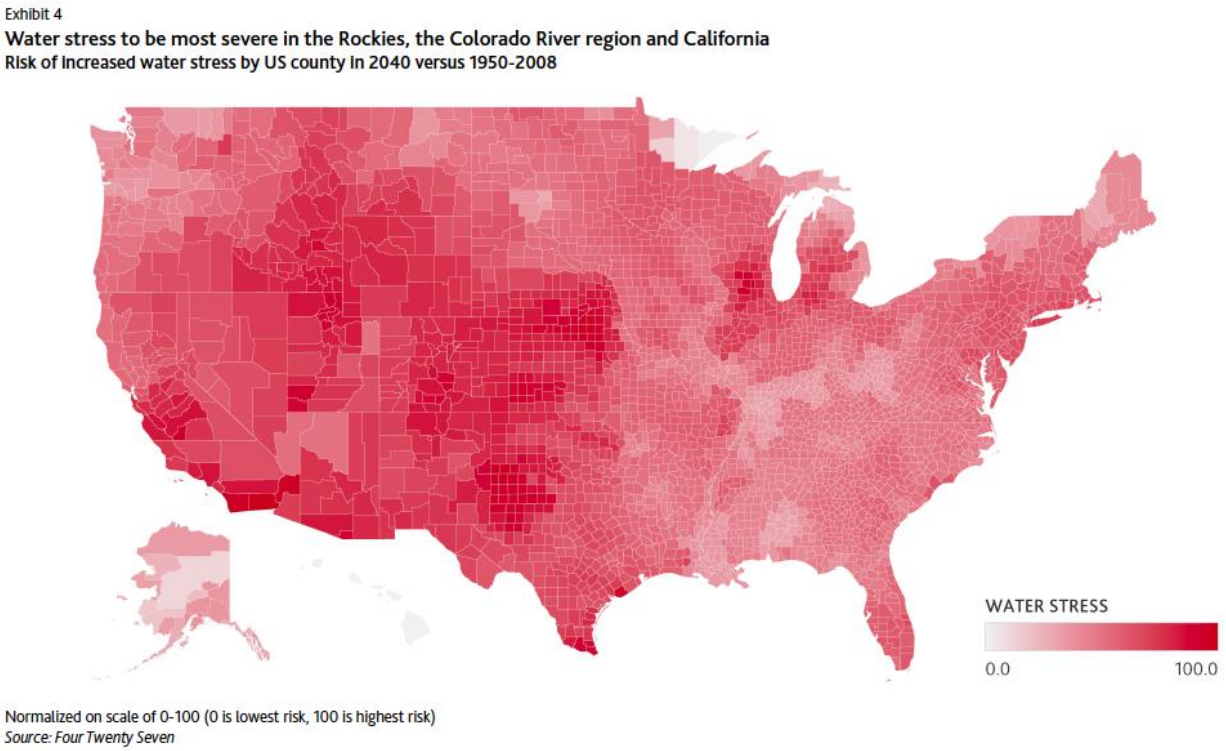


Image from Moody's Investors Service January 2020 report, "US regulated electric utilities face varied exposure to climate hazards"

Moody's also noted: "However, these same regions benefit from robust wind and solar generation resources, which use little to no water to produce power."

A 2019 report by BlackRock assessed the climate risks to electric utilities and the power plants they operate, and found that "climate-related risks are real for utilities, but mostly not priced in." It also noted power plants fueled by coal and gas face more types of climate risks than other power generation facilities:

We see gas (35% of total U.S. generation capacity according to 2018 EIA data) and coal-fired power plants (27%) as exposed to a broader swath of climate risks, including wildfires, high temperatures, floods and drought.

Reports published by the federal government have also warned of the risks of drought to power plants. A 2016 report by the U.S. Department of Energy on Climate Change and the Electricity Sector noted that "warmer water temperatures and reduced water availability for cooling at thermoelectric facilities could reduce generation capacity." The Fourth National Climate Assessment, published in 2018, concluded:

The ability of hydropower and fossil fuel electricity generation to meet growing energy use in the Southwest is decreasing as a result of drought and rising temperatures. Many renewable energy sources offer increased electricity reliability, lower water intensity of energy generation, reduced greenhouse gas emissions, and new economic opportunities.

Electric utilities in the Western U.S. warn investors of drought risks to coal plants

In addition to analysts' warnings, major electric utilities in the Western U.S. themselves also warn investors of the water supply risks of drought to the coal plants they operate, and most acknowledge that climate change will exacerbate those risks. Reports filed with the Securities and Exchange Commission show that the largest electric utilities in Arizona, New Mexico, Colorado, Nevada, Utah, and Wyoming, and the operator of the largest coal plant in Montana, all reported that drought in the Western U.S. could disrupt water supplies used by their power plants. Utilities warned that drought and water supply risks to coal plants could increase costs for the utility and electricity consumers, make it difficult or impossible to generate electricity, and could harm utilities' financial conditions. Many also noted the risks of legal disputes over water.

New Mexico's largest utility, PNM, reported extensively in its 2019 10-K about water risks, including to coal plants that it plans to close (San Juan Generating Station, or "SJGS") or exit (Four Corners):

Assured supplies of water are important for PNM's generating plants. Drought conditions in New Mexico, especially in the "four corners" region, where SJGS and Four Corners are located, may affect the water supply for PNM's generating plants. If inadequate precipitation occurs in the watershed that supplies that region, PNM may have to decrease generation at these plants. This would require PNM to purchase power to serve customers and/or reduce the ability to sell excess power on the wholesale market and reduce revenues. Drought conditions or actions taken by the court system, regulators, or legislators could limit PNM's supply of water, which would adversely impact PNM's business.

Pinnacle West, the parent company of Arizona's largest utility Arizona Public Service Company, noted in its 2019 10-K that climate change impacts in the southwestern U.S. are projected to "exacerbate prolonged drought conditions leading to the declining availability of water resources," and warned about the potential impacts to its thermal power plants:

Decrease in snowpack can also lead to reduced water supplies in the areas where APS relies upon non-renewable water resources to supply cooling and process water for electricity generation. Prolonged and extreme drought conditions can also affect APS's long-term ability to access the water resources necessary for thermal electricity generation operations. Reductions in the availability of water for power plant cooling could negatively impact APS's financial condition, results of operations or cash flows.

Berkshire Hathaway Energy, the parent company of Pacificorp, the largest utility in Utah and Wyoming, and NV Energy, the largest utility in Nevada, reported in its 2019 10-K that "Climate change may cause physical and financial risk," including:

Availability of resources to generate electricity, such as water for hydroelectric production and cooling purposes, may also be impacted by climate change and could influence the Registrants' existing and future electricity generating portfolio. These issues may have a direct impact on the costs of electricity production and increase the price customers pay or their demand for electricity.

Tri-State Generation and Transmission Association, which sells power to electric cooperatives in Colorado, New Mexico, Wyoming, and Nebraska, reported in its 2019 10-K:

Our generating facilities are located in the western part of the United States where demand for available water supplies is heavy, particularly in drought conditions. Litigation and disputes over water supplies are common and sometimes protracted, which can lead to uncertainty regarding any user's rights to available water supplies. If we become subject to adverse determinations in water rights litigation or to persistent drought conditions, we could be forced to acquire additional water supplies or to curtail generation at our facilities.

Xcel Energy, the largest electric utility in Colorado, warned in its 2019 10-K that "We are subject to physical and financial risks associated with climate change," including:

Drought or water depletion could adversely impact our ability to provide electricity to customers, cause early retirement of units and increase the price paid for energy. We may not recover all costs related to mitigating these physical and financial risks.

Talen Energy, which operates the Colstrip Station in Montana, does not file a 10-K report but noted in a 2015 prospectus filed with SEC:

Climate change could also affect the availability of a secure and economical supply of water in some locations, which is essential for the continued operation of our generation plants.

Tucson Electric Power, which operates the Springerville Generating Station in Arizona, also highlighted in its 2020 Integrated Resource Plan:

Water availability is a major issue for utilities operating power plants or planning new resources in the Desert Southwest. For facilities already in operation, utilities need to be cognizant of water use and supply trends in the area immediately surrounding those facilities. While existing facilities have likely secured the legal rights to the water needed for operation, there can be a disconnect between the legal right to water and its physical availability. For this reason, technologies, and strategies to decrease power plant water use can become an important planning goal within the integrated resource planning process. The most effective means of reducing power plant water use is through transitioning to a lower water use generating resource.

In its announcement that it will end its use of coal and replace that generation with renewable energy, energy storage, and energy efficiency, Tucson Electric Power highlighted that its plan will not only reduce emissions, but also eliminate surface water use and reduce groundwater use by 70%.

