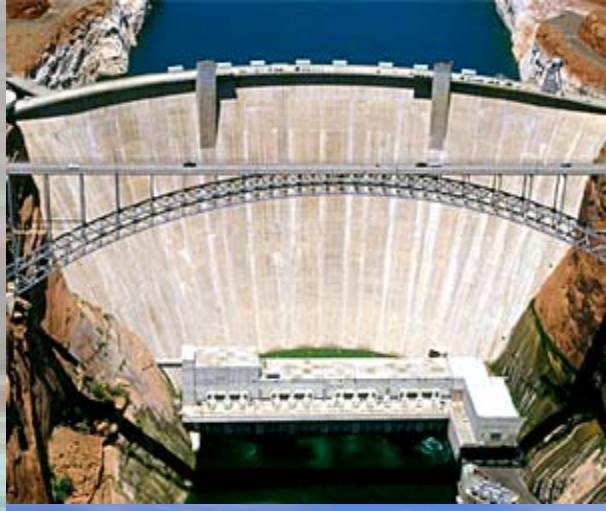
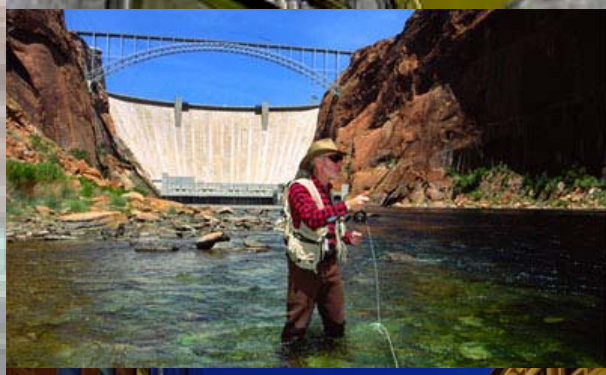
The House of Power and Light:

Hydroelectric Power in the Upper Colorado River Basin





Colorado River Energy Distributors Association

Introduction

The only solution to balance competing societal and environmental needs lies in carefully managing reservoir operations in appropriate hydrologic conditions.

There is a story behind every light switch and power button. In the West, that story is intertwined with the story of settlement, reclamation, recreation and the environment. It is easy to take electricity for granted. But demands are skyrocketing and electrical generation is not keeping pace. Household and commercial electronics, air conditioners, population growth, and even the Internet, are fueling these rising demands.

2006 marks the 50th anniversary of the Colorado River Storage Project Act (CRSP). This landmark federal law authorized the construction of water storage and hydroelectric plants in the Upper Colorado River Basin. Today, CRSP hydropower is one of the most important sources of electricity in the West. But production from even these renewable resources is being restrained in a way that could stress the system to the breaking point.

Two federal agencies operate CRSP reservoirs: the U.S. Bureau of Reclamation (Bureau) and the Western Area Power Administration (Western). Today, they must grapple with societal needs for water and power along with recreational demands and the most powerful and restrictive environmental laws in the world.

Glen Canyon Dam power plant generators - by T. Ross Reeve, courtesy of the Bureau of Reclamation

The only solution to balance these competing environmental and societal needs lies in carefully-managing reservoir operations in appropriate hydrologic conditions.

Courtesy of the Bureau of Reclamation

How electricity works

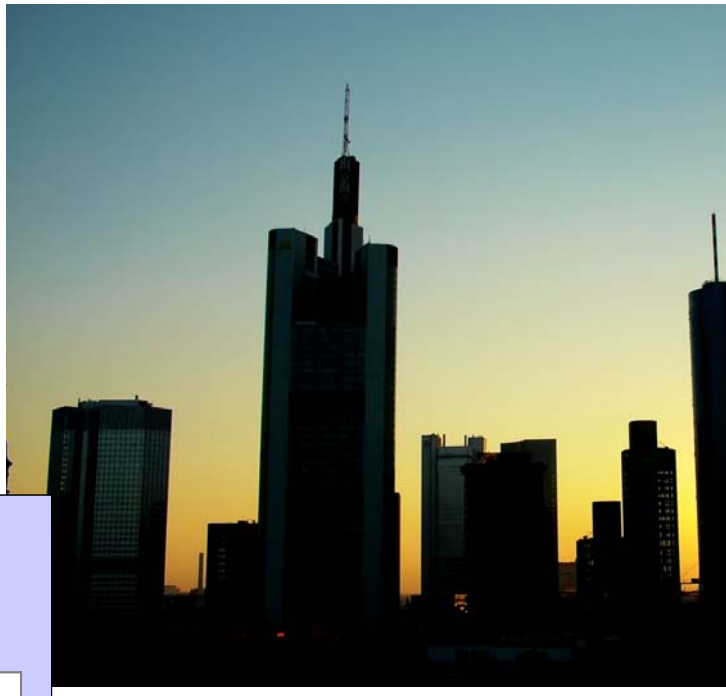
Capacity is the maximum amount of electricity a generator can produce at one time. For example, on an August evening, an average residential consumer may need 3 kW or .003 MW of electricity. Power plants must have enough capacity to produce an average of 3 kW of electricity for every consumer plus additional needs of commercial and industrial customers. In the West, one megawatt generally provides enough electricity for 400 to 900 homes.

