PROTECTING THE LIFELINE OF THE WEST

How Climate and Clean Energy Policies Can Safeguard Water

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

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

WESTERN RESOURCE ADVOCATES

Western Resource Advocates

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

Our lawyers, scientists and economists:

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

2) promote urban water conservation and river restoration; and

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

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

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PROTECTING THE LIFELINE OF THE WEST: HOW CLIMATE AND CLEAN ENERGY POLICIES CAN SAFEGUARD WATER

Western Resource Advocates & Environmental Defense Fund

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“The greatest issue facing future generations is the combined effect of ever increasing human numbers and the emergence of a dramatically altered climate. Only by pursuing water efficient renewable energy supplies immediately, beginning the long journey to a more water and energy efficient culture, and managing our water resources adaptively, do our children even have a chance of meeting the challenges that surely will confront them.”

-- *Patricia Mulroy, General Manager, Las Vegas Valley Water District and Southern Nevada Water Authority*

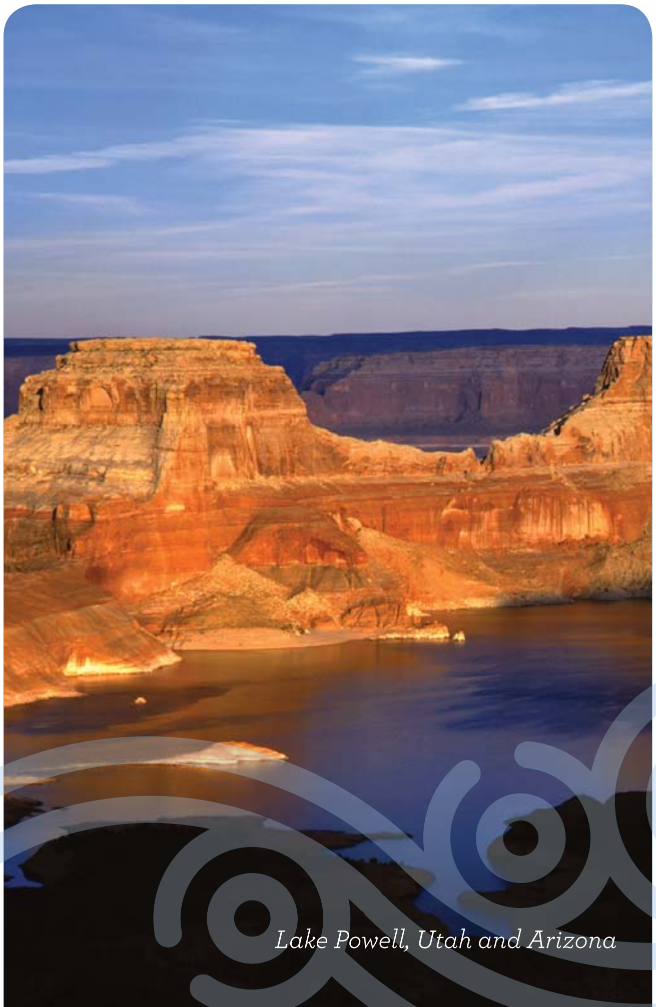
EXECUTIVE SUMMARY

Water is the lifeline of the West, and is essential to sustaining our people, economy, rivers, and wildlife. In the words of a Montana business owner and fly fishing guide, "Our livelihoods depend on it." However, climate change is threatening the West's water. Meeting the water demands of the region's vibrant cities, burgeoning recreational industry, and agricultural sector – the bedrock of our rural communities – is already a challenge. But scientists project that climate change will make the West both hotter and drier, with longer and more intense droughts — exacerbating today's challenges.

A national climate policy would protect the West's water supplies and create important incentives for energy efficiency and electricity sources, such as wind and solar photovoltaics, that do not emit greenhouse gases and use no water. Likewise, these policies could incentivize innovative, resilient water supply strategies — including water conservation, re-use, and smart projects that provide a steady flow of affordable water while minimizing new energy demands.

A well-designed national climate policy is vital to protect the lifeline of the West's environment and its economy, ensuring that westerners continue to have clean, safe, reliable water supplies for decades to come.

An 11-year drought has plagued the Colorado River, reducing storage in Lake Mead and Lake Powell to only 55% of capacity. And runoff in 2010 — projected to be only 63% of average — will not relieve drought conditions in the basin.



Lake Powell, Utah and Arizona

Climate Change Jeopardizes the West's Water

Climate change is already impacting western water resources. Scientists have measured long-term downward trends of snowpack in western coastal states and shifts toward earlier spring runoff in mountainous river basins across the region. If climate change is not addressed, future changes will greatly exacerbate the West's water supply challenges. Compounding these challenges, climate change is also projected to intensify storms and flooding, increase the frequency of wildfires, and adversely impact water quality. These changes impact human communities as well as the habitat essential to wildlife.

In the Colorado River Basin, climate change issues could not be more pressing. The river supplies water to over 30 million people and 1.4 million acres of farmland, but an 11-year drought in the basin has left the two main reservoirs, Lake Mead and Lake Powell, at only 55% of their total capacity. Today, water demands exceed supplies in the basin; any further reduction in available water will directly impact current users — farmers, cities, and industry. And in a recent assessment, 46 of 49 global circulation model simulations projected a more arid southwestern U.S. in future years, with the droughts of the past becoming the norm.

Thermoelectric power plants in Arizona, Colorado, New Mexico, Nevada, and Utah consumed an estimated 292 million gallons of water a day (MGD) in 2005 – approximately equal to the water consumed by Denver, Phoenix, and Albuquerque, combined.

Clean Energy Policies Can Protect Western Water Supplies

Sound climate policies will incentivize clean energy sources, with strong implications for water. Conventional fossil fuels used for electricity generation and transportation consume considerable amounts of water. For example, thermoelectric power plants in Arizona, Colorado, New Mexico, Nevada, and Utah consumed an estimated 292 million gallons of water a day (MGD) in 2005 — approximately equal to the water consumed by Denver, Phoenix, and Albuquerque, *combined*. Moreover, water use for power production in the Rocky Mountain/Desert Southwest region is projected to grow by 200 MGD by 2030. If not used for power production, that water would otherwise be available to meet the needs of almost 2.5 million people.

The oil and gas industry also imposes a heavy burden on the West's water resources. For the 10 states of the Rocky Mountain Oil and Gas Supply Region, the U.S. Department of Energy projects that water consumed for conventional oil and gas production will increase from approximately 500 MGD in 2005 to 700 MGD in 2030. Development of oil shale and tar sands would carry even more dramatic implications for the West's dwindling water supplies. Oil shale extraction is a highly water-intensive process — some proposed technologies could consume as much as four barrels of water per barrel of oil produced. In its environmental analysis of possible oil shale development in western Colorado, eastern Utah, and southwest Wyoming, the Bureau of Land Management concluded, "water is likely to be transferred from traditional agricultural uses to industrial uses, resulting in the loss of traditional irrigated agriculture."

In contrast, clean renewable sources of energy and energy efficiency can provide important water savings *(Figure ES-1)*. Wind and solar photovoltaics use virtually no water during operation, and generating power from methane gas captured at landfills or wastewater treatment plants consumes no water. Geothermal power plants typically use negligible amounts of freshwater, though they may use larger quantities of water high in salts or other minerals. Western states are endowed with high-quality wind, solar, and geothermal resources. Tapping these renewables will play an important role in meeting the region's future energy and water demands.

Water Intensity of Electricity Generation

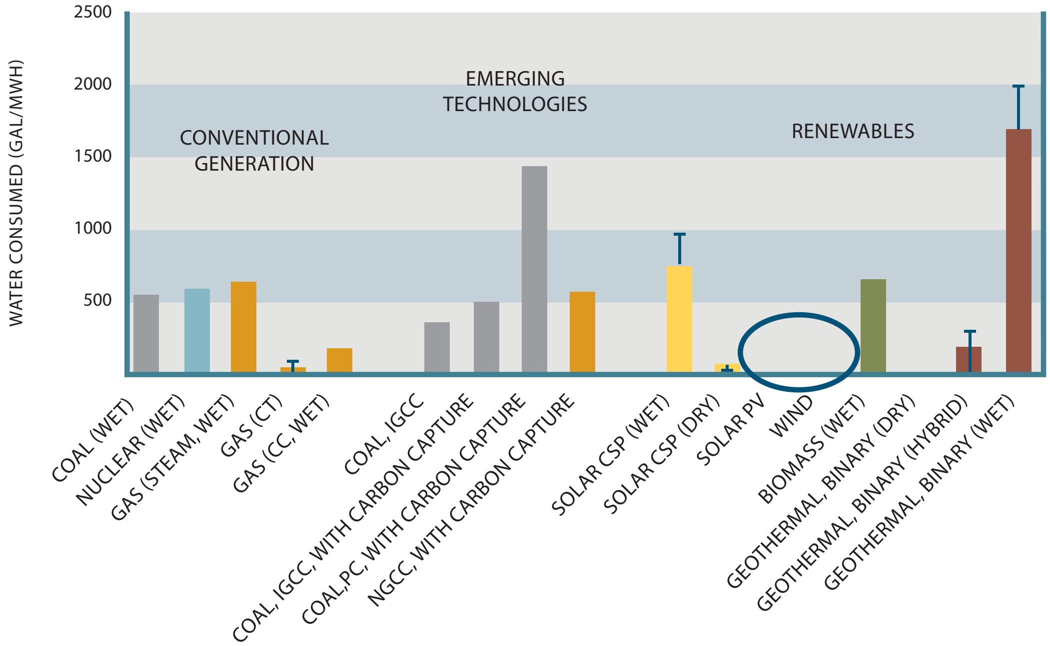


Figure ES-1. Water use for electricity generation varies substantially. Importantly, renewables like wind and solar photovoltaics (PV) use virtually no water. Water use for geothermal plants can range substantially, but most geothermal plants in the Interior West use negligible amounts of freshwater, as they usually rely on water high in salts or other minerals for cooling.