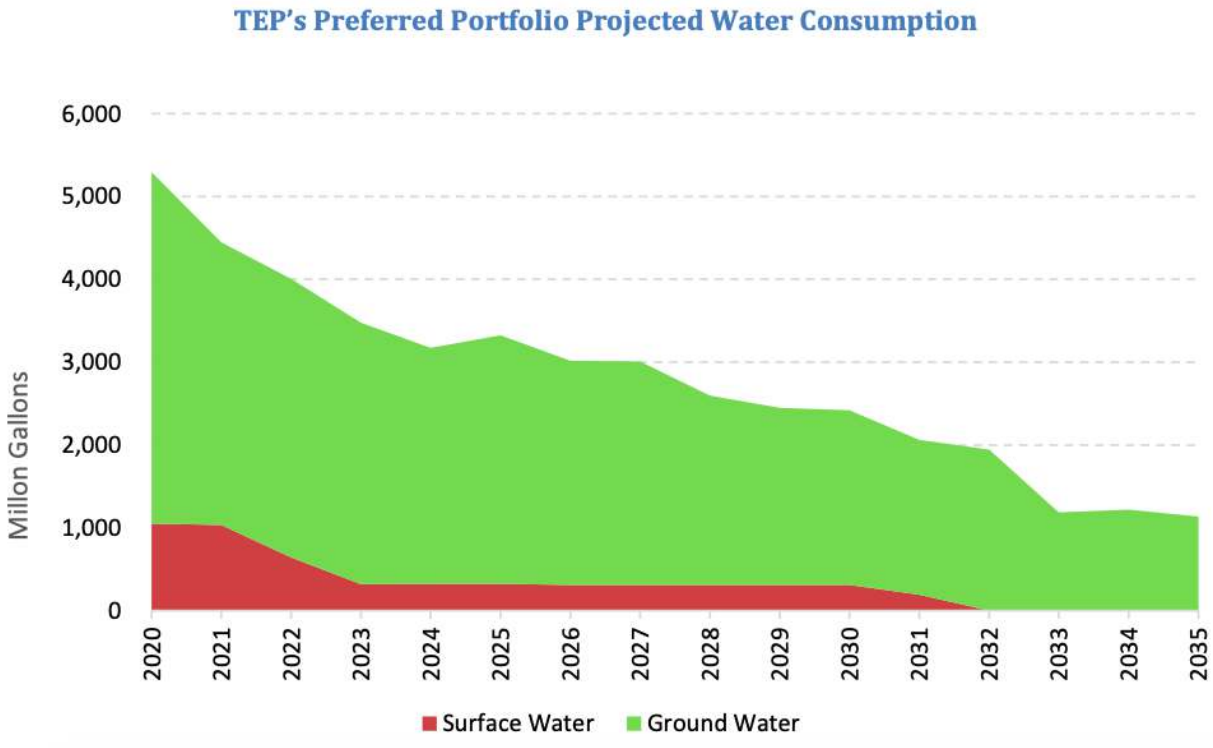


Image from Tucson Electric Power 2020 Integrated Resource Plan

Carbon capture infrastructure would nearly double water consumed by coal plants

While closing coal plants promises to free up water for other needs, installing carbon capture infrastructure on coal plants would nearly double the plants' water consumption, dramatically increasing their water supply risks.

A study on the water impacts of carbon capture and sequestration published in *Energy, Sustainability and Society* notes that "water use (consumption or withdrawals) is almost doubled when a power plant becomes equipped with a CCS technology," and explains:

CCS installations are expected to impose new water stresses due to additional water requirements for chemical and physical processes to capture and separate CO2. In addition to these processes, the parasitic loads imposed by carbon capture on power plants will reduce their efficiency and thus require more water for cooling the plant.

A study by the American Chemical Society, "Water Use at Pulverized Coal Power Plants with Postcombustion Carbon Capture and Storage," determined that "The addition of an amine-based CCS system would approximately double the consumptive water use of the plant."

A study published in *Environmental Research Letters,* "Life cycle water use for electricity generation: a review and harmonization of literature estimates," also found that CCS could nearly double water needs of coal plants:

Carbon capture and sequestration (CCS) can increase operations water consumption by about 75% and water withdrawal by between and 64% and 97%, due to a combination of lower efficiencies and additional process demands for certain CCS technologies.

Carbon capture infrastructure is particularly water intensive when used at coal plants. A study comparing the life-cycle water consumption of coal and gas fired power plants in Texas, published in *Environmental Research Letters*, shows that installing carbon capture infrastructure would increase cooling water consumption by 95% for coal plants, compared to 75% for gas plants. Installing carbon capture at coal plants would also increase the amount of water used to mine coal by 43%, because carbon capture processes use a portion of the coal plant's steam and so require burning more coal to generate the same amount of electricity.

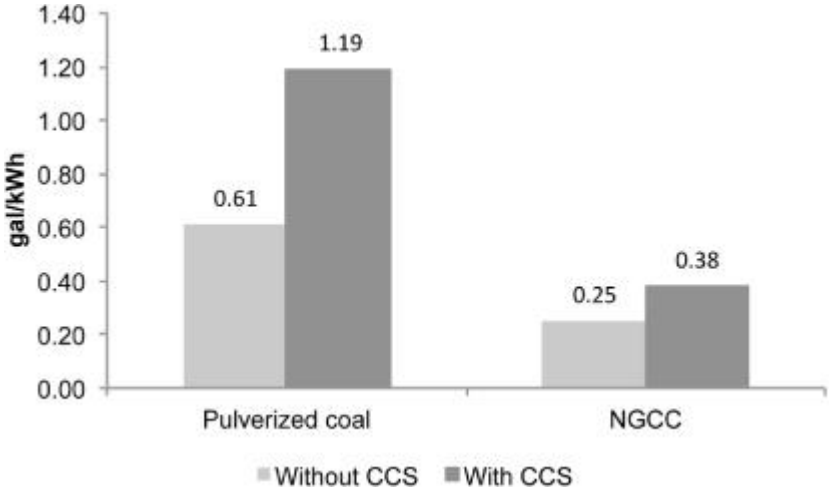


Chart showing increased water consumption of carbon capture infrastructure when applied to coal plants and natural gas combined cycle (NGCC) plants, from "Can switching fuels save water? A life cycle quantification of freshwater consumption for Texas coal- and natural gas-fired electricity," Environmental Research Letters, October 2012

The increased water needs of carbon capture infrastructure mean that adding CCS to coal plants would further exacerbate their impacts on water resources, according to a study published in *Nature Sustainability*, "Hydrological limits to carbon capture and storage."

That study also found that, even before the addition of carbon capture infrastructure, 60% of the water-cooled coal plant capacity in the U.S. faces water scarcity for at least one month per year, with similar figures for coal plants in China and India. Water scarcity affects some of those coal plants for half the year or more: "In the United States, at least 20% of [coal-fired power plant] capacity faces water scarcity from April to November."

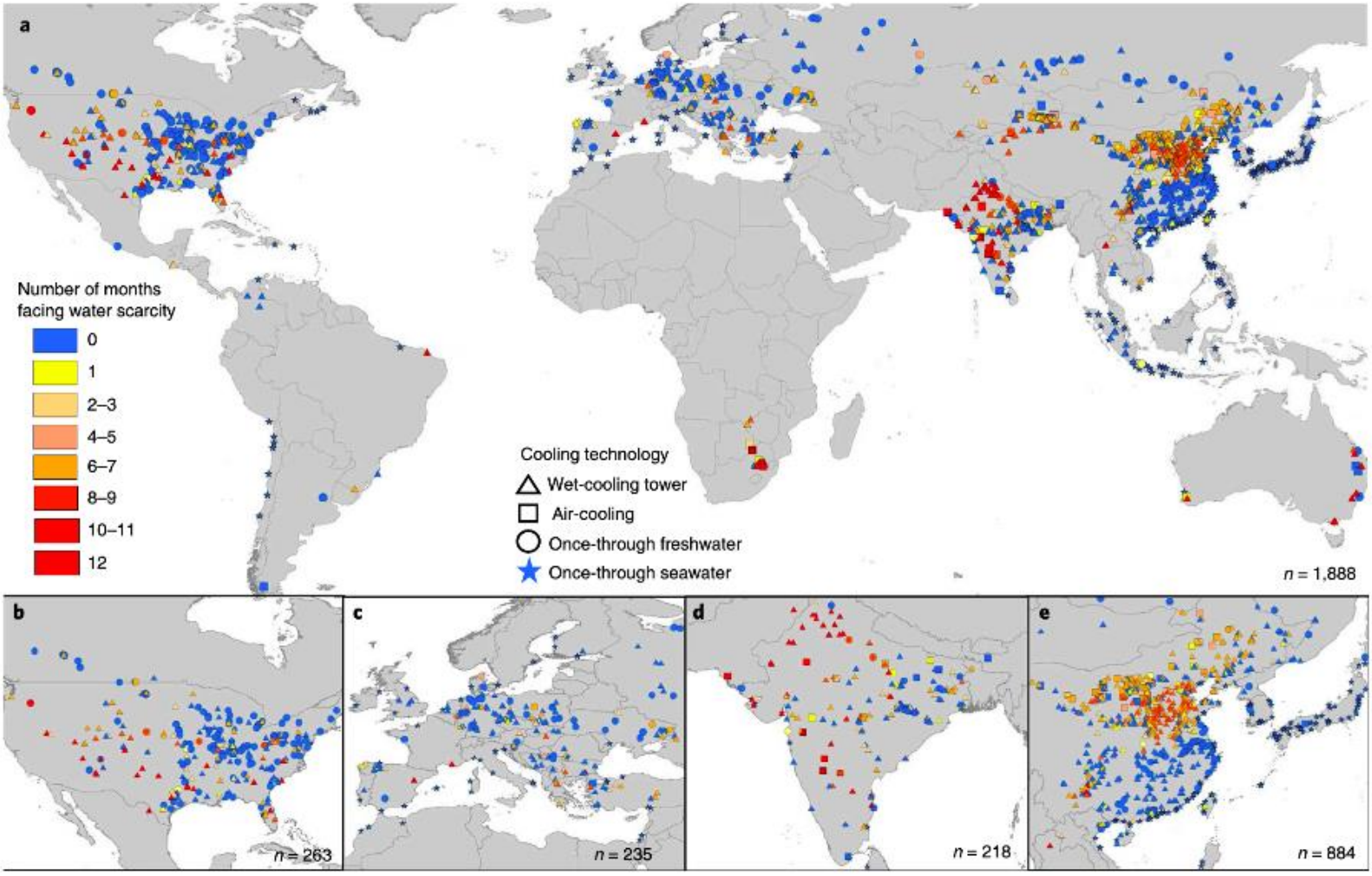


Fig. 1 | Geospatial distribution of coal-fired plants facing water scarcity in the 2011–2015 period. a, Location, number of months per year facing water scarcity and cooling technology of 1,888 coal-fired plants (*n*) worldwide. **b–e**, The four main regions where CFPPs are located: United States (**b**), Europe (**c**), India (**d**) and China (**e**). CFPPs facing water scarcity appear either in intensively irrigated areas (for example, high plains in the United States), in regions with high population densities (Pretoria, Johannesburg conurbations), or in irrigated and populated areas (North China Plain, India). Water scarcity also occurs in arid regions with a well-defined dry season (western United States, India, Australia, and Xinxiang and Inner Mongolia provinces in China). Generating units with once-through cooling are shown, distinguishing between the use of seawater and freshwater as the cooling medium.