Most of the nation's power comes from burning fossil fuels, like coal and natural gas. Unlike these thermal technologies, which exhaust the energy resource used, hydropower relies upon an abundant and renewable energy source -- water. Hydropower Is typically produced at a dam by converting the kinetic energy of falling water into electricity. After running through the turbine, the water returns to the river. Hydropower is the leading renewable energy resource. It provides a low-cost and efficient way of producing electricity with no pollutants. As much as 90% of the fuel flowing into hydropower plants is converted into electricity compared to 35% at traditional fossil fuel burning plants. It has low operating costs and is very reliable. Hydropower also reduces dependence on less environmentally sensitive fossil fuels.

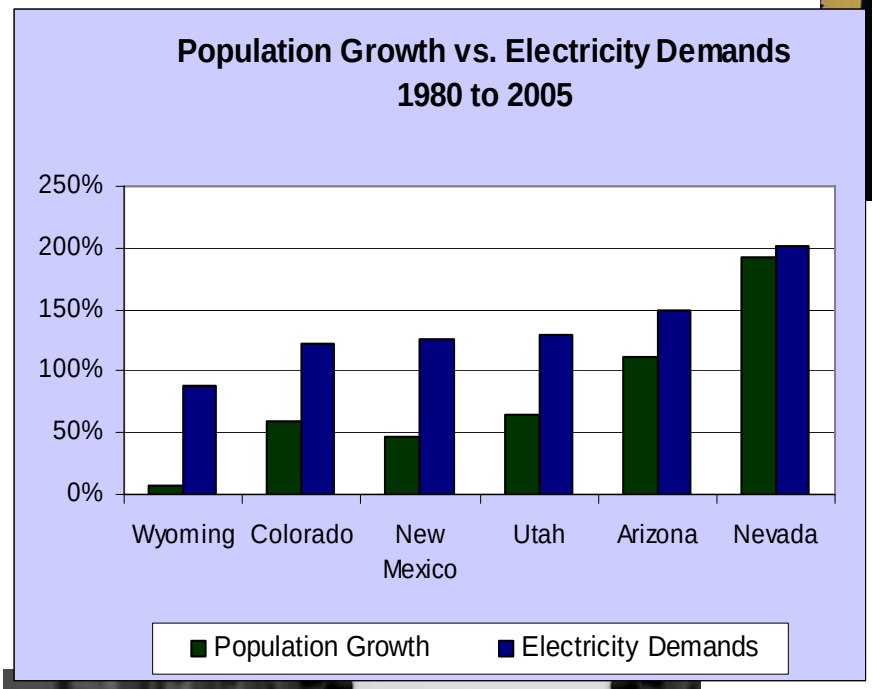
Hydropower helps to reduce dependence on fossil fuels.

Hydropower is key to system reliability of the power grid in the West. Power must be produced and delivered when it is needed. Baseload units, normally fossil fuel plants, provide the minimum amount of electricity necessary to satisfy demand. They run continuously and take a long time to start up again once they are shut down. When temperatures rise or drop and demand for electricity increases, peaking units, like hydropower, step in to compensate for additional demand. Hydropower can ramp-up to meet demands quickly and efficiently. Both baseload and peaking units are essential for a reliable system.