Smart Water Policies Are Smart Energy Policies

An overwhelmingly arid region, the West has developed around its limited water supplies. But providing clean, safe, drinkable water often requires substantial amounts of energy, and rising water demands translate directly into new energy demands. Most western cities already have tapped the cheapest, easiest water supplies. New water supplies will, in most cases, be more energy-intensive than existing supplies — groundwater pumped from greater depths, water conveyed over longer distances, and use of lower-quality water (requiring more advanced treatment) all will demand more energy than existing supplies *(Figure ES-2)*. Indeed, almost every western state has at least one proposed new energy-intensive water supply project.

Energy Intensity of the West's Water Supplies

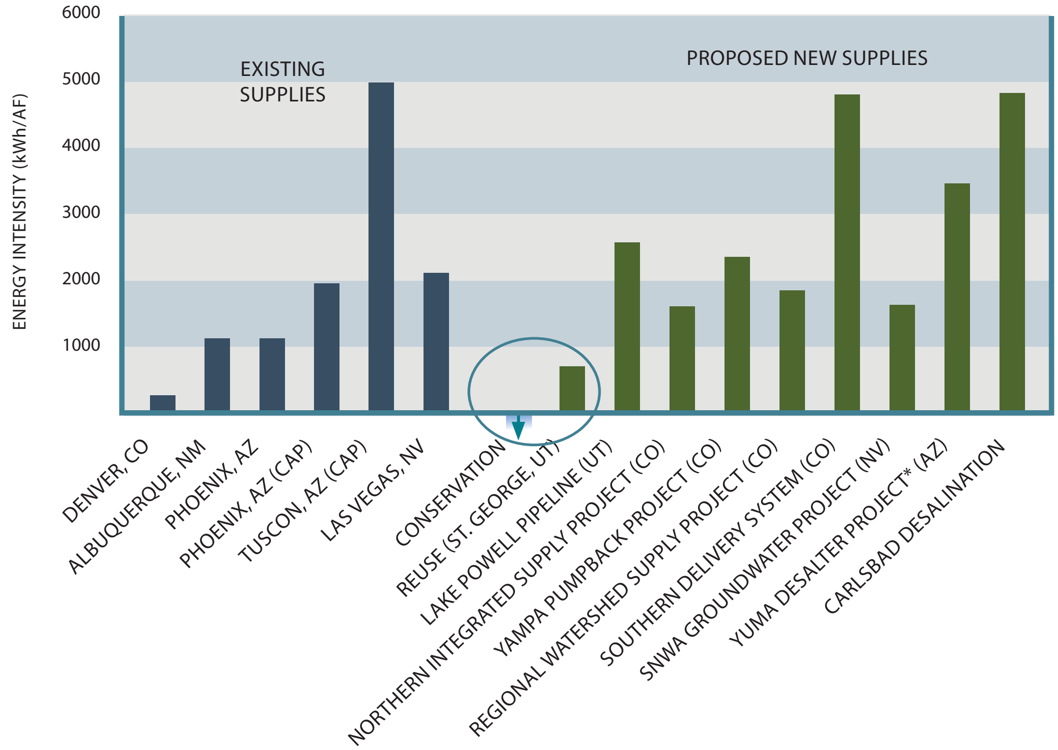


Figure ES-2. Western water supplies use energy today, but many of the West's proposed new supplies — except reuse and additional conservation — will be more energy-intensive.

*The Yuma Desalter uses energy on-site and additional energy is used to pump water to the Metropolitan Water District, Las Vegas, and Phoenix.

Western water utilities have an important role to play in reducing energy use and greenhouse gas emissions, by adopting robust water conservation programs and avoiding energy-intensive new water supplies. Many western water utilities have already made demonstrable progress. In 2008 alone, conservation programs adopted by the Albuquerque Bernalillo County Water Utility Authority (ABCWUA) saved over 19 billion gallons of water and an estimated 138,000 megawatt-hours (MWh) of electricity. Since the utility initiated its water conservation programs in 1994, *the cumulative greenhouse gas emissions avoided total one million tons of carbon dioxide*.

Since it started its water conservation program in 1994, Albuquerque's water utility has saved over 136 billion gallons of water and over 1 million tons of carbon dioxide.

Albuquerque, along with other western cities like Tucson, Denver, and Las Vegas, has made great strides in water conservation, but much more is possible, and will be essential with the impacts of climate change and continued population growth. A comprehensive climate and energy policy would provide incentives for utilities to pursue robust, energy-smart water supply strategies.

Protecting the Lifeline of the West

Minimizing climate change and managing the change that is already underway requires immediate, comprehensive action. Policies that work to reduce greenhouse gas emissions will help protect western water supplies — the foundation of our agricultural communities, cities, and recreational industry. A national policy to cap and reduce global warming pollution can change our course by protecting the climate — and stimulating win-win projects that steward our precious water supplies and increase the use of clean energy.

The following measures are essential to the current and future prosperity of the West:

1 | Adopting comprehensive, national climate and clean energy legislation.

The West has already pioneered a variety of state and local solutions for transitioning to a clean-energy and water-smart economy. A well-designed national climate policy will strengthen existing efforts and will protect the West's economy and environment for decades to come.

2 | Implementing energy-efficiency measures in homes, businesses, and the industrial sector.

Energy-efficiency measures provide tremendous energy and water savings, while saving customers money. Installing efficient lighting or space cooling equipment, along with actions as simple as planting shade trees, can generate important energy savings in existing buildings. Following Leadership in Energy and Environmental Design™ (LEED™) guidelines or similar green building principles can reduce new buildings' energy and water demands and greenhouse gas emissions. State and national efficiency policies that establish standards for utilities, appliances, or building codes are a key component of accelerating the adoption of efficiency measures. In the West, NV Energy has been a leader on energy efficiency, with efficiency programs that target the residential, commercial, and industrial sectors and consistently surpass the utility's expected savings.

3 | Expanding the region's reliance on carbon- and water-efficient sources of energy.

Renewable energy from wind, solar, geothermal, and sustainable biomass resources are lower emitters of carbon dioxide, and many sources of renewable energy consume very little water. State renewable electricity standards have fostered electric utilities' transition toward cleaner sources of energy. Renewable energy resources are also an effective hedge against volatile fossil-fuel prices. Colorado's renewable energy standard, passed in early 2010, will require investor-owned utilities to supply 30% of their power from renewable sources of energy by 2020. The state's renewable energy standard has had important effects on the ground — Colorado now has over 1,200 MW of wind power installed, and Xcel Energy, the state's largest utility, leads the nation in wind power. Colorado's wind investment saves an estimated 1.6 billion gallons of water *each year*.

4 | **Accelerating efforts to improve urban water conservation.**

Municipal water utilities can create incentives for customers to purchase water-efficient indoor appliances and to expand the use of drought-tolerant landscaping. Incentives include direct rebates, as well as rate structures that promote efficiency. Much of the West's new water demands will occur in new communities. Municipal planning authorities can reduce these new demands by promoting or requiring locally appropriate landscapes in new developments and providing incentives to developers who design and build "water-smart" communities. For example, county permitting authorities provided financial incentives to the developers of the community of Rancho Viejo, NM, a model of new water-smart development in the Southwest.

5 | **Expanding use of recycled water.**

Recycled water can serve as a dependable, affordable alternative to potable water supplies, while in many places reducing energy use. To reduce the up-front costs of installing new recycled water pipelines and retrofitting plumbing systems, state and local governments can provide financial incentives. In regions where potable water supplies are particularly energy-intensive, energy utilities should also be encouraged to invest in recycled water infrastructure as a means of meeting energy efficiency targets. Tucson, Arizona, has invested in an extensive recycled water system; expanding the city's reliance on recycled water could delay the city's need to develop new water supplies, and avoid higher costs and expansive energy needs.

6 | **Advancing new, emerging technologies that optimize reductions in carbon emissions and water use.**

To the extent the West continues to rely on fossil fuels, utilities, developers, and industry must deploy technologies that minimize emissions and impacts on water resources. Advanced coal projects to mitigate carbon emissions must also mitigate water use; for example, to reduce the water needs of an integrated gasification combined cycle (IGCC) plant, the plant should employ a hybrid or dry cooling system. Certain water- and carbon-intensive energy sources, like oil shale, must not be developed until technologies advance sufficiently to eliminate the severe global warming pollution and water use.

State public utility commissions have an important role in evaluating the water use of power plants. For example, the Arizona Corporation Commission is investigating ways to integrate the value of water into electric resource planning. And in 2010, Arizona Public Service began reporting water use for existing facilities and proposed resource plans. Regulators and utilities in other states should follow the steps taken by Arizona.

7 | **Working collaboratively to move away from the most polluting, water-intensive resources.**

Retiring the region's aging, high-emitting power plants will open opportunities for new, durable technologies that provide economic growth and protect the region's natural resources. Collaboration by utilities and stakeholders around the region can help carry out a smooth, cost-effective transition to lower-emitting, water-wise resources, similar to the collaboration reflected in Colorado's 2010 Clean Air-Clean Jobs Act. Government agencies and public utility commissions will play an essential role in finding the right balance of incentives and guidelines to drive creative, collaborative solutions. We encourage these agencies to recognize the water, carbon, health, and economic benefits of retiring aging coal plants and replacing them with cleaner resources.