Image from "Hydrological limits to carbon capture and storage," Nature Sustainability, May 2020

Water supply risks facing coal plants in the American West

The sections below discuss key water supply risks facing particular coal plants in the American West, including groundwater consumption by coal plants in Arizona, legal disputes over water rights between Native American communities and utilities, increased water consumption of a carbon capture proposal in New Mexico, the impacts of drought in Colorado, Montana, and Wyoming, and more. The sections are organized by state, but it's important to note that most of these issues are regional; coal plants located in one state are often owned by multiple utilities that sell power in neighboring states, coal plants consume water from rivers that flow through several states, and aridification driven by climate change is impacting water supplies throughout the entire region.

Arizona

Coal plants in Arizona consumed 70,766,000,000 gallons of water between 2014 and 2018, averaging 14.6 billion gallons each year or 40 million gallons each day.

Arizona coal plant water consumption data. All figures are in millions of gallons.

Coal plant name	Total water consumption 2014 - 2018	Average annual water consumption	Average daily water consumption	Water source	Closure date	Estimated water consumption 2020 - 2040/ closure date
Apache Station	590*	590	1.62	Groundwater	None	11,800
Cholla Power Plant	15,960	3,192	8.75	Groundwater	Unit 2: 2015 Unit 4: 2020 Units 1 & 3: 2025	8,512
Coronado Generating Station	11,395	2,279	6.24	Groundwater	2032	29,627
Navajo Generating Station	25,486	5,097	13.96	Colorado River (Lake Powell)	2019	--
Springerville Generating Station	17,335	3,467	9.50	Groundwater	Unit 1: 2027 Unit 2: 2032 Unit 3 & 4: None	53,512
Totals	70,766	14,625	40.07			103,451

**EIA only reports water consumption data for Apache Station in 2018, not earlier years.*

Navajo Generating Station closure could free up water for Native American communities

The Navajo Generating Station, which was the largest coal plant in Arizona and the Western U.S., closed in November 2019. Between 2014 and 2018, Navajo Generating Station consumed an average 14 million gallons each day from Lake Powell, more than any other coal plant in the state.

Navajo Generating Station consumed 14 million gallons of water each day from Lake Powell

The Arizona Mirror reported that the Navajo Generating Station closure leaves questions about water ownership:

Multiple sources told the Arizona Mirror that the future of the water formerly used to operate NGS, which will shut down in December, is uncertain. But the Navajo Nation has claimed it, along with the rest of Arizona's water from the Upper Colorado River Basin. Navajo Nation legal counsel said the history of discussions around the water that was used at NGS indicates that the water belongs to the Nation.

"When the NGS participants proposed a power plant that would use this water, they knew that it would be necessary to acquire the consent of the Navajo Nation to the use of the water by NGS, and they obtained various resolutions from the Navajo Tribal Council expressing the Nation's acquiescence to the use of the water by NGS," Stanley Pollack, a contract attorney for the Navajo Nation's Water Rights Unit, told the Mirror via email.

Multiple other entities could also lay claim to the water, including the Hopi Tribe and several nearby municipalities.

The water in question is the lion's share of Arizona's allotment from the Upper Colorado River Basin: 34,000 acre-feet per year, currently being drawn from the river via Lake Powell. That's enough to satisfy all of the municipal and industrial uses for all of Pinal County, according to Sarah Porter, director of Arizona State University's Kyl Center for Water Policy.

In addition to the water consumed by the Navajo Generating Station, Navajo Nation communities have also been impacted by decades of groundwater consumption for mining and transporting coal. Peabody Energy pumped around a billion gallons of groundwater each year from the Navajo Aquifer until 2005, to transport coal through a slurry pipeline, as well as at its Kayenta coal mine which supplied the Navajo Generating Station.

Native environmental groups including Black Mesa Water Coalition, Diné C.A.R.E., and Tó Nizhóní Áni ("Sacred Water Speaks") have outlined steps to help address the impacts of the legacy of coal extraction on Navajo Nation communities, including securing water rights and developing water projects:

Decades of coal strip-mining on Black Mesa depleted the N-Aquifer many times faster than its ability to recharge. Navajo Generating Station used tens of thousands of acre-feet of water from the Colorado for power that flowed over our communities' heads to faraway cities. Many Navajo families remained without running water.

With the closing of Kayenta Mine and Navajo Generating Station, we can begin to right the longstanding wrongs on water. The 50,000 acre-feet of Upper Basin Colorado water for NGS must return to Navajo people. Peabody and the Office of Surface Mining, Reclamation and Enforcement must see to the full reclamation of the N-Aquifer.

All coal plants operating in Arizona consume groundwater

Nationally, groundwater consumption by power plants is relatively rare, and nearly all occurs in the Southwest, according to the EW3 report. Most of the groundwater consumed by coal plants in the Southwest is pumped from aquifers in Arizona. Except for the Navajo Generating Station, every coal plant in Arizona consumes groundwater.

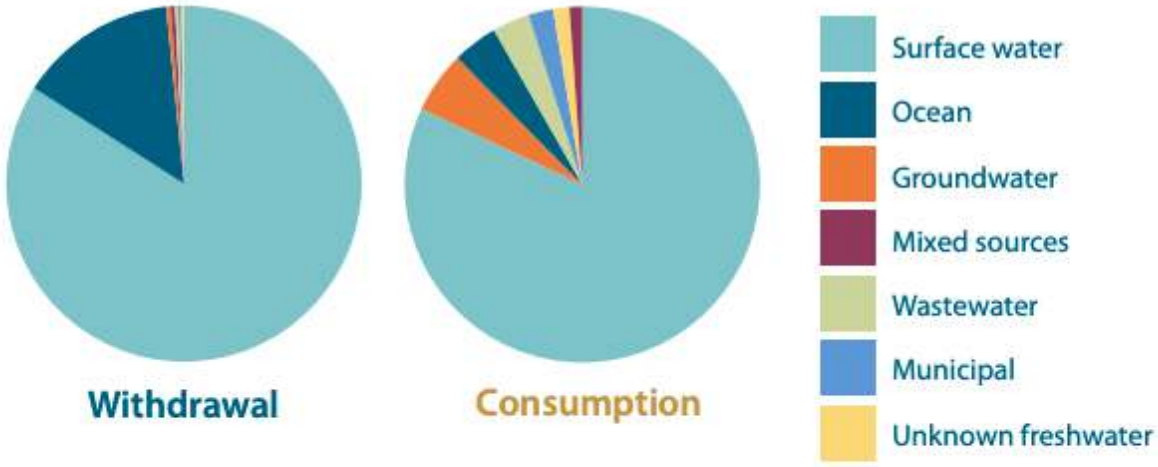


FIGURE 1. Sources of Water Used by Power Plants

In 2008, power plants withdrew 84 percent of their cooling water from rivers and lakes. The balance came mainly from the ocean in coastal regions. Most water that power plants consumed similarly came from surface sources. However, in some regions—notably the arid Southwest—cooling water came from a broader array of sources, including groundwater and wastewater.

Image from Freshwater Use by U.S. Power Plants, a report of the Energy and Water in a Warming World Initiative (EW3)

The EW3 report explains a variety of concerns with groundwater consumption by power plants, including competition with other demands for water, uncertainties about the extent of some groundwater resources, and contributing to the unsustainable draining of aquifers. It also notes that power plants can account for a significant portion of groundwater consumption in some regions. In northeastern Arizona, for example, U.S. Geological Service data from 2005 show that power plants were the largest consumers of groundwater. In Apache County, where the Springerville and Coronado coal plants are located, power plants accounted for 68% of groundwater withdrawals in 2005. That figure was 28% in Navajo County, where the Cholla Power Plant is located, according to the EW3 report. A review of U.S. Geological Service data from 2015 shows similar figures for both counties.

Combined, the Cholla, Coronado, and Springerville coal plants consumed 24.5 million gallons of groundwater each day between 2014 and 2018.

APS reported in its 2019 10-K that the groundwater used for its Cholla Power Plant could be an issue in a legal action involving the Hopi tribe and Navajo Nation:

APS has filed claims to water in the Little Colorado River Watershed in Arizona in an action pending in the Apache County, Arizona, Superior Court, which was originally filed on September 5, 1985. APS's groundwater resource utilized at Cholla is within the geographic area subject to the adjudication and, therefore, is potentially at issue in the case. APS's claims dispute the court's jurisdiction over its groundwater rights. Alternatively, APS seeks confirmation of such rights. Other claims have been identified as ready for litigation in motions filed with the court. A trial is scheduled for June of 2020 regarding the contested claims of the Hopi tribe for federal reserve water rights. Similar claims of the Navajo Nation are pending, but a schedule for discovery and resolution of the tribe's federal reserve water rights has not been established.