For years, state and local governments have taken the lead in developing climate-friendly clean energy and water supply strategies — this leadership must continue in the future. But the potential costs of climate change — to the West's communities, economy, and water resources — demand federal leadership.

For the transition to a clean energy economy to succeed, collaboration will be key. A protective federal climate change policy will provide the essential framework for innovation and economic development, and state agencies, public utility commissions, and local governments will have an essential role in carrying out a smart, smooth transition to a clean energy economy.

Safe, clean, reliable water supplies are the lifeline of western communities. A rigorous national climate and energy policy can create incentives for smart energy and water choices, while protecting our communities and our water supplies and our economy from the potentially devastating impacts of a changing climate.

A well-designed national climate and clean energy policy will safeguard the West's water.

1 | INTRODUCTION

From the sunny metropolises of southern Arizona and Nevada to the windy plains of Colorado, the Interior West is a dynamic center of growth in the U.S. The West is also an overwhelmingly arid region that has been shaped by its scarce water supplies. The West's major urban areas, projected to see considerable population growth in the coming decades, depend on water supplies to sustain and support growth *(Figure 1)*.[1] And water is vital for the agricultural industry, the bedrock of our rural communities, as well as our growing recreational sector.

Climate change threatens western water supplies, the foundation of our economy. By reducing snowpack, lengthening droughts, and increasing water needs, climate change is poised to alter the reliability of the region's water supplies. The path of climate change is not fixed, however; a national, comprehensive climate change policy is essential for protecting western water supplies. A robust policy would create incentives for renewable energy and energy efficiency, both of which typically use less water than conventional fuels. And it would incentivize creative, resilient, water supply strategies that minimize new strains on energy resources.

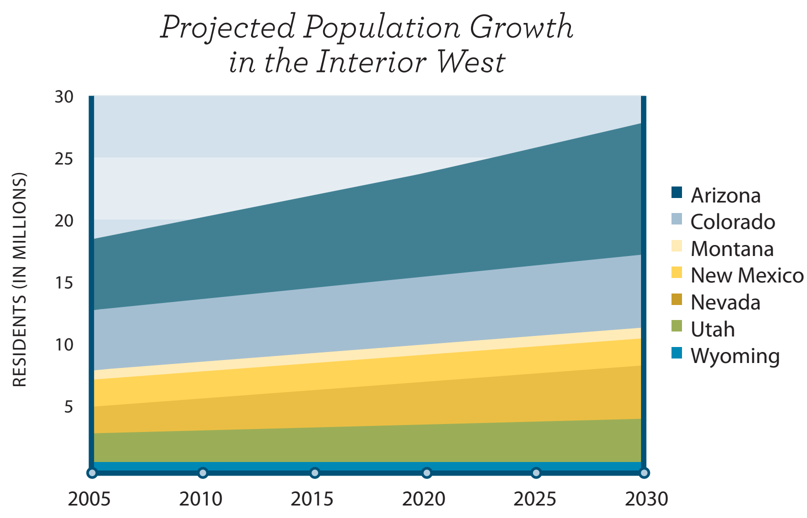


Figure 1. The population of southwestern states is projected to grow by over nine million new residents between 2005 and 2030.[2]

Absent prudent planning, competing demands for the West's limited water resources are set up for conflict. Growing urban electricity demands could create additional water demands, straining supplies essential for agricultural production and vital aquatic ecosystems. New water supply projects could create major new energy demands — further contributing to climate change.

But coordinated, smart climate and energy policies can protect the West's limited water resources, ensuring that western communities, the agricultural industry, and the burgeoning recreational sector will continue to have clean, safe, reliable water for decades to come.

This report illustrates the key connections between climate change, energy, and water in the West:

- **Chapter 2** reviews the large body of evidence demonstrating that climate change is already adversely impacting western water supplies and that these impacts are projected to grow more severe without action to mitigate global warming.
- **Chapter 3** evaluates energy options through the lens of water use, finding that fossil-fuel-based electricity and transportation fuels consume significant amounts of water, while tapping efficiency and renewable energy could reduce the freshwater consumption used in energy production.
- **Chapter 4** evaluates water supply strategies through the lens of energy use, highlighting how proposed new water supply projects are highly energy-intensive, while increasing water use efficiency can save substantial amounts of energy.
- **Chapter 5** summarizes the challenges we face and the climate, energy, and water policies that will be essential for solving them.

We focus on the states of the Interior West — Arizona, Colorado, Montana, Nevada, New Mexico, Utah, and Wyoming. The communities and landscapes of these states are far from homogeneous, yet all of them face similar pressures of growing populations and dwindling water supplies. And all of them have expansive energy-efficient and low-emitting resources.

Throughout this report are case studies of water and energy projects and policies in the Interior West. These case studies examine how a protective national climate policy incentivizes mutually beneficial water and energy choices that provide the foundation for sustained prosperity. The first case study focuses on a new law in Colorado that provides for a smooth and coordinated transition away from aging, high-emitting, and water-intensive coal-fired units in the Denver metro area. The power plants, located in the South Platte Basin, compete directly with the expanding water demands of nearby cities, rural farming communities, and the environment.

The challenges in the South Platte and throughout the region are not insurmountable. National climate policies will drive innovative solutions that will strengthen our clean energy economy, create jobs, and protect our limited water supplies.

Tucson, Arizona

COLORADO'S CLEAN AIR-CLEAN JOBS ACT: AN INNOVATIVE WESTERN SOLUTION

Westerners have a long history of forging unique partnerships and innovative solutions; Colorado's Clean Air-Clean Jobs Act, passed in 2010, is a recent example. Air quality in Front Range communities has suffered, due in part to emissions from several aging coal units. One of these plants, the Cherokee Station, is located in downtown Denver and emits over 21,000 tons of sulfur dioxide and nitrogen oxides and 5,716,000 tons[3] of carbon dioxide (CO_2) each year. And the plant consumes over 2.5 billion gallons of water from the South Platte, which, for much of the year, leaves only a trickle below the power plant's intake. The solution pioneered by environmental and industry groups will help remedy these problems.

In the coming months, Xcel Energy will evaluate the potential for natural gas and other lower-emitting resources, including energy efficiency, to replace the utility's aging coal-fired power plants, like the Cherokee Station. Retiring the Cherokee Station will reduce air pollution and health impacts on neighboring low-income communities — estimated to impose over $90 million[4] in health-harming impacts each year — and presents a pivotal opportunity for restoring the South Platte to a more healthy, flowing river. Reducing water use by the power plant will provide other benefits, too: the South Platte is fully or over-allocated, and additional water could be used by the region's growing cities and irrigated farms.

The South Platte is not unique. Throughout the West, rivers, aquifers, and lakes are stretched to their limits, and climate change and population growth will create further strains. An integrated clean energy and water-wise strategy will provide key opportunities to reduce air pollution and protect the region's water resources.

2 | CLIMATE CHANGE JEOPARDIZES THE WEST'S WATER

Climate models project that, in the Southwest, droughts of the past will become the norm, and future droughts will be more severe than any experienced in centuries (Seager et al., 2007).

Dry riverbed, Arizona

Wallace Stegner wrote that the abiding unity of the American West is aridity. The whole fabric of the West is woven from human communities, land, plants, and animals that depend on a fragile supply of water, which in turn is sensitive to a changing climate. Climate change complicates every challenge the West is facing. Recognizing that "[w]ater is, quite literally, the lifeblood of the Southwest," the U.S. Global Change Research Program found that "[t]he prospect of future droughts becoming more severe as a result of global warming is a significant concern, especially because the Southwest continues to lead the nation in population growth."[5]

The U.S. Global Change Research Program has concluded that "[h]uman-induced climate change appears to be well underway in the Southwest."[6] During the 20th century, global average surface temperatures increased by 0.6°C (1°F). Multiple data sets confirm widespread warming in the western U.S. over that same period, consistent with the global trend.[7] Even without more warming, extremely hot summer temperatures already are pushing the boundary of livability in many parts of the desert Southwest, with air conditioning loads in cities like Phoenix and Las Vegas straining electrical supplies.

Climate change is already impacting western water resources. Although the continental U.S. generally became wetter during the 20th century, scientists analyzing long-term observational trends report evidence of increased drought severity and duration in the western U.S.[8] Scientists have found that warming in the Southwest is among the most serious in the nation, with rising summertime temperatures and challenging water cycle changes:

Recent warming is among the most rapid in the nation, significantly more than the global average in some areas. This is driving declines in spring snowpack and Colorado River flow. Projections suggest continued strong warming, with much larger increases under higher emissions scenarios compared to lower emissions scenarios. Projected summertime temperature increases are greater than the annual average increases in some parts of the region, and are likely to be exacerbated locally by expanding urban heat island effects. Further water cycle changes are projected, which, combined with increasing temperatures, signal a serious water supply challenge in the decades and centuries ahead.[9]

The Intergovernmental Panel on Climate Change (IPCC) projects that over the next century, global average surface temperatures will increase by 1 to 5ºC (2 to 9ºF), depending on what steps are taken to reduce emissions of greenhouse gases.[10] Temperatures in the U.S. are likely to increase by 1 to 4ºC (2 to 7ºF). With prompt action to reduce greenhouse gas emissions, scientists believe we can avert the more drastic changes at the high end of their warming projections.[11]

In the Interior West, climate change projections are most troubling for the Colorado River, the major source of fresh water for over 30 million people and 1.4 million acres of farmland.[12] The Colorado River's flow is over-allocated among the seven states that make up its upper and lower basins in the U.S. and the two states in Mexico. Finding water to supply this region's brisk growth is already a challenge. More importantly, *actual* water use now exceeds available supplies *(Figure 2)* and any reduction in runoff will result in a shortage to current water users — farmers, cities, power plants, and others. At present, an 11-year drought in the basin has reduced storage in the two main reservoirs, Lake Mead and Lake Powell, to 55% of capacity.[13] Runoff in 2010 will not likely relieve drought conditions; total inflows into Lake Powell are projected to be only 63% of average.[14]

"We are already seeing significant climate-change related impacts to our water resources from a variety of sources, including some unanticipated and disturbing."

- Brad Udall, Director, Western Water Assessment

Recent projections indicate that as climate change advances, the West is likely to become drier as well as hotter. In a recent, comprehensive assessment, researchers found that 46 of 49 global circulation model simulations project a more arid southwestern U.S. in future years.[15] Looking forward to mid-century, 23 of 24 global circulation model (GCM) runs project decreased runoff for the upper Colorado River, the source of most of the basin's water, on the order of 5 to 20%.[16] *Figure 3* illustrates projected changes in runoff in basins throughout the nation, with the most severe reductions – and the most certainty in model projections – in the Colorado Basin. Ominously, climate change models predict that droughts will become the norm in the Southwest and that some will be more severe than any experienced in centuries.[17]

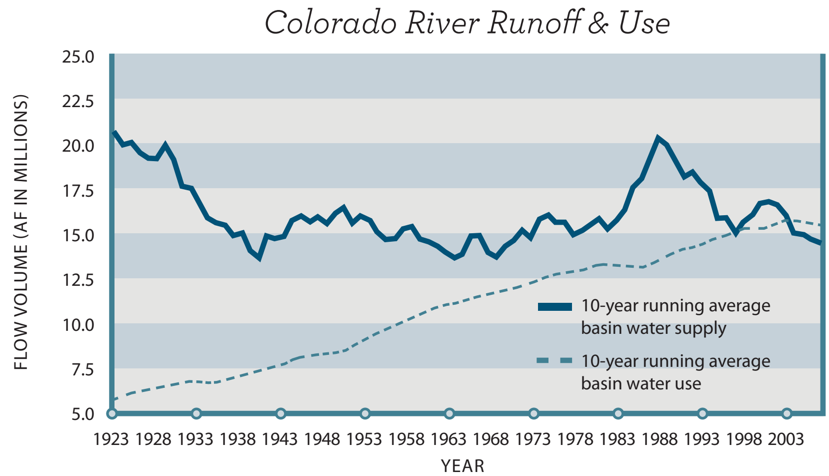


Figure 2. In the Colorado River Basin, consumptive water use already exceeds available supplies. Any reductions in water supplies will result in unmet demands.[18]

While water availability is projected to decrease in the western U.S., global climate models also project that intense rainstorms will become more common;[19] this in turn would increase soil erosion, especially on arid lands. Water managers are tasked with the responsibility of safely managing floods and storing water for future municipal or agricultural needs. More intense or unpredictable rainstorms make both tasks more challenging.

Beyond affecting water supply, warmer temperatures also affect water quality and suitability as fish habitat. Researchers examining this response found that the effect of doubled CO_2 concentrations on lake water temperatures could cut in half the habitat available for cold-water fish, while habitat for warm-water fish would increase.[20] A warmer and drier climate in the western U.S. would reduce stream flows as well as increase stream temperatures, with severe consequences for cold-water fish, such as native trout. Warmer temperatures and reduced stream flows also enhance the growth of nuisance aquatic organisms, such as blue-green algae, which in turn can lead to low-oxygen conditions that threaten aquatic life.[21]

Projected consequences of a warmer, drier climate in the West include increases in the number and frequency of wildfires, insect outbreaks, and invasions of exotic plants. The increase in the frequency and intensity of western wildfires since the mid-1990s has been strongly associated with rising spring and summer temperatures and earlier spring snowmelt.[22] Climate models project a significant upsurge in number of days with high fire danger in the West;[23] as forest fires become more frequent, water quality is expected to decline. For example, in the midst of severe drought in 2002, the Hayman fire — Colorado's worst wildfire to date — roared through forested lands surrounding the South Platte River.[24] To deal with ensuing flood and sedimentation problems, Denver Water was forced to temporarily drain one of its reservoirs on the South Platte.

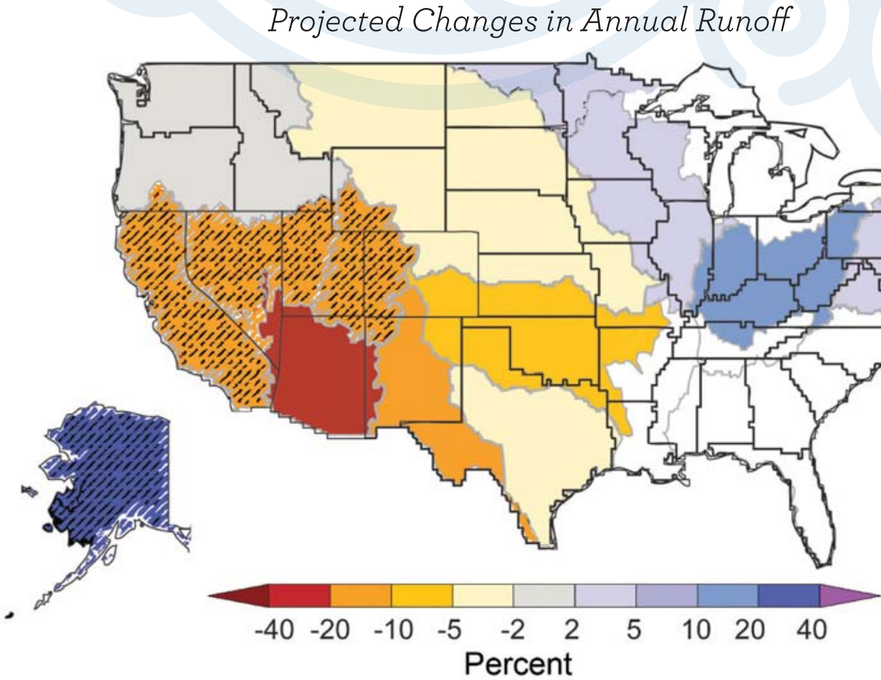


Figure 3. By the time period 2041–2060, median runoff in southwestern watersheds is projected to decline. Percentage changes are relative to a 1900–1970 baseline; hatched areas reflect strong agreement among models (> 90%). Results are based on emissions in between the lower- and higher-emissions scenarios.[25]

For scenarios that assume steadily increasing greenhouse gas concentrations, climate projections for the western U.S. present a stark forecast of critical resource management, infrastructure, and human health challenges.

But the path of future climate change is not fixed; rather it depends on what steps are taken to reduce emissions of greenhouse gases. Minimizing the magnitude of climate change and its impacts and managing the change that is already underway requires immediate, comprehensive efforts. Policies and actions must work to both reduce greenhouse gas emissions globally and increase the efficiency of energy and water use in the region.

THE WEST'S GROWING OUTDOOR RECREATIONAL INDUSTRY

Many of the West's most popular outdoor activities — fishing, rafting, kayaking, skiing, and camping, among others — have grown into valuable, dependable economic sectors. In the West, fishing alone generated over $2.9 billion in gross revenues in 2006 (Figure 4).[26] Other projections are even higher. In states like Montana, where outdoor recreation is a major component of the state's economy, it is responsible for an estimated 34,000 jobs and 7.5% of the gross state product.[27]

At the heart of many recreational activities is water. Warmer temperatures and reduced runoff threaten these resources: A recent report estimated that four key trout species could lose 5 to 17% of essential habitat by 2030 due to temperature changes alone;[28] changing patterns of precipitation could amplify these impacts. And in 2002, during Colorado's most severe drought, the economic revenues generated by rafting fell by almost 40%.[29]

A coordinated effort to reduce emissions, protect instream flows and essential habitat, and develop adaptive management strategies will help protect the West's most treasured streams and the economy that relies on them.

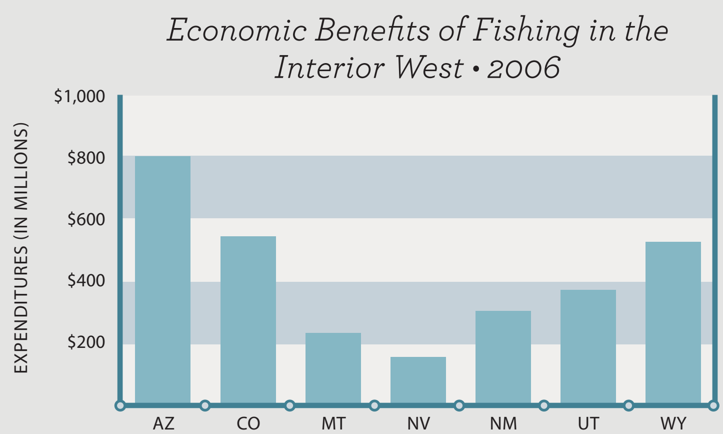


Figure 4. Throughout the West, outdoor recreation is a burgeoning industry. Expenditures on fishing alone amounted to billions of dollars in 2006.[30]

3 | CLEAN ENERGY POLICIES CAN PROTECT WESTERN WATER SUPPLIES

Spanish Fork Wind Farm, Utah

The energy sector is widely recognized as a major source of air pollution. Less well-recognized is the extent to which electricity generation and fuel production depend on and consume water. Energy strategies that rely primarily on fossil fuel resources strain limited water supplies in the West, with water demands increasingly coming into conflict with the needs of other water users. In contrast, a national climate and energy policy would create incentives for efficiency and renewable energy choices with dramatically lower water demands, leaving all westerners better off.