The Cholla Power Plant, which consumed 8.8 million gallons of groundwater each day, will close by 2025, with one unit scheduled to close in 2020. In its 2020 Integrated Resource Plan, APS noted that "Between 2019 and 2035, the Company's goal is to reduce our groundwater use by 71%-75%," and highlighted how the Cholla closure will result in significant water savings:

Cholla Unit 2 was retired effective October 1, 2015, resulting in a decrease of approximately 3,000-4,000 acre-feet annually. Cholla remains the largest user of nonrenewable groundwater in the APS fleet, however, APS has committed to cease coal generation at that site in 2025.

APS also explained in its IRP that "The focus is on non-renewable water (i.e., groundwater) because this supply is at the greatest risk of depletion and is a significant source of supply at seven of nine APS power plants."

The Coronado Generating Station, which consumed 6.2 million gallons of groundwater each day, will close by 2032.

Tucson Electric Power announced in June 2020 that it will close Springerville Unit 1 by 2027 and Unit 2 by 2032. In its 2020 Integrated Resource Plan, TEP also noted: "At Springerville, it is to TEP's advantage, by virtue of an agreement with a local Native American Tribe, to limit withdrawals of groundwater at the plant to 20,000 acre-feet annually."

Springerville Unit 3 is owned by Tri-State, and Unit 4 is owned by Salt River Project; neither utility has scheduled those units to close. If Units 3 and 4 continue to operate at a similar level as they did between 2014 and 2018, they will consume 36 billion gallons of groundwater by 2040.

High water usage at Apache Station "taxed deep well and water storage facilities"

The Apache Station, which burns both coal and gas, consumed 1.6 million gallons each day in 2018 (EIA data do not show this plant's water consumption in earlier years). Arizona G&T Cooperatives owns and operates the Apache Generating Station, and sells power to electric cooperatives in Arizona, Nevada, and California.

In its 2018 annual report, Arizona G&T Cooperatives discussed the challenges it faced that year with the groundwater it uses to cool the plant: “Exceedingly high temperatures, and unusual marketing conditions, led to higher water usage that taxed deep well and water storage facilities.”

The annual report explained some of the ways that the power provider responded to those challenges, including by purchasing power from other sources, and stringing together temporary hoses and implementing special water cycling measures at the power plant. To prepare for the 2019 Summer, Arizona G&T Cooperatives reported that “deep wells have been refurbished, and we have repurposed a five-million gallon fuel tank to better manage water resources.”

Colorado

Coal plants in Colorado consumed 58,631,000,000 gallons of water between 2014 and 2018, averaging 11.7 billion gallons each year or 32.1 million gallons each day.

Colorado coal plant water consumption data. All figures are in millions of gallons.

Coal plant name	Total water consumption 2014 - 2018	Average annual water consumption	Average daily water consumption	Water source	Closure date	Estimated water consumption 2020 - 2040/ closure date
Comanche Generating Station	17,127	3,425	9.38	Arkansas River	Unit 1: 2022 Unit 2: 2025 Unit 3: None	31,343
Craig Station	15,274	3,055	8.37	Yampa River	Unit 1: 2025 Unit 2: 2028 Unit 3: 2030	26,510
Hayden Generating Station	8,064	1,613	4.42	Yampa River	Unit 1: 2030 Unit 2: 2036	23,547
Martin Drake Power Plant	1,613	323	0.88	Reclaimed municipal water	Unit 1: 2017 Units 2 & 3: 2023	902
Pawnee Generating Station	8,412	1,682	4.61	Groundwater	None	33,648
Rawhide Energy Station	5,478	1,096	3.00	Reclaimed municipal water	2030	10,956
Ray D Nixon Power Plant	2,663	533	1.46	Groundwater	2030	5,326
Totals	58,631	11,727	32.12			132,232

Note: water consumption data for the Nucla Station, which closed in 2019, is not included in this table because EIA data appears to be inaccurate.

Coal plant closures free up water from the Yampa, Arkansas, San Miguel Rivers

Utilities in Colorado have recently announced plans to close most of the state's coal capacity by 2030. Those closures will significantly reduce the amount of water used to generate electricity in the state, a dramatic change from earlier expectations as the Colorado Sun reported:

State water planners long assumed that the amount of water needed to cool major power plants would increase with the booming population. Planners in 2010 predicted that, within 25 years, major power plants would be consuming 104,000 acre-feet per year of their own water. The Colorado Sun found that their annual consumption will end up closer to 10% of that figure.

Tri-State announced in January 2020 that it will close all of the units at the Craig Station by 2030. Unit 1 will close by the end of 2025 (as previously planned), and Unit 2 will close in 2028. Tri-State operates the plant, and owns all of Unit 3, while Units 1 and 2 are owned by Pacificorp, Salt River Project, Xcel Energy, Platte River Power Authority, and Tri-State. The Craig Station consumed 8.4 million gallons each day from the Yampa River.

KUNC reported on the conversations underway in Northwest Colorado "about how this newly freed up water should be put to use," once the Craig coal plant closes. A spokesperson for Tri-State told KUNC the utility wasn't yet ready to discuss the water issues related to the closure of the Craig coal plant.

Craig Station consumed 8.4 million gallons of water each day from the Yampa River

Xcel Energy plans to close two of the three units at the Comanche Generating Station near Pueblo, Colorado; Unit 1 will close in 2022 and Unit 2 will close in 2025, while the larger and newer Unit 3 will remain open. The Comanche plant consumed 9.4 million gallons of water each day from the Arkansas River, the most of any coal plant in Colorado.

EIA data doesn't report water consumption at the Comanche plant by unit; a spokesperson for Xcel Energy explained that the Comanche plant "is not set up to measure water usage by unit. We estimate 70 percent of the water is used at Units 1 and 2 combined, while 30 percent is used by Unit 3. Units 1 & 2 are cooled conventionally using water. Unit 3 has a hybrid cooling system and its water use varies seasonally, depending on conditions such as humidity and temperature."

Freshwater News reported that "the Arkansas River water now being used to cool the Comanche Generating Station is leased from the Pueblo Board of Water Works, and thus will be returned to the utility when two units of the station close, according to Xcel Energy spokesperson Michelle Aguayo."

Colorado Springs Utilities announced in June 2020 that it will close the Martin Drake coal plant by 2023 and the Ray Nixon coal plant by 2030. The Ray Nixon Power Plant consumed 1.5 million gallons of groundwater each day. The Martin Drake Power Plant consumed 880,000 gallons of reclaimed municipal water.

Tri-State's closure of the smaller Nucla Station in 2019 will also free up water from the San Miguel River. In a filing with the Colorado Public Utilities Commission, Western Resources Advocates urged the Commission to review Tri-State's decommissioning plan for the Nucla plant, in part because "Tri-State owns certain water rights that were necessary for the operation of Nucla Station and which may be available for transfer, including donation, lease or sale." WRA noted:

Water rights are a valuable asset, and the transfer of these rights has the potential to impact Tri-State and its ratepayers financially. Any change in use of water rights also has the potential to positively (or negatively) impact the public interest. Specifically, a reduction in the amount of water diverted or consumed can increase stream flows, with attendant local environmental and recreational benefits. And, to the extent those volumes are delivered downstream, water rights freed up through a generation plant retirement may help the State of Colorado meet any interstate water delivery obligations. Abandoning operation of the power plant will eliminate the need for Tri-State to continue to use these water rights for their originally decreed purposes.

Two towns and the County where the Nucla plant is located, along with a cooperative water supplier for agriculture in the region, also sought to intervene in the proceeding by noting that they "have an interest in the ultimate disposition and diversion of said water."

Xcel Energy operates remaining coal capacity in Colorado not yet scheduled to close by 2030

In addition to Unit 3 of the Comanche plant, two coal plants in Colorado are not yet scheduled to close by 2030; all are operated by Xcel Energy. In Northeast Colorado, Xcel's Pawnee Generating Station consumed 4.6 million gallons of groundwater each day.

Xcel also operates the Hayden Generating Station in Northwest Colorado, which it co-owns with Salt River Project and Pacificorp. The Hayden coal plant consumed 4.4 million gallons of water each day from the Yampa River, which has recently faced new challenges during drought conditions. In September 2018, the Colorado Division of Water Resources (DWR) curtailed water use from the Yampa River for the first time. Some agricultural users lost access, some of the city of Steamboat Springs' water rights were shut off, and the DWR closed the Yampa to recreational uses. The DWR did not curtail the Craig and Hayden coal plants because they have older water rights.

Xcel Energy has not yet scheduled closure dates for either the Hayden or Pawnee plants or Unit 3 of the Comanche plant, despite its commitment to reduce its carbon emissions system-wide 80% by 2030. Colorado's climate law also requires those emissions reductions for the utility's electricity sales in Colorado.

Hayden Generating Station consumed 4.4 million gallons of water each day from the Yampa River

Utilities using reclaimed water can still face water supply risks

Two coal plants in Colorado use reclaimed municipal water, both owned by municipal electric utility providers; the Martin Drake Power Plant owned by Colorado Springs Utilities, and the Rawhide Energy Station owned by Platte River Power Authority. Platte River Power Authority, which provides power to four municipal utilities in Northern Colorado, notes that the "use of wastewater effluent in place of higher quality water frees up resources that benefit local communities."