Water for Conventional Electricity Generation

In the Interior West, thermoelectric power plants (e.g., nuclear, coal, natural gas, and biomass-fueled steam cycle plants) withdrew over 680 million gallons of water a *day* (MGD) in 2005.[31] Approximately one-fifth of power plants' water use was groundwater (mostly used in Arizona); the balance was surface water.[32] Because the power plants in the Interior West rely primarily on recirculating cooling systems, approximately 56% of the water withdrawn is consumed — lost to the atmosphere through evaporation. For comparison, the total volume of water consumed by plants in these states is approximately equal to the combined water use of Denver, Albuquerque, Phoenix, and Tucson, combined.

The U.S. Department of Energy recently projected that if electricity generation expands and continues its reliance on fossil fuels, freshwater consumption for thermoelectric power generation in the Rocky Mountain/Desert Southwest region (most of Arizona, New Mexico, Colorado, and Wyoming) would grow by nearly 66%, from about 300 MGD to more than 500 MGD, between 2005 and 2030.[33] If not used for power production, that 200 MGD of water would otherwise be available to meet the needs of almost 2.5 million people.

Rates of water withdrawal and consumption per unit of electricity generated differ dramatically across electricity generation technologies *(Figure 5)*. For thermoelectric power plants, water use is strongly affected by the type of cooling system employed.[34] As the name implies, once-through cooling uses water only once as it passes through a condenser to absorb heat. Most western power plants rely on recirculating or closed-cycle systems, which withdraw substantially less water from rivers or aquifers, but lose almost all of the water withdrawn through evaporation. The most common recirculating configuration uses wet cooling towers to dissipate heat from the cooling water to the atmosphere.

One option for reducing water use for power production is to use air-cooled steam condensers, eliminating the need for cooling water. In the U.S., only about 1% of electrical generating capacity uses air cooling, which is a relatively expensive option.[35] Use of this technology may expand in the future as water availability increasingly constrains power generation options. Another alternative is hybrid cooling systems, which utilize both wet and dry cooling, depending on water supplies and weather conditions. Xcel Energy's Comanche Unit 3 plant in Pueblo, Colorado, will use a hybrid cooling system that is anticipated to reduce water consumption by about 50% compared to a conventional recirculating system.

Emerging technologies like carbon capture and sequestration (CCS) and integrated gasification combined cycle (IGCC) coal conversion technologies will have varied impacts on water resources. IGCC coal plants may use slightly less water than existing coal plants, but CCS is expected to increase water demands. Retrofitting existing coal or gas plants with CCS technologies could be very water-intensive — potentially tripling the water use of a conventional coal plant. However, IGCC coal plants with CCS can minimize carbon emissions and water use by adopting dry or hybrid cooling systems.

THE NAVAJO GENERATING STATION

Perhaps no western power plant illustrates the circular interaction of western water and power infrastructure more than the Navajo Generating Station, located on the Navajo Nation in northern Arizona.

This 2,250-megawatt (MW) coal-fired power plant's three electrical generating units were constructed in the mid-1970s to provide electricity to pump water for the Central Arizona Project (CAP), a series of canals, pumping stations, dams, and reservoirs built to deliver water from the Colorado River to central Arizona. The CAP delivers some of the most energy-intensive water supplies in the West; each acre-foot (AF, or 352,851 gallons) of water pumped to Phoenix requires over 1,500 kilowatt-hours (kWh) of electricity, and to Tucson, 3,200 kWh of electricity. Navajo Generating Station also provides electricity for customers in Arizona, Nevada, and California. Each year, the plant uses about eight billion gallons of cooling water from Lake Powell.[37] The plant burns up to 25,000 tons of coal a day if all units are running at capacity. In 2005, Navajo Generating Station was the seventh-largest power plant emitter of carbon dioxide in the U.S., discharging more than 19 million tons of the heat-trapping greenhouse gas.

The owners of the Navajo Generating Station have recently extended the cooling water supply pipeline in Lake Powell, out of concern that cooling water might not be available under persistent drought conditions. The impetus for this move was the Southwest drought that began around 2000, dropping the water level in Lake Powell from nearly full in 1999 to about 30% of capacity in March 2005.[38]

Win-Win Solutions: Renewable Energy and Energy Efficiency

Renewable sources of energy and energy efficiency can provide important water savings. In contrast to thermoelectric technologies, wind and solar photovoltaics use very little water during operation. Similarly, microturbines that generate power from methane gas captured at landfills or wastewater treatment plants consume no water. Geothermal power plants typically use negligible amounts of freshwater, though they may use larger quantities of water high in salts and other minerals (which are generally unsuitable for municipal or agricultural use).

The water saved with renewable energy or energy efficiency can be substantial. For example, replacing just one 500-MW pulverized coal (PC) plant[39] with wind turbines capable of producing an equivalent amount of energy would save nearly 1.9 billion gallons a year of water withdrawals and 1.6 billion gallons a year of water consumption — the annual domestic, consumptive water needs of approximately 50,000 people.

Water Intensity of Electricity Generation

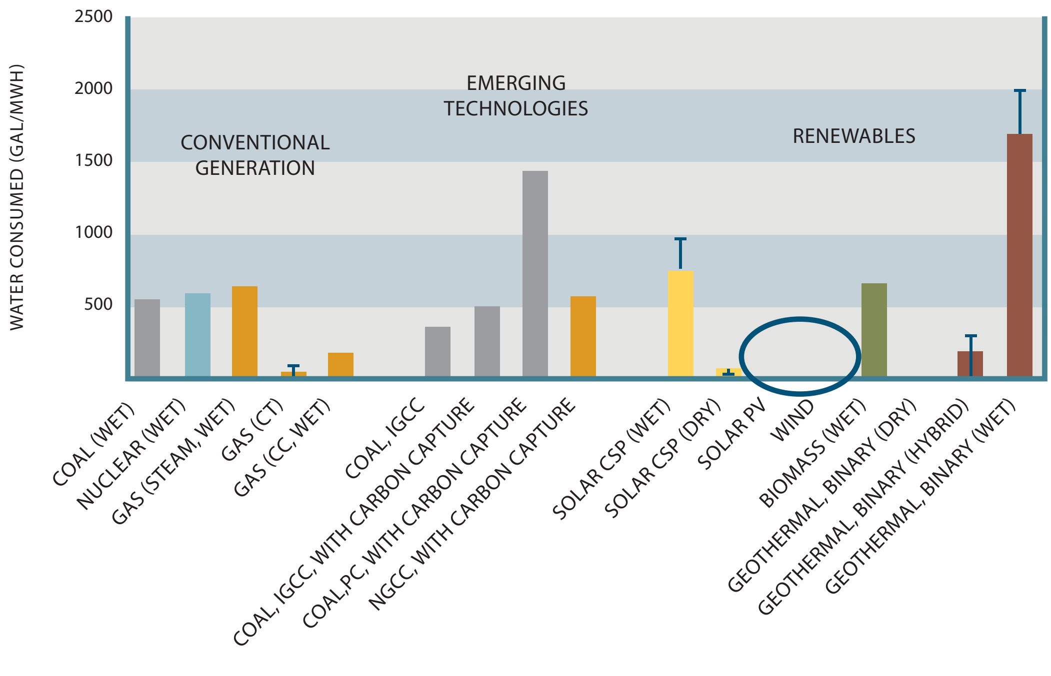


Figure 5. Water consumed for electricity generation varies substantially. Importantly, renewables like wind and solar photovoltaics (PV) use virtually no water. Although geothermal plants appear to use significant amounts of water, they consume minimal amounts of freshwater, as they usually rely on water high in salts or other minerals for cooling.

GEOTHERMAL ENERGY DEVELOPMENT IN NEVADA

Northeast Nevada is a dynamic center of geothermal power. The state is the second-largest producer of geothermal energy, behind California, with thousands of megawatts of new projects in various stages of planning. Geothermal plants can provide reliable, baseload power at a cost comparable to conventional fossil-fuel-based power plants. Unlike most coal or gas plants, however, many geothermal plants can meet cooling requirements with produced water that is high in salts or other minerals, and can be designed to use little or no freshwater. The water savings are particularly important in Nevada, which is located almost entirely within the Great Basin Desert and is the driest state in the nation.

Geothermal plant outside Reno, Nevada

Water Demand for Oil and Gas Production

For the 10 states of the Rocky Mountain Oil and Gas Supply Region, the U.S. Department of Energy (DOE) recently projected water consumption for conventional gas production (processing, transport, and other plant operations) will increase from about 320 million gallons of water per day in 2005 to 450 MGD in 2030,[43] and water consumption for conventional oil production from about 180 MGD in 2005 to 250 MGD in 2030.[44] The DOE notes that these projections may underestimate future water demand in the conventional oil production sector, because they assume the percentages of oil recovered using primary, secondary, and tertiary methods remain constant over time, whereas use of water-intensive tertiary methods may well increase. In any case, the projected increases are substantial, and would exert yet more demand on a water supply system that is already tapped out.

Development of oil shale resources would carry even more dramatic implications for dwindling western water supplies. Oil shale extraction is a highly water-intensive process — directly consuming up to four barrels of water per barrel of oil produced[45] — and is being considered for an especially water-strapped region: the Green River Formation in western Colorado, eastern Utah, and southwest Wyoming. In addition to water and land-use impacts, oil shale also carries a high price in global warming pollution. Studies that account for greenhouse gas emissions over the life cycle of fuel production, refining, and combustion in a motor vehicle indicate gasoline from oil shale would produce from 1.3 to 2.7 times more greenhouse gas emissions than gasoline from conventional oil production, due to the energy-intensity of oil shale extraction processes and, in the case of the upper bound estimate, the potential for decomposition of carbonate minerals.[46]

Farmland in Colorado

"The prospects of oil shale proceeding to high-level development and the prospects of developing water for Front Range growth are mutually exclusive..."

— Colorado River Water Conservation District, 2008

Estimates of the developable amount of oil in the West's oil shale deposits — and the attendant water needs — vary substantially. A recent report prepared for the Colorado and Yampa/White River Basin Roundtables, state-created stakeholder groups in northwestern Colorado, assumed that under a "high production scenario" the industry would produce 1.55 million barrels/day in northwestern Colorado.[47,48] The water demands of an oil shale industry of this size would amount to almost 340 MGD, equal to the water needs of almost 1.9 milloin residents on Colorado's Front Range. Use of such large volumes will place tremendous strains on water resources in these basins. In its environmental analysis of possible oil shale development, the Bureau of Land Management concluded, "water is likely to be transferred from traditional agricultural uses to industrial uses, resulting in the loss of traditional irrigated agriculture."[49]

The technology and economics for oil shale production have not yet been established, so as with past attempts, current development efforts may fail to overcome the technical, economic, and environmental barriers that challenge this technology. As decision-makers examine prospects for oil shale exploitation, implications for water use and global warming pollution must be front and center in their assessments.

4 | SMART WATER POLICIES ARE SMART ENERGY POLICIES

In the arid West, water policies directly impact the energy sector. Water utilities use energy to pump, treat, and distribute potable water supplies; customers use energy to heat, cool, or pressurize water; and wastewater utilities use energy to treat and discharge wastewater (*Figure 6*). Many proposed new water supplies would be more energy-intensive than existing supplies — groundwater pumped from greater depths, water conveyed over longer distances, and lower quality water (requiring more advanced treatment) will all demand more energy than existing supplies.

Alternative water supply strategies, like conservation and reuse, however, require considerably less energy than proposed supplies. Indeed, western water utilities can play an important role in *reducing* energy use and greenhouse gas emissions by adopting robust water conservation and efficiency programs and avoiding energy-intensive new water supplies.

SOURCE & CONVEYANCE ▶ TREATMENT ▶ DISTRIBUTION ▶ END USE ▶ WASTEWATER TREATMENT

Figure 6. Energy is used to pump, treat, distribute, and use potable water, as well as to treat wastewater.[50]


South Platte Bridge, Denver, Colorado

The energy embedded in water supplies varies substantially. Most of Denver's supplies, for example, flow from the Rocky Mountains; Denver Water uses relatively little energy to pump, treat, and distribute water. Even so, in 2007 Denver Water used 51,000 MWh of electricity — equivalent to the annual energy needs of 5,100 Coloradans — to supply its customers with potable water. In contrast, the Central Arizona Project, the single largest consumer of electricity in Arizona, used approximately 2,800,000 MWh of electricity in 2009 to pump water from Lake Havasu to Phoenix, Tucson, and agricultural operations in central Arizona. Tucson, at the terminus of the CAP, has some of the most energy-intensive water in the

Southwest: Delivering an acre-foot of Colorado River water to residents of Tucson uses almost 5 MWh of electricity, not including the energy that customers use to heat water (*Figure 7* and *Figure 8*). While Tucson has had a successful conservation program, the energy intensity of the city's water provides an added incentive for additional conservation and expanded reliance on recycled water.

Energy Intensity of Colorado River Water Supplies in Tuscon, Arizona

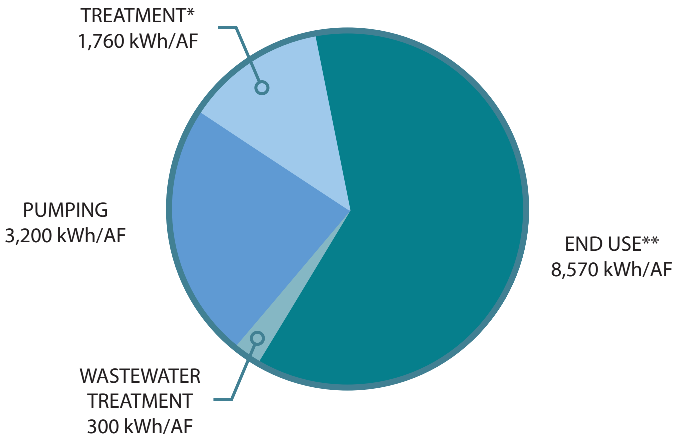


Figure 7. Tucson's Colorado River water, which the city will rely on almost exclusively in the future, is exceptionally energy-intensive.

* Colorado River water is "treated" by using it to recharge local aquifers, mixing it with native groundwater, and pumping it from existing wells.

** End use reflects the average energy intensity of water use by the customer, including outdoor irrigation and the use of hot and cold water indoors.

An array of new proposed water supply projects will, if built, further increase the energy "footprint" of the West's water utilities. Nearly every state has a proposed energy-intensive water supply project (*Figure 8* and *Figure 9*). In Utah, the Lake Powell Pipeline would pump water 160 miles, from Lake Powell to southeastern Utah, and would consume 536,000 MWh of electricity annually. For comparison, the average Utahan uses 10 MWh per year. The energy intensity of water supplied by other projects, like Colorado's Southern Delivery System (SDS), is astoundingly high, at over 4.6 MWh per acre-foot of water.[51] The energy embedded in water delivered by the SDS rivals seawater desalination, the most energy-intensive water supply today. Energy-intensive water supplies have numerous pitfalls, including high operating costs that depend heavily on electricity and fuel costs.

Energy Intensity of the West's Water Supplies

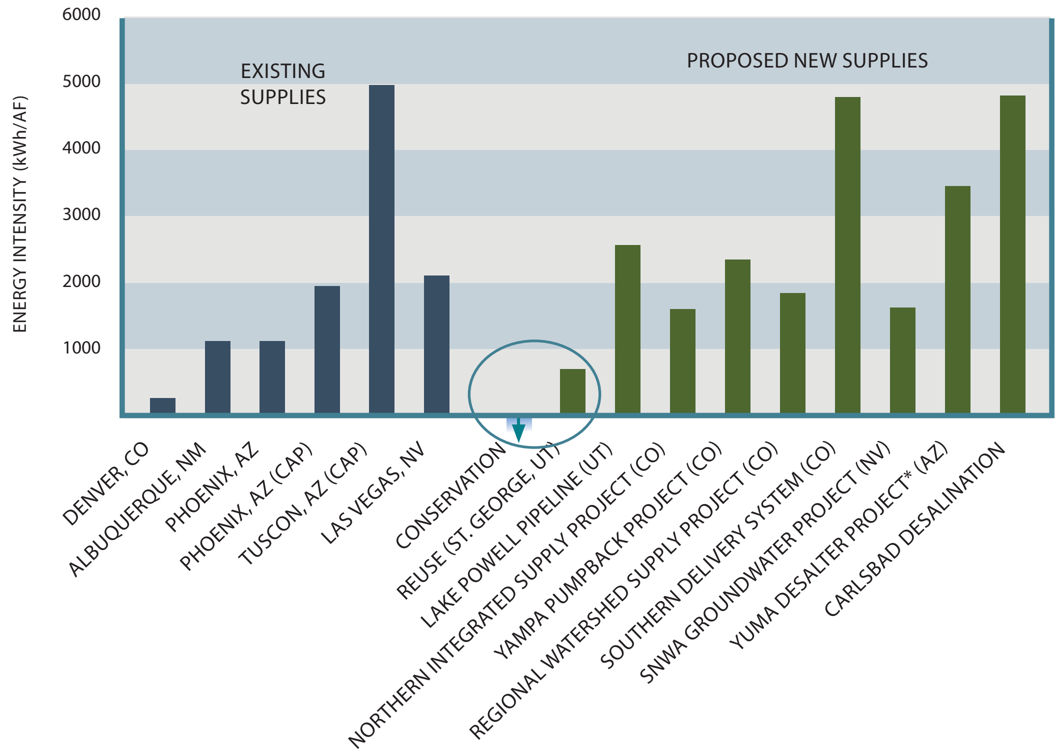


Figure 8. Nearly every western state has at least one proposed new water supply project. Many of these projects will be more energy-intensive than existing supplies. In contrast, water conservation can provide substantial energy savings, and reuse can use less energy than traditional new projects. Figure 9 shows the locations of existing and proposed projects. (Not shown in Figure 8: the Carlsbad Desalination Project, Central Utah Project, and San Juan-Chama Project.)

*The Yuma Desalter uses energy on-site and additional energy is used to pump water to the Metropolitan Water District, Las Vegas, and Phoenix.