However, using reclaimed water at coal plants does not necessarily eliminate water supply risks. Platte River Power Authority's Water Resources Reference Document explains that the utility maintains water rights which it transfers to the city of Fort Collins, which then provides the utility with the reclaimed water after it is used. Most of that water is pumped across the Continental Divide from the Colorado River via the Windy Gap project, which has not worked as planned:

During its lifetime, the Windy Gap water supply has proven to be less reliable than initially anticipated. Weather conditions such as severe drought or extreme snowpack limit Windy Gap water availability. There have been numerous occasions, even as recent as the 2015, 2016, and 2017 water years, when Platte River was operating in a "water short" situation (a special arrangement with Fort Collins), which severely limits the ability to produce the water necessary for Rawhide operations. Although Rawhide has never been curtailed due to a lack of water supply, continued dependence on weather events to secure Platte River's water supply is not a reliable long-term strategy.

To help address these risks, Platte River Power Authority and the other participants in the Windy Gap project plan to build another reservoir to create a more reliable water supply. That Windy Gap Firming Project is controversial because it would lead to additional water transfers from the Colorado River, and environmental organizations have challenged it in court. According to the utility's Water Resources document, the Windy Gap Firming project is estimated to cost $612 million, of which Platte River Power Authority would be responsible for $108 million.

Meanwhile, Platte River Power Authority will likely need much less water over the next decade. The utility resolved in December 2018 to pursue a "100 percent non-carbon energy mix by 2030" and announced in June 2020 that it will close the Rawhide Generating Station by 2030.

New Mexico

Coal plants in New Mexico consumed 51,071,000,000 gallons of water between 2014 and 2018, averaging 10.2 billion gallons each year or 28 million gallons each day.

New Mexico coal plant water consumption data. All figures are in millions of gallons.

Coal plant name	Total water consumption 2014 - 2018	Average annual water consumption	Average daily water consumption	Water source	Closure date	Estimated water consumption 2020 - 2040/ closure date
Escalante Generating Station	1,805	361	0.99	Groundwater	2020	361
Four Corners Generating Station	23,633	4,727	12.95	San Juan River	2031	56,719
San Juan Generating Station	25,633	5,127	14.05	San Juan River	Units 2 & 3: 2017 Units 1 & 4: None*	68,116
Totals	51,071	10,215	27.99			125,196

**PNM has proposed closing the San Juan Generating Station by 2022, but the city of Farmington and Acme Equities are seeking to keep it open and install carbon capture infrastructure that would increase water consumption. The 68 billion gallon figure represents how much water the plant would consume by 2040 without carbon capture, so the figure could be much higher if that plan is approved, or much lower if the plant is closed by 2022. More details below.*

Coal plant closures free up water for Native American communities

The Four Corners Generating Station, in the Navajo Nation in Northwestern New Mexico, consumed 13 million gallons of water each day from the San Juan River. The plant is operated and majority-owned by Arizona Public Service, with partial ownership by PNM, Salt River Project, and Tucson Electric Power. Arizona Public Service announced in January 2020 that it would close the Four Corners coal plant by 2031, as part of the utility's plan to eliminate all fossil fuels and move to 100% clean energy.

The planned closure of the Four Corners Generating Station, along with the 2019 closure of the Navajo Generating Station and plans to close the San Juan Generating Station in 2022, means that the Navajo Nation faces declining tax revenue and other economic impacts. In January 2020, Navajo Nation President Jonathon Nez wrote to the Arizona Corporation Commission to propose that the shareholders of the utilities that own those coal plants provide Just Transition Funding. In addition to funding and other measures such as locating new renewable energy projects in the Navajo Nation, the proposal urges the utilities to help build water infrastructure for the Navajo Nation, and secure rights to water made available by coal plant closures:

Approximately 40% of the households on the Navajo Nation must haul their potable water. This is unacceptable. Water is a fundamental precondition to life. More practically, the lack of

formally quantified water rights significantly inhibits our ability to attract investments to pursue alternative economic development strategies. TEP (Tucson Electric Power) should, in concert with other former NGS owners, provide technical and legal support to the Navajo Nation to help secure the quantification of those water rights.

The Escalante Generating Station, in western New Mexico, consumed 1 million gallons of groundwater. The plant is owned and operated by Tri-State Generation and Transmission Association, which announced in January 2020 that it will close the plant by the end of 2020.

In its 2019 10-K filing with the Securities and Exchange Commission, Tri-State reported a long-running legal dispute with Native American communities in New Mexico over the rights to water consumed by the Escalante coal plant:

We are involved in a proceeding in the State of New Mexico that could impact the water rights for Escalante Station. It is an adjudication of water rights associated with the Bluewater Toltec Area to determine the past, present and future use of water rights of the Pueblos of Acoma and Laguna, which we collectively refer to as the Pueblos. Specifically, the Pueblos are seeking a determination of the volume of ground water and surface water available to them and to determine the priority of those water rights. Should the Pueblos prevail in court, permitted water rights available for the Escalante Station will be significantly reduced, potentially requiring us to secure alternative water supplies at a cost which could potentially be higher than the cost of the water supplies currently being used.

According to a description of those legal proceedings in *Pueblo Indian Water Rights: Charting the Unknown*, Tri-State was "the most active opponent of the Pueblos' claims in the litigation," and was the only entity that opposed extending settlement negotiations.

In Tri-State's announcement of its plans to close the Escalante and Craig coal plants, Tri-State CEO Duane Highley said that "The timeline to retire Escalante Station by the end of 2020 is driven by the economics of operating the power plant in a competitive power market, and by Tri-State's addition of low-cost renewable resources."

Escalante Station consumed 1 million gallons of groundwater each day

Carbon capture proposal for San Juan coal plant would increase water consumption

The San Juan Generating Station consumed 25,633,000,000 gallons of water from the San Juan River between 2014 and 2018, averaging 5.1 billion gallons each year or 14 million gallons each day. PNM, the largest utility in New Mexico, operates the coal plant but plans to retire it in 2022 because "data compiled for our integrated resource plan showed that removing coal from our energy mix would provide a long term cost benefit to customers."

However, Enchant Energy, which is owned by hedge fund Acme Equities, has proposed installing carbon capture and sequestration infrastructure at the San Juan plant instead of closing it. That CCS proposal is based on "hollow assumptions and quixotic projections," according to a report from the Institute for Energy Economics and Financial Analysis, but it has gained support from the City of Farmington, which is a partial owner of the plant.

PNM has explained that it opposes adding carbon capture to the San Juan plant because it would increase costs, and has also highlighted that CCS "could increase the plant's water intake by another 50% to 60%."

A pre-feasibility study of the CCS proposal noted that "water consumption will increase due to the capture facility," and evaluated ways to limit that increase in order to remain within the existing water rights associated with the coal plant. The report said that "the facility will use ~18,000 acre-feet per year out of a permit for 19,000 acre-feet per year," but also suggested that a desalination operation could be required, and that further analysis could better assess the plant's water needs if CCS were installed:

Presumably future refinements to the pre-feasibility study will refine the plan for water use, resulting in a better estimate of how close a proposed facility would be relative to the existing permit. One strategy for minimizing needs for fresh water might be to explore the future incorporation of a coupled CO2-storage and water desalination operation local to the SJGS.

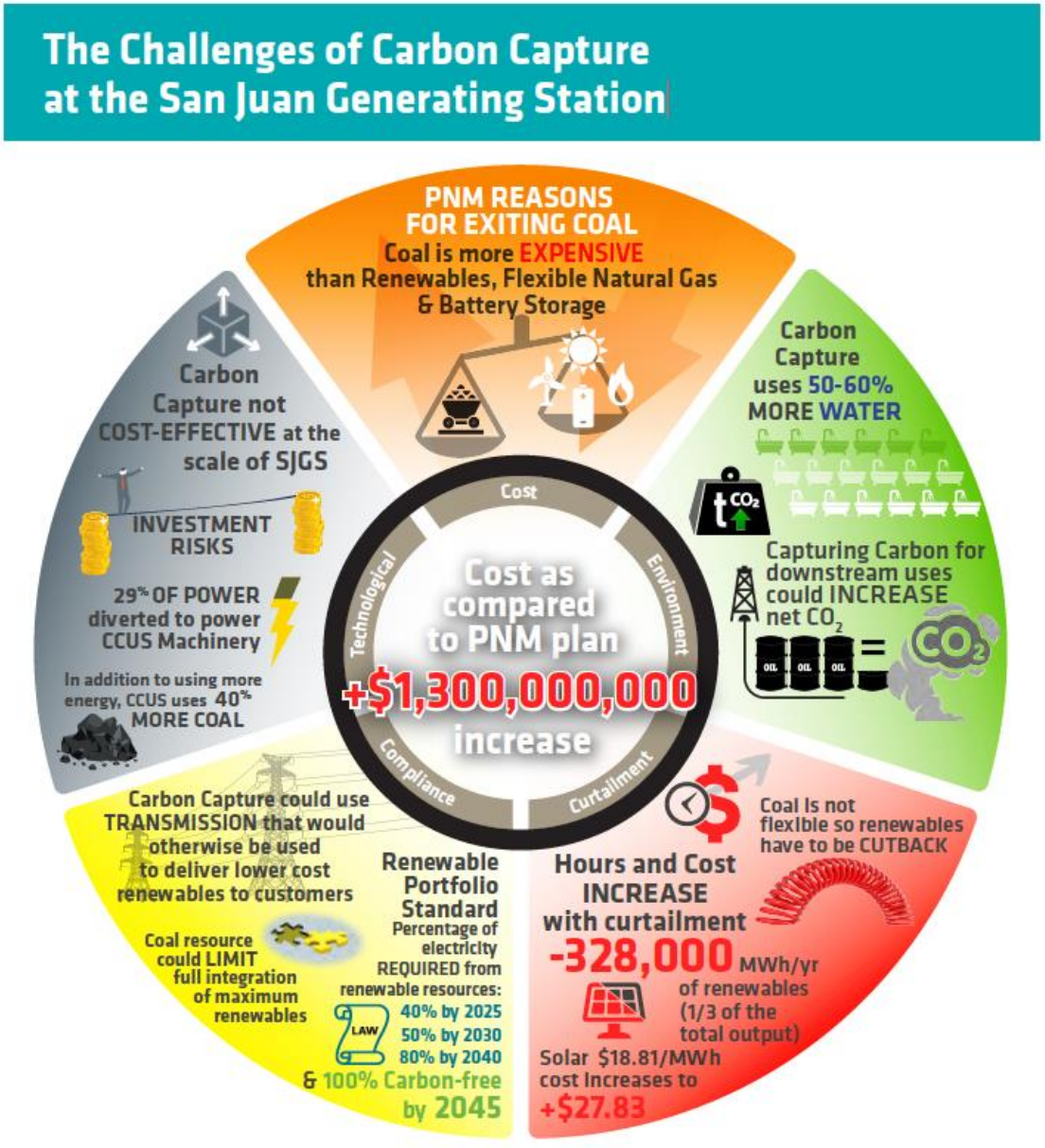
The additional water needs of CCS infrastructure could exceed the guaranteed water rights associated with the San Juan coal plant, according to PNM. PNM spokesperson Ray Sandoval said the San Juan coal plant has a deed for 8,000 acre feet of water each year, but that some of that water (between 1,300 and 1,900 acre feet each year) must be set aside for groundwater recovery, as well as for operations and reclamation at the San Juan coal mine. The permit also allows the San Juan plant access to water that is unused by the Four Corners coal plant, which currently amounts to another 11,000 acre feet each year, but is not guaranteed. Sandoval noted in an email to EPI:

It is reported that carbon capture processes could add 50% to 60% to the water consumption at SJGS. If that is the case, and Enchant desires to have guaranteed water rights for all their activities, they will need to acquire additional guaranteed water rights between 10,000 afa to 11,000 afa from others in the region. Otherwise, if a guaranteed water supply is not required by Enchant and its investors, the Permit 2838 may provide enough water for its operations.

Moreover, Enchant Energy's assessment that adding carbon capture to the San Juan Generating Station would increase water consumption by 50% is far lower than figures in the academic literature, which have found that carbon capture at coal plants roughly doubles water consumption.

Meanwhile, the other partial owner of the San Juan Generating Station, Tucson Electric Power, emphasized in its 2020 Integrated Resource Plan that its exit from the plant will reduce its water availability risk:

The availability of water that is withdrawn from surface waters, as in the case of the Four Corners Power Plant (Morgan Lake and the San Juan River) and the San Juan Generating Station (San Juan River), is highly dependent on precipitation and snow pack, as well as other uses. TEP's reference case portfolio calls for retirement of or exit from each of these facilities within the planning period, with the majority occurring within the next two years, which significantly reduces and eventually eliminates any risk of water availability for power generation from surface waters.



"The Challenges of Carbon Capture at the San Juan Generating Station" graphic published by PNM, the operator of the coal plant

Utah

Coal plants in Utah consumed 66,097,000,000 gallons of water between 2014 and 2018, averaging 13.2 billion gallons each year or 36.2 million gallons each day.

Utah coal plant water consumption data. All figures are in millions of gallons.

Coal plant name	Total water consumption 2014 - 2018	Average annual water consumption	Average daily water consumption	Water source	Closure date	Estimated water consumption 2020 - 2040/ closure date
Bonanza Power Plant	6,672	1,334	3.66	Green River	2030	14,678
Hunter Power Plant	23,458	4,692	12.85	Cottonwood Creek	None	93,832
Huntington Power Plant	15,451	3,090	8.47	Huntington Creek	2036	52,533
Intermountain Power Project	20,516	4,103	11.24	Sevier River (DMAD Reservoir)	2025	24,619
Totals	66,097	13,219	36.22			185,662

Pacificorp coal plants in Utah could consume 146 billion gallons of water by 2040

Over half (59%) of that water was consumed by two coal plants owned and operated by Pacificorp, whose subsidiary Rocky Mountain Power is the largest electric utility in Utah. Pacificorp's Hunter Power Plant consumed 12.9 million gallons of water each day from Cottonwood Creek, while its Huntington Power Plant consumed 8.5 million gallons of water each day from Huntington Creek.

While Pacificorp's October 2019 Integrated Resource Plan proposed early closures for some of its coal plants, those plans did not affect the utility's coal plants in Utah. If the Hunter coal plant is not closed and continues to consume water at a similar rate, it will consume over 93 billion gallons of water by 2040. If the Huntington coal plant operates until 2036 as planned and continues to consume water at a similar rate, it will consume over 52 billion gallons of water.

Pacificorp owns more coal capacity than any other utility in the Western U.S., including coal plants it operates in Wyoming and Utah, as well as partial ownership of coal plants operated by other utilities in Colorado, Montana, and Arizona. Throughout the region, coal capacity owned by Pacificorp consumed over 102 billion gallons of water between 2014 and 2018, 27% of the total.

Other coal plants in Utah will close over the next decade

The Bonanza Power Plant, on the Uintah and Ouray reservation in northeastern Utah, consumed 3.7 million gallons of water each day from the Green River. It is owned and operated by Deseret Electric Power Cooperative, a generation and transmission association that sells power to six electric cooperatives in Utah, Nevada, Wyoming, Arizona, and Colorado. The Bonanza coal plant is likely to close by 2030, under a settlement agreement with the Environmental Protection Agency and environmental groups to comply with clean air rules.

The Intermountain Power Project coal plant consumed 11.2 million gallons of water each day from the Sevier River. The Intermountain Power Project is owned and operated by the Intermountain Power Agency, a power provider for municipal and cooperative utilities in Utah and Southern California. The Los Angeles Department of Water and Power accounts for nearly half its sales, and other municipalities in Southern California account for another quarter, all of which must by law stop purchasing electricity generated by coal by 2025. Intermountain Power Agency plans to replace the coal plant with a power plant that burns gas and hydrogen, along with hydrogen and compressed air storage facilities.

Nevada

Coal plants in Nevada consumed 5,591,000,000 gallons of water between 2014 and 2018, averaging 1.1 billion gallons each year or 3 million gallons each day.

Nevada coal plant water consumption data. All figures are in millions of gallons.

Coal plant name	Total water consumption 2014 - 2018	Average annual water consumption	Average daily water consumption	Water source	Closure date	Estimated water consumption 2020 - 2040/ closure date
North Valmy Generating Station	2,797	559	1.53	Groundwater	Unit 1: 2021 Unit 2: 2025	2,329
TS Power Plant	2,794	559	1.53	Groundwater	None	11,176
Totals	5,591	1,118	3.06			13,505

This data includes the North Valmy Generating Station, owned by NV Energy and Idaho Power, and the TS Power Plant, owned by Nevada Gold Mines, each of which consumed about 1.5 million gallons of groundwater each day. It excludes the Reid Gardner Generating Station, which closed in 2017.

The North Valmy coal plant will close by the end of 2025, with Unit 1 scheduled to close by the end of 2021. Nevada Gold Mines announced in February 2020 that it will convert the TS coal plant to allow it to burn gas as well as coal.

Montana

Coal plants in Montana consumed 30,130,000,000 gallons of water between 2014 and 2018, averaging 7.5 billion gallons each year or 20.5 million gallons each day.

Montana coal plant water consumption data. All figures are in millions of gallons.

Coal plant name	Total water consumption 2014 - 2018	Average annual water consumption	Average daily water consumption	Water source	Closure date	Estimated water consumption 2020 - 2040/ closure date
Colstrip Power Plant	29,001	7,250	19.86	Yellowstone River	Units 1 & 2: 2020 Units 3 & 4: None	104,065
Hardin Generator Project	1,129	226	0.62	Bighorn River	None	4,516
Totals	30,130	7,476	20.48			108,581

Colstrip consumed more water than any other coal plant in the Western U.S.

The Colstrip Power Plant consumed 19.9 million gallons of water each day from the Yellowstone River - the most of any coal plant in the Western U.S. The Colstrip plant is operated by Talen Energy, and owned by Talen Energy, NorthWestern Energy, Portland General Electric, Puget Sound Energy, Avista, and PacifiCorp.

Low water levels in the Yellowstone River have led Talen Energy to ask residents of the nearby town of Colstrip to limit their water use in order to help ensure that the coal plant had enough water. The Mayor of Colstrip told the Associated Press in 2016 that “low water levels and high temperatures have been causing problems with Talen's water intake system on the Yellowstone River.”

Colstrip Units 1 and 2 closed in January 2020. Units 3 and 4 have no clear closure date, but some of the utilities that are partial owners of Colstrip will be required to exit from the coal plant because of clean energy policies in Oregon and Washington.

The closures of Colstrip Units 1 and 2 will reduce water consumption at the plant, but those units were responsible for less than one third of the plant’s total water consumption. Between 2014 and 2018, the larger Units 3 and 4 consumed 14.2 million gallons of water each day, while Units 1 and 2 consumed 5.6 million gallons of water each day. That means that even with the closures of Units 1 and 2, Colstrip will remain one of the largest water consuming coal plants in the West. If Units 3 and 4 remain open and continue to consume water at a similar rate, Colstrip will consume 104 billion gallons of water by 2040.

Wyoming

Coal plants in Wyoming consumed 88,269,000,000 gallons of water between 2014 and 2018, averaging 17.6 billion gallons each year, or 48.4 million gallons each day.

Wyoming coal plant water consumption data. All figures are in millions of gallons.