Existing and Proposed Western Water Supply Projects

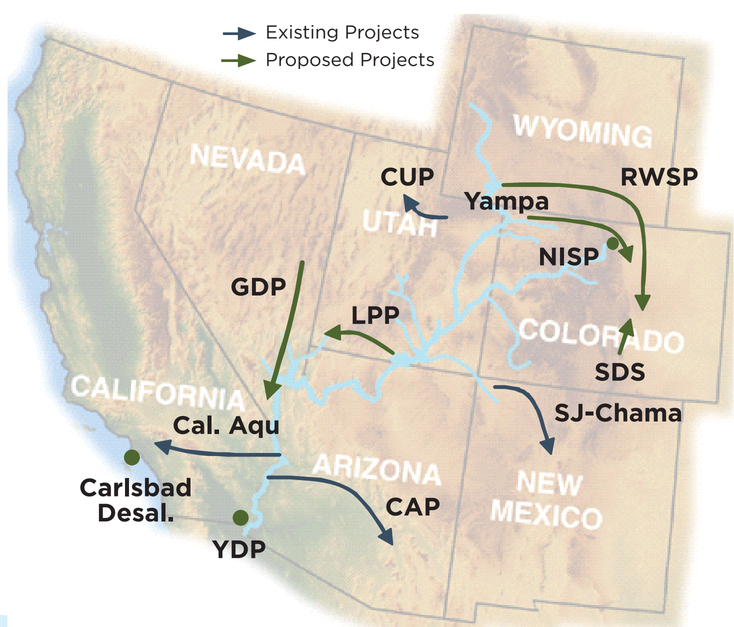


Figure 9. Proposed new water supplies would, as planned, move water over hundreds of miles, often over mountain ranges. (Abbreviations: Carlsbad Desal. = Carlsbad Desalination Project; Cal. Aqu. = California Aqueduct; YDP = Yuma Desalination Project; CAP = Central Arizona Project; GDP = Groundwater Development Project; LPP = Lake Powell Pipeline; CUP = Central Utah Project; Yampa = Yampa Pumpback Project; NISP = Northern Integrated Supply Project; RWSP = Regional Watershed Supply Project; SDS = Southern Delivery System; and SJ-Chama = San Juan-Chama Project.)

In contrast, many western cities have opportunities to avoid developing new, energy-intensive water supplies:

- **Water conservation** serves as a reliable, cost-effective "new" water supply. Residential water use in western cities ranges from 110 gallons per capita per day (GPCD) in Albuquerque to 165 GPCD in Las Vegas.[52] Efficient indoor fixtures and landscapes could reduce that demand significantly — several studies have estimated efficient indoor residential use at 40 to 45 GPCD.[53]

- **Recycled water,** a reliable, drought-proof supply, reduces pressure to develop pristine freshwater supplies and may provide important energy savings.[54] Recycled water uses substantially less energy than seawater desalination, making recycling a particularly attractive alternative in coastal regions where effluent is otherwise discharged into the ocean.

- **Rainwater harvesting systems** — mandated in some southwestern communities — capture rainwater that falls on roofs and use it to water outdoor landscapes.[55] By reducing the use of potable water for outdoor irrigation, rainwater harvesting saves the energy that would have been used to pump, treat, and distribute water to customers.

Each of these measures can provide multiple benefits and will play an important role in meeting the West's future water and energy needs. Of particular importance, however, is water conservation. All water conservation measures reduce the volume of water pumped from ground or surface water sources, treated, and distributed to customers, saving energy at each of those steps. Indoor water conservation measures also reduce the amount of water flowing to a wastewater treatment plant, saving energy at the treatment plant.

Indoor measures that save hot water save energy used by the customer. In fact, in Colorado, heating water represents 14 to 25% of an average household's energy consumption.[56] Simple measures, like replacing older showerheads and faucets with newer, water-efficient models, can dramatically reduce water-related energy use in the home, and often have payback periods of less than a year. Importantly, all water conservation measures delay or eliminate the need to build new, energy-intensive water supply systems.

In the West, water agencies at all levels of government have a long history of collaborative management. Most recently, the Bureau of Reclamation initiated its Colorado River Basin Study, which will assess future water supply and demands in the basin, as well as the potential for conservation, water recycling, aquifer storage, and other measures to meet those demands. The bureau's study will expand and deepen our understanding of basin-wide water stresses and solutions. Meeting the West's growing water and energy demands, while protecting our valuable natural resources, will demand continued collaboration between federal, state, and local water managers.

Arkansas River, Colorado

The responsibility of providing safe drinking water supplies falls primarily on the shoulders of local water authorities, but the federal government plays a critical role. First and foremost, the federal government has the authority to enact comprehensive climate change legislation. The West's water supplies are particularly vulnerable to even modest changes in temperature and precipitation, but by reducing greenhouse gas emissions, we can avoid the most severe impacts of climate change. Second, the federal government can promote research, like the Bureau of Reclamation's basin study, that provides information to western water managers on how to mitigate and adapt to climate change. Third, the federal government can refrain from investing in energy-intensive water supplies when alternatives exist. And finally, the federal government can provide incentives for robust water management strategies, like aggressive water conservation programs.

ALBUQUERQUE: A CASE STUDY IN SMART WATER POLICY

The Albuquerque Bernalillo County Water Utility Authority (ABCWUA) has made impressive strides toward sustainability, on both water and energy. ABCWUA set an ambitious goal of reducing per capita water use by 40% between 1994 and 2015, and is well on its way to reaching that goal. In 2008, Albuquerque residents used 165 gallons per person per day, 34% less than in 1994 (and significantly less than residents of many other western cities).[57,58] These water savings translate directly into energy savings. In 2008, ABCWUA's conservation programs saved over 19 billion gallons of water and an estimated 138,000 MWh of electricity. Since the utility initiated its water conservation programs in 1994, the cumulative greenhouse gas emissions avoided total almost one million tons of CO_2.[59] Importantly, ABCWUA has pursued robust conservation programs that will continue providing water savings in the future, as climate change impacts both weather patterns and water demands.[60]

ABCWUA has also installed methane digesters in its wastewater treatment plant, capturing methane — a potent greenhouse gas — and using it to generate both electricity and heat. In 2008, the treatment plant generated 26% of its power demands. Unfortunately, many wastewater treatment plants flare their methane gas, thereby missing an important opportunity to save energy and greenhouse gas emissions.

5 | PROTECTING THE LIFELINE OF THE WEST

The Interior West has always been a major source of energy resources for America. But expansive reliance on high-emitting electricity resources or new and conventional carbon-intensive transportation fuels could create vast new water demands in an already stressed region, while worsening the impacts of climate change. In contrast, focusing on efficiency and on clean energy resources with low water use can help minimize the strains on our water supplies and climate. Similarly, many new proposals to expand water supplies entail significant electricity demands, while urban water conservation presents a tremendous opportunity to meet future water needs, save energy, and preserve our limited water supplies.

A national policy that addresses the climate crisis is critical for protecting the West's precious water supplies, while spurring innovation in both the energy and water sectors. In water-strapped river basins like the Colorado, innovation and collaboration will be essential for sustaining continued population and economic growth.

Western communities already are pioneering creative solutions: Colorado is phasing out aging, high-emitting coal plants that consume extensive volumes of fresh water, and has recently enacted a new, rigorous renewable portfolio standard; Albuquerque has reduced per capita urban water use by 34% over 14 years; and the Arizona Corporation Commission is investigating how to evaluate water in electric utilities' resource plans. To unleash a new era of western innovation, collaboration, and economic development, the following actions are critical:

1 | Adopting comprehensive, national climate and clean energy legislation.

The West has already pioneered a variety of state and local solutions for transitioning to a clean-energy and water-smart economy. National climate policies will strengthen and accelerate existing efforts and will benefit the West for decades to come.

2 | Implementing energy-efficiency measures in homes, businesses, and industry.

Using energy more efficiently means using less energy to attain the same result — lighting, space cooling, water heating, motor power, and so forth. Greater efficiency can be achieved by substituting more advanced technology for older technology, by changing physical designs, and by changing behavior.

Examples of advanced technologies include more efficient lighting, space cooling equipment, motors and drives, and refrigeration equipment. More efficient design can be accomplished by following Leadership in Energy and Environmental Design™ (LEED™) guidelines or similar green building principles, and by such simple solutions as planting shade trees. Efficiency policies may establish standards for utilities (such as reducing energy sales by a certain amount by a specified time), appliance standards, or building codes. Effective strategies to implement efficiency programs include the following:

- Create visibility for energy efficiency through demonstration projects and other means.
- Offset the high initial cost of some efficiency measures through financial incentives.
- Partner with existing community organizations to mobilize resources for efficiency programs.
- Create opportunities for economies of scale in manufacturing and installation of efficient measures.
- Create transparency concerning energy use, such as informing consumers about their energy use relative to the energy use of similar consumers.

In the West, NV Energy has been a leader on energy efficiency, with programs that target the residential, commercial, and industrial sectors, and consistently surpass the utility's expected savings.

3 | Expanding the region's reliance on carbon- and water-efficient sources of energy.

Renewable energy from wind, solar, geothermal, and sustainable biomass resources are lower emitters of carbon dioxide. Wind energy and photovoltaics have minimal water requirements, and geothermal facilities typically consume very little freshwater. Concentrating solar power (CSP) projects may have large water requirements for cooling steam, but they can also be designed to use dry cooling. Renewable energy resources are also an effective risk management strategy against uncertain fossil fuel prices and future environmental compliance costs for conventional power plants.

Across the West, state renewable electricity standards have fostered electric utilities' transition toward cleaner sources of energy. These standards are employed by many states and require utilities to obtain a specified percentage of their energy from eligible renewable energy technologies by a certain date. Colorado's renewable energy standard, passed in early 2010, will require investor-owned utilities to supply 30% of their power from renewable sources of energy by 2020. The state's renewable energy standard has had important effects on the ground — Colorado now has over 1,200 MW of wind power installed, and Xcel Energy, the state's largest utility, leads the nation in wind power.[61] Colorado's wind investment saves an estimated 1.6 billion gallons of water *each year*.[62]

4 | Accelerating efforts to improve urban water conservation.

Municipal water utilities can create incentives for customers to purchase water-efficient indoor appliances and to replace turfgrass with drought-tolerant landscaping. Incentives include direct rebates, as well as rate structures that promote efficiency. Increasing block rate structures, for example, reward conservation while providing municipal utilities with a dependable revenue stream.

Much of the West's new water demands will occur in new communities. Municipal planning authorities can reduce new demands by promoting or requiring locally appropriate landscapes in new developments and providing incentives to developers who design and build "water-smart" communities. For example, county permitting authorities provided financial incentives to the developers of the community of Rancho Viejo, NM, a model of new water-smart development in the Southwest.[63]

5 | Expanding use of recycled water.

Recycled water can serve as a dependable, affordable alternative to potable water supplies, while in many places reducing energy use. To reduce the up-front costs of installing new recycled water pipelines and retrofitting plumbing systems, state and local governments can provide financial incentives. Water utilities should focus first on large customers, like golf courses and water-intensive industrial operations. In regions where potable water supplies are particularly energy-intensive, energy utilities should also be encouraged to invest in recycled water infrastructure as a means of meeting energy efficiency targets. Tucson has invested in an extensive recycled water system; expanding the city's reliance on recycled water could delay the city's need to develop new water supplies, and avoid considerably higher costs and energy needs.

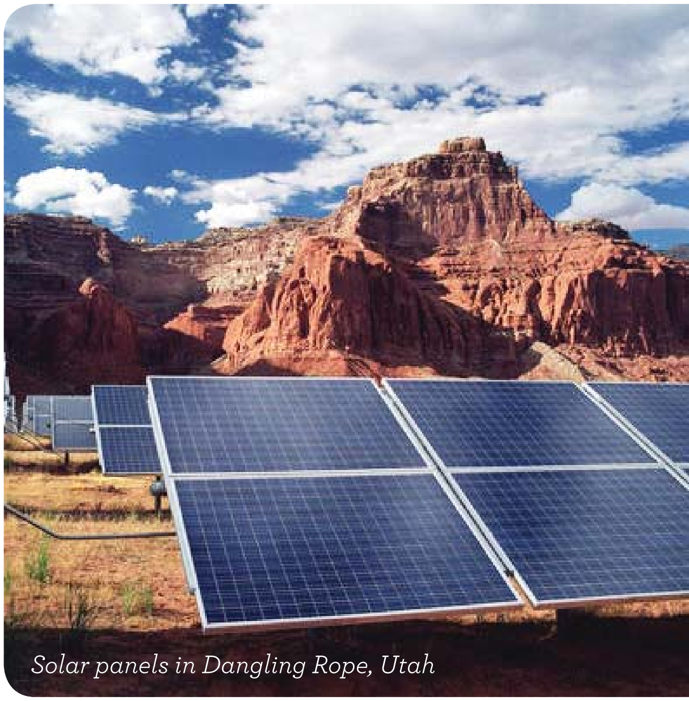
6 | Advancing new, emerging technologies that optimize reductions in carbon emissions and water use.

To the extent the West continues to rely on fossil fuels, utilities, developers, and industry must deploy technologies that minimize emissions and impacts on water resources. Advanced coal projects to mitigate carbon emissions must also mitigate water use. For example, to reduce an IGCC plant's water needs, the plant should employ a hybrid or dry cooling system. Certain water- and carbon-intensive energy sources, like oil shale, must not be developed until technologies advance sufficiently to eliminate the severe global warming pollution and water use impacts.

State public utility commissions have an important role in evaluating the water use of power plants. For example, the Arizona Corporation Commission is investigating ways to integrate the value of water into electric resource planning. And in 2010, Arizona Public Service began reporting water use for existing facilities and proposed resource plans. Regulators and utilities in other states should follow the steps taken by Arizona.

7 | Working collaboratively to move away from the most polluting, water-intensive resources.

Retiring the region's aging, high-emitting power plants will open opportunities for new, durable technologies that provide economic growth and protect the region's natural resources. Collaboration by utilities and stakeholders around the region can help carry out a smooth, cost-effective transition to lower-emitting, water-wise resources, similar to the collaboration reflected in Colorado's Clean Air-Clean Jobs Act. Government



Solar panels in Dangling Rope, Utah

agencies and public utility commissions will play an essential role in finding the right balance of incentives and guidelines to drive creative, collaborative solutions. We encourage these agencies to recognize the water, carbon, and health benefits of retiring aging coal plants and replacing them with cleaner resources.

For years, state and local governments have taken the lead in developing clean energy and water supply strategies, but the potential costs of climate change to the West's communities, economy, and water resources demand federal leadership. Indeed, the urgent challenge of safeguarding the West's water supplies, clean air, and quality of life demand protective action on the part of all levels of government to reduce greenhouse gas emissions. Our case studies underscore the tremendous water and energy solutions that innovative action at every level of government have fostered, from a local water utility to a state legislature. These actions provide an essential foundation for federal climate policies, which represent the strongest, most effective strategy for reducing the nation's harmful global warming pollution.

For the transition to a clean energy economy to succeed, collaboration will be essential. A protective federal climate change policy will provide the essential framework for innovation and economic development, but state and local governments will have an essential role in carrying out a smart, smooth transition to a clean energy economy. The current and future prosperity of western communities depends on safe, clean, reliable water supplies. A rigorous national climate and energy policy can create incentives for smart energy and water choices, while protecting our communities and our water supplies from the potentially devastating impacts of a changing climate.

A well-designed national climate and clean energy policy will safeguard the West's water.

Appendix A | Sources for Water Use Estimates for Energy Generation

Typical water use for electricity generation.

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

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

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

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

Appendix B | Sources of Data for Energy Intensity of Water Supplies

EXISTING WATER SUPPLIES	ENERGY INTENSITY (KWH/AF)	SOURCE
Denver Water	232	*Personal communication with Bob Peters, Water Resource Engineer, Denver Water, June 28, 2008.*
Albuquerque Bernalillo County Water Utility Authority	1,097	*Personal communication with Bagher Dayyani, SCADA Manager, ABCWUA, August 21, 2009.*
Phoenix, Arizona (average)	1,063	*Hoover, Joseph. 2009. The water-energy nexus: electricity for water and wastewater services. Masters thesis, University of Arizona.*
Phoenix, Arizona (CAP)	1,915	*Hoover, Joseph. 2009.*
Tucson, Arizona (average)	1,832	*Personal communication with Tom Arnold, Senior Management Analyst, Tucson Water, March 23, 2010.*
Tucson, Arizona (CAP)	4,960	*Ibid.*
Las Vegas, Nevada	2,078	*Personal communication with Bronson Mack, Las Vegas Valley Water District, June 26, 2009. Personal communication with Charles Trushel, City of Las Vegas, September 1, 2009. Personal communication with Suzette Wheeler, City of Henderson, August 27, 2009.*
NEW WATER SUPPLIES		
Reuse (St. George, Utah)	670*	*Personal communication with Ben Ford, WWTP Manager, St. George, 2010, and Gay Cragun. Response to WRA GRAMA Request, January 29, 2010.*
Lake Powell Pipeline (Utah)	2,556‡#	*Utah Board of Water Resources. 2008. Lake Powell hydroelectric system notice of intent to file an application for original license (volume I).*
Northern Integrated Supply Project (Colorado)	1,600‡	*U.S. Army Corps of Engineers. 2008. Northern Integrated Supply Project draft environmental impact statement, table 4-15. April 2008.*
Yampa Pumpback Project (Colorado)	2,330‡	*Northern Colorado Water Conservancy District. 2006. Multi-basin water supply investigation.*
Regional Watershed Supply Project (Colorado)	1,825‡§	*Colorado Water Conservation Board. 2009. Strategies for Colorado's water supply future, draft report, section 4 and 5. Prepared by CDM.*
Southern Delivery System (Colorado)	4,781‡‡	*U.S. Bureau of Reclamation. 2008. Southern Delivery System final environmental impact statement. December 2008.*
Groundwater Development Project (Nevada)	1,448‡	*Southern Nevada Water Authority. 2007. Clark, Lincoln, and White Pine Counties groundwater development project draft conceptual plan of development.*
Yuma Desalting Plant (Arizona)	3,449†	*Personal communication with Jennifer Pitt, Environmental Defense Fund, 2010.*
Seawater Desalination	4,805‡	*City of Carlsbad, CA. 2005. Precise development plan and desalination plant project environmental impact report, p. 4.2-19.*

* Figure includes tertiary treatment (only) and pumping into the distribution system.

† Figure reflects energy used at the YDP and the energy used to provide "augmented" Colorado River supplies to Metropolitan Water District (80%), Las Vegas (10%), and Arizona (10%).

‡ Figure includes 150 kWh/AF for distribution of potable supplies.

§ Figure includes potential hydropower generation.

Estimate reflects energy used to move water to the St. George area, and does not include the pumped storage reservoir or pumping water to Cedar Valley.

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-- Patricia Mulroy, General Manager, Las Vegas Valley Water District and Southern Nevada Water Authority

“Nature delivers climate change by altering our rivers and streams. What we may see in the future may be very different from what we see today.”

-- Eric Kuhn, General Manager, Colorado River Water Conservation District

“Our nation needs a coordinated response to the challenges of climate change that threaten our water supply, the growing season, and the viability of farming and ranching. We support legislation that takes into account the need of our country for food safety and security and does not place new, unfair burdens on family farmers and ranchers.”

-- Kent Peppler, President, Rocky Mountain Farmers Union

“Those of us who rely on rivers for our livelihoods are already seeing the impacts of climate change - and we’re very concerned. Our concerns demand action.”

-- Julie Eaton, Fly fishing guide and co-owner, Eaton Outfitters, Montana

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