Coal plant name	Total water consumption 2014 - 2018	Average annual water consumption	Average daily water consumption	Water source	Closure date	Estimated water consumption 2020 - 2040/ closure date
Dave Johnston Power Plant	18,982	3,796	10.40	North Platte River	2027	30,371
Dry Fork Station	0	0	0	--	None	--
Jim Bridger Power Plant	33,125	6,625	18.15	Green River	Unit 1: 2023 Unit 2: 2028 Units 3 & 4: 2037	81,590
Laramie River Station	24,203	4,841	13.26	Laramie River (Grayrocks Dam)	None	96,812
Naughton Power Plant	11,959	2,392	6.55	Hams Fork River	Unit 3: 2020 Units 1 & 2: 2025	9,015
Wygen Power Plant	0	0	0	--	None	--
Wyodak Power Plant	0	0	0	--	None	--
Totals	88,269	17,654	48.36			217,788

Pacificorp resource plan could reduce coal plant water consumption in Wyoming

In its 2019 Integrated Resource Plan, Pacificorp proposed closing several coal plants, including in Wyoming, which the utility's vice president of resource planning and acquisitions said "reflects the ongoing cost pressure on coal as wind generation, solar generation and storage have emerged as low-cost resource options for our customers."

Pacificorp's IRP proposes to close the Dave Johnston Power Plant in 2027, which consumed 10.4 million gallons of water each day from the North Platte River, and the Naughton Power Plant in 2025 (including closing Unit 1 in 2020), which consumed 6.5 million gallons of water each day from the Hams Fork River. Pacificorp also proposed closing Unit 1 of the Jim Bridger Power Plant in 2023 and Unit 2 in 2028, while Units 3 and 4 would continue to run until 2037. The Jim Bridger coal plant consumed 18.1 million gallons of water each day from the Green River, more than any other plant in Wyoming.

However, Wyoming Governor Mark Gordon and other policymakers in the state have sought to derail Pacificorp's plans to retire coal plants in Wyoming, including by passing legislation that requires the utility to try and sell coal plants before retiring them, and by pressuring the Wyoming Public Service Commission to "investigate" Pacificorp's resource planning process.

Dry cooling systems reduce water consumption, but are less efficient

Three coal plants in Wyoming use dry cooling systems, which use air instead of water, including the Dry Fork Station and the Wyodak and Wygen coal plants near Gillette, Wyoming. Dry cooling systems are rare among U.S. coal plants, and have their own drawbacks. "Dry and hybrid cooling account for 3% of U.S. thermoelectric generating capacity," according to the EIA, and most of those are used at gas plants (83%).

Dry cooling systems are less efficient, which increases costs and air pollution impacts, as the Union of Concerned Scientists explains:

Dry-cooling systems use air instead of water to cool the steam exiting a turbine. Dry-cooled systems use no water and can decrease total power plant water consumption by more than 90 percent. The tradeoffs to these water savings are higher costs and lower efficiencies. In power plants, lower efficiencies mean more fuel is needed per unit of electricity, which can in turn lead to higher air pollution and environmental impacts from mining, processing, and transporting the fuel.

Drought increased costs for Basin Electric by forcing it to purchase water from ranchers

Drought increased Basin Electric's costs of operating the Laramie River Station for six years, by forcing the generation and transmission association to purchase water when it couldn't rely on the reservoir created for the coal plant. From 2004 until 2010, drought led to insufficient water levels at Grayrocks Reservoir, which is fed by the Laramie River.

The Laramie River Station is operated by Basin Electric, and owned by Basin Electric, Tri-State Generation and Transmission Association, Western Minnesota Municipal Power Agency, Lincoln Electric System, and Wyoming Municipal Power Agency.

A video produced by Basin Electric explained how the drought led to higher costs for the Laramie River Station because it "was forced to buy well water from local farmers and ranchers to keep the plant running."

The drought increased the costs of operating the coal plant for six years, as Basin Electric's 2010 annual report explained:

Laramie River Station will not need to purchase water in 2011 as Grayrocks Reservoir is full and will provide all of the plant's needs. There had been a drought in the region since 2004 and

Grayrocks Reservoir was 10 percent full in 2008. As summer 2010 began, the reservoir was 45 percent full and two months later, more than 100 percent full.

During the drought, the Laramie River Station consumed tens of billions of gallons of groundwater, according to the EW3 report:

When the reservoir fell to 10 percent of capacity during an extended drought, the plant's owner had to obtain 80 percent of the plant's cooling water—more than 26 billion gallons (80,000 acre feet)—from wells and other leased groundwater sources, most from the High Plains Aquifer, from October 2004 to May 2010.

Between 2014 and 2018, the Laramie River Station consumed 13.3 million gallons of water each day, or 4.8 billion gallons each year. Basin Electric has not set a retirement date, and the generation and transmission association does not present a resource plan for approval by regulators. If the coal plant is not closed and it continues to consume water at a similar rate, it will consume over 96 billion gallons of water by 2040.

A spokesperson for Basin Electric said that the increased cost of obtaining alternate water supplies to operate the Laramie River Generating Station during the drought was not available, but that "the cost information was shared with our membership at that time and included in our facility operating costs."

Recommendations

As climate change fuels hotter and drier conditions in the American West, coal plant operators will face increased water supply risks, legal disputes, and conflicts with other water users. Electric utility executives, regulators, policymakers, and investors should consider those risks in light of the uniquely essential nature of water for all communities and life in the West, including:

- Electric utilities and their regulators should assess the water supply risks facing power plants in the Western U.S., and the potential environmental and economic benefits of replacing water-consuming coal-fired power plants with resources that use little or no water, including energy efficiency, solar photovoltaic energy, and wind energy.

- Regulators, policymakers, and investors considering carbon capture proposals at coal plants should assess the costs and water supply risks of the increased water consumption required for those projects.

- Efforts by regulators and utilities to assess the water supply risks and costs of new and existing power plants, such as during electric resource planning, should incorporate the latest science showing a long-term aridification trend in the Western U.S. driven by climate change.

Further reading

Freshwater Use by U.S. Power Plants; Electricity's Thirst for a Precious Resource, Energy and Water in a Warming World Initiative (EW3)

A Powerful Thirst: Managing the Electricity Sector's Water Needs and the Risk of Drought, Western Resources Advocates

How it Works: Water for Power Plant Cooling, Union of Concerned Scientists

Water Use in the United States Energy System: A National Assessment and Unit Process Inventory of Water Consumption and Withdrawals, American Chemical Society

Thermoelectric Power Water Use, U.S. Geological Service

Climate Change and Electricity Sector: Guide for Climate Change Resilience Planning, U.S. Department of Energy

Could water from retiring coal plants help solve the Upper Colorado River Basin's "demand management" problem?, Eric Kuhn

Climate change and the aridification of North America, Jonathan T. Overpeck and Brad Udall

Getting physical: assessing climate risks, BlackRock

Ameren, Xcel, Dominion, Duke among most at-risk from changing climate: Moody's, UtilityDive

Fourth National Climate Assessment, Southwest, U.S. Global Change Research Program

Methodology

Coal plant water consumption data is from the Energy Information Agency, and those figures are reported to the EIA by coal plant operators. Coal plants that were closed or converted to gas between 2014 and 2018 are excluded. Water consumption data for the Nucla Station is also excluded, because the EIA data for that plant appears to be inaccurate. EIA is missing water consumption data for Apache Station except for 2018. Because of those exclusions, the top line figures in this report slightly underestimate the amount of water consumed by coal plants in the Western U.S. between 2014 and 2018. When coal unit water consumption is reported for fewer than each of the five years, the average annual and daily water consumption figures are calculated using the amount of years of available data, so combined unit-level averages do not always total to coal plant averages.

Coal unit closure dates are compiled from a variety of sources, including reporting by the Los Angeles Times and other news outlets, utility press releases, resource plans, and websites, and data provided by the Sierra Club.

To estimate how much water a coal plant will consume between 2020 and its closure date, we multiplied the average annual water consumption of that plant during 2014-2018, by the amount of years until its planned closure. Several coal plants include multiple units that are scheduled to close in different years; for those we used unit-level water consumption data to estimate how much water will be consumed by each unit until its closure date, and then combined those figures for all of the units at a coal plant. For most coal plants, EIA reports each coal unit's water consumption. For three coal plants, EIA only reports water consumption data at the plant level, not the unit level; for two of those we calculate unit-level water consumption based on the size of each unit in megawatts. For the Comanche plant, unit-level water consumption is based on an estimate provided by Xcel Energy, because Unit 3 uses a different type of cooling system than Units 1 and 2. For coal units without an announced closure date, we estimate water consumption from January 1, 2020 until January 1, 2040.

Coal plant water consumption data from Energy Information Agency

All figures are in millions of gallons.

Coal Plant Name	2014	2015	2016	2017	2018	Total 2014-2018	Average Annual	Average Daily
Colstrip Power Plant	**7,779**	**--**	**7,380**	**7,336**	**6,506**	**29,001**	**7,250**	**19.86**
1	1,160	--	923	901	861	3,845	961	2.63
2	1,175	--	1,090	1,125	953	4,343	1,086	2.97
3	2,549	--	2,861	2,397	2,450	10,257	2,564	7.03
4	2,895	--	2,506	2,913	2,242	10,556	2,639	7.23
Jim Bridger Power Plant	**7,580**	**7,171**	**5,686**	**6,156**	**6,532**	**33,125**	**6,625**	**18.15**
1	1,672	1,849	1,549	1,553	1,360	7,983	1,597	4.37
2	1,969	2,043	1,616	1,261	1,615	8,504	1,701	4.66
3	1,986	1,309	1,319	1,648	1,790	8,052	1,610	4.41
4	1,954	1,971	1,202	1,693	1,766	8,586	1,717	4.70
San Juan Generating Station	**6,675**	**5,005**	**5,196**	**4,123**	**4,634**	**25,633**	**5,127**	**14.05**
1	1,475	1,234	1,323	2,062	1,782	7,876	1,575	4.32
2	1,699	1,291	1,227	--	--	4,217	1,406	3.85
3	1,742	1,353	1,294	--	--	4,389	1,463	4.01
4	1,760	1,127	1,352	2,062	2,852	9,153	1,831	5.02
Navajo Generating Station	**6,215**	**5,284**	**4,493**	**4,531**	**4,963**	**25,486**	**5,097**	**13.96**
1	2,004	1,952	1,600	1,570	1,648	8,774	1,755	4.81
2	2,165	1,794	1,348	1,446	1,656	8,409	1,682	4.61
3	2,046	1,538	1,545	1,515	1,659	8,303	1,661	4.55
Laramie River Station	**4,256**	**4,790**	**4,822**	**4,608**	**5,727**	**24,203**	**4,841**	**13.26**
1	1,648	1,127	1,488	1,358	1,310	6,931	1,386	3.80
2	1,430	1,879	1,546	1,691	2,478	9,024	1,805	4.94
3	1,178	1,783	1,787	1,559	1,939	8,246	1,649	4.52

Coal Plant Name	2014	2015	2016	2017	2018	Total 2014-2018	Average Annual	Average Daily
Four Corners Generating Station	**5,203**	**5,366**	**4,185**	**4,244**	**4,635**	**23,633**	**4,727**	**12.95**
4	2,738	2,824	2,122	2,753	1,951	12,388	2,478	6.79
5	2,465	2,542	2,063	1,491	2,684	11,245	2,249	6.16
Hunter Power Plant	**3,815**	**4,178**	**4,638**	**6,020**	**4,807**	**23,458**	**4,692**	**12.85**
1	1,418	1,761	1,669	1,508	1,507	7,863	1,573	4.31
2	1,646	1,637	1,577	1,725	1,634	8,219	1,644	4.50
3	752	780	1,392	2,787	1,666	7,377	1,475	4.04
Intermountain Power Project	**5,346**	**4,439**	**3,189**	**3,715**	**3,827**	**20,516**	**4,103**	**11.24**
1	2,495	2,464	1,531	1,923	1,787	10,200	2,040	5.59
2	2,851	2,285	1,658	1,792	2,040	10,626	2,125	5.82
Dave Johnston Power Plant	**2,935**	**2,874**	**2,558**	**4,309**	**6,306**	**18,982**	**3,796**	**10.40**
1	429	429	427	1,034	979	3,298	660	1.81
2	435	432	420	1,053	1,056	3,396	679	1.86
3	476	479	461	1,133	3,101	5,650	1,130	3.10
4	1,596	1,534	1,251	1,089	1,171	6,641	1,328	3.64
Springerville Generating Station	**4,392**	**3,824**	**3,827**	**3,406**	**1,886**	**17,335**	**3,467**	**9.50**
1	*1,054*	*918*	*918*	*817*	*453*	*4,160*	*832*	*2.28*
2	*1,054*	*918*	*918*	*817*	*453*	*4,160*	*832*	*2.28*
3	*1,142*	*994*	*995*	*886*	*490*	*4,507*	*901*	*2.47*
4	*1,142*	*994*	*995*	*886*	*490*	*4,507*	*901*	*2.47*
Comanche Generating Station	**3,251**	**3,319**	**3,413**	**3,523**	**3,621**	**17,127**	**3,425**	**9.38**
1	*1138*	*1162*	*1195*	*1233*	*1267*	*5995*	*1,199*	*3.28*
2	*1138*	*1162*	*1195*	*1233*	*1267*	*5995*	*1,199*	*3.28*
3	*975*	*996*	*1024*	*1057*	*1086*	*5138*	*1,028*	*2.82*

Coal Plant Name	2014	2015	2016	2017	2018	Total 2014-2018	Average Annual	Average Daily
Cholla Power Plant	**2,957**	**4,240**	**2,436**	**3,159**	**3,168**	**15,960**	**3,192**	**8.75**
1	--	494	133	361	439	1,427	357	0.98
2	--	802	--	--	--	802	802	2.20
3	1,118	1,022	611	1,100	1,126	4,977	995	2.73
4	1,839	1,922	1,692	1,698	1,603	8,754	1,751	4.80
Huntington Power Plant	**3,445**	**3,254**	**2,894**	**3,145**	**2,713**	**15,451**	**3,090**	**8.47**
1	1,477	1,676	1,332	1,609	1,328	7,422	1,484	4.07
2	1,967	1,578	1,562	1,536	1,385	8,028	1,606	4.40
Craig Station	**4,536**	**1,346**	**3,605**	**2,934**	**2,853**	**15,274**	**3,055**	**8.37**
1	1,320	498	1,086	1,058	1,032	4,994	999	2.74
2	1,565	453	1,260	869	1,112	5,259	1,052	2.88
3	1,651	396	1,260	1,007	709	5,023	1,005	2.75
Naughton Power Plant	**1,950**	**2,094**	**2,792**	**2,257**	**2,866**	**11,959**	**2,392**	**6.55**
1	473	511	687	507	699	2,877	575	1.58
2	591	664	825	734	932	3,746	749	2.05
3	886	919	1,280	1,017	1,235	5,337	1,067	2.92
Coronado Generating Station	**2,750**	**2,207**	**2,329**	**2,124**	**1,985**	**11,395**	**2,279**	**6.24**
1	1,462	1,055	1,245	1,131	867	5,760	1,152	3.16
2	1,288	1,152	1,084	992	1,118	5,634	1,127	3.09
Hayden Generating Station	**1,867**	**1,678**	**1,551**	**1,532**	**1,436**	**8,064**	**1,613**	**4.42**
1	*747*	*671*	*620*	*613*	*574*	*3,225*	*645*	*1.77*
2	*1120*	*1007*	*931*	*919*	*862*	*4,839*	*968*	*2.65*
Pawnee Generating Station	**1,282**	**1,734**	**1,492**	**2,054**	**1,850**	**8,412**	**1,682**	**4.61**

Coal Plant Name	2014	2015	2016	2017	2018	Total 2014-2018	Average Annual	Average Daily
Bonanza Power Plant	**1,378**	**1,345**	**1,133**	**1,342**	**1,474**	**6,672**	**1,334**	**3.66**
Rawhide Energy Station	**1,095**	**1,095**	**1,098**	**1,095**	**1,095**	**5,478**	**1,096**	**3.00**
Apache Station	**--**	**--**	**--**	**--**	**590**	**590**	**590**	**1.62**
1	--	--	--	--	--	--	--	--
2	--	--	--	--	321	321	321	0.88
3	--	--	--	--	269	269	269	0.74
North Valmy Generating Station	**832**	**197**	**125**	**542**	**1,101**	**2,797**	**559**	**1.53**
1	423	122	56	260	420	1,281	256	0.70
2	409	--	--	--	--	409	409	1.12
3	--	75	68	282	680	1,105	276	0.76
TS Power Plant	**736**	**577**	**470**	**461**	**550**	**2,794**	**559**	**1.53**
Ray D Nixon Power Plant	**539**	**499**	**470**	**698**	**457**	**2,663**	**533**	**1.46**
Escalante Generating Station	**339**	**295**	**405**	**344**	**422**	**1,805**	**361**	**0.99**
Martin Drake Power Plant	**438**	**475**	**242**	**254**	**204**	**1,613**	**323**	**0.88**
5	24	86	--	--	--	110	55	0.15
6	174	183	122	135	122	736	147	0.40
7	240	207	120	118	82	767	153	0.42
Hardin Generator Project	**552**	**420**	**5**	**78**	**74**	**1,129**	**226**	**0.62**
Dry Fork Station	**--**	**--**	**--**	**--**	**--**	**0**	**0**	**0**
Wygen Power Plant	**--**	**--**	**--**	**--**	**--**	**0**	**0**	**0**
Wyodak Power Plant	**--**	**--**	**--**	**--**	**--**	**0**	**0**	**0**
Totals	**82,143**	**67,706**	**70,434**	**73,990**	**76,282**	**370,555**	**76,033**	**208.31**

Water consumption data for coal capacity owned by Pacificorp

Water consumption figures are in millions of gallons. Coal unit capacities owned by Pacificorp are from Pacificorp parent company Berkshire Hathaway Energy's 2019 10-K.

Coal units	Coal units total capacity (MW)	Coal units' total water consumption 2014 - 2018	Pacificorp owned capacity (MW)	Pacificorp ownership percentage of coal units	Pacificorp portion of coal units' water consumption 2014 - 2018
Jim Bridger Units 1, 2, 3 and 4	2,123	33,125	1,415	66.65%	22,078
Hunter Units 1, 2 and 3	1,363	23,458	1,158	84.96%	19,930
Huntington Units 1 and 2	909	15,451	909	100%	15,451
Dave Johnston Units 1, 2, 3 and 4	745	18,982	745	100%	18,982
Cholla Unit 4	395	8,754	395	100%	8,754
Naughton Unit 1 and 2	357	11,959	357	100%	11,959
Wyodak Unit 1	332	0	266	80.12%	0
Craig Units 1 and 2	837	10,253	161	19.24%	1,972
Colstrip Units 3 and 4	1,480	20,813	148	10%	2,081
Hayden Units 1 and 2	441	8,064	77	17.46%	1,408
Totals	8,982		5,631		102,615