Increasing demands



Over the past 25 years, demand for electricity in the West rose at nearly twice the rate of the population growth. In the Colorado River Basin States of Arizona, Colorado, Nevada, New Mexico, Wyoming, and Utah, the consumption of electricity increased at a far greater rate than even population growth. Collectively, the population of these states grew 71% from 1980 to 2005. At the same time, demand for electricity in these states skyrocketed by 130%. The population of these states is predicted to increase another 54% by 2030. Electricity demands, then, could double <u>again</u> in the next 25 years. The Energy Information Administration (EIA) predicts the need for 347,000 MW of new capacity nationwide by 2030. This amounts to more than 1900 new power plants or approximately 75 new power plants per year. But high costs, limitations on transmission and environmental restrictions present significant barriers to new generation. The National Energy Policy Development Group painted a bleak picture of the future of electricity in the United States, *"Our nation's electricity supply has failed to keep pace with growing demand. This imbalance is projected to persist into the future. The adverse consequences have manifested themselves most severely in the West, where supply shortages have led to high prices and even blackouts. . . ."* Population increases and technological advances, like the Internet, are helping to fuel these rising demands. For example, Microsoft and Yahoo each announced new campuses to handle the servers necessary to operate and provide Internet services to consumers. This infrastructure takes an enormous amount of power. One rack of servers, two feet-by-three feet, takes as much power as 25 homes. And these two Internet giants will have hundreds of thousands of servers in their new facilities. Incredibly, the Microsoft and Yahoo campuses will be located within 1.5 miles of each other in the Pacific Northwest due to an abundant supply of inexpensive and reliable hydropower.



A single rack of computer servers uses as much electricity as 25 homes.

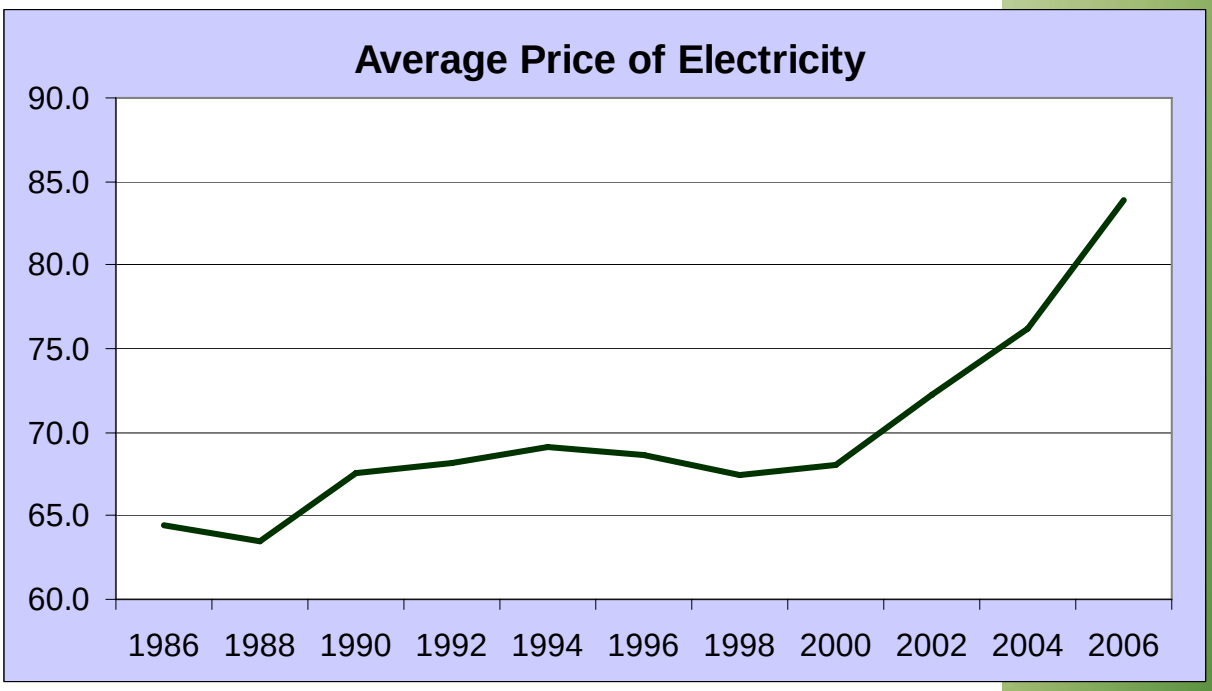
Power shortages

Rising demands, hurdles to building new generation, and restrictions on peaking power sources, like hydropower, contribute to power failures. Blackouts already cost the U.S. approximately $80 billion annually plus countless levels of aggravation and inconvenience. Besides the loss of light, the loss of power can result in water system failures, a complete loss of air and other transportation as well as the interruption of cell phone networks and 911 communications. Even worse, blackouts can tax emergency personnel to the limit, cause fires and lead to the loss of human life. Blackouts are occurring more often across the U.S. due to rising demand and reduced supplies.

EIA predicts the need for 347,000 MW of new capacity nationwide by 2030. This amounts to more than 1900 new power plants or approximately 75 new power plants per year.

Rising prices

When supply fails to keep pace with demand, costs to consumers and businesses rise and reliability falls. In 1970, the average price of electricity was 17.0 mills per kWh. By 2005, the average price was 75.2 mills per kWh. As of April 2006, the price had risen to 83.9 mills per kWh. And prices are expected to continue to climb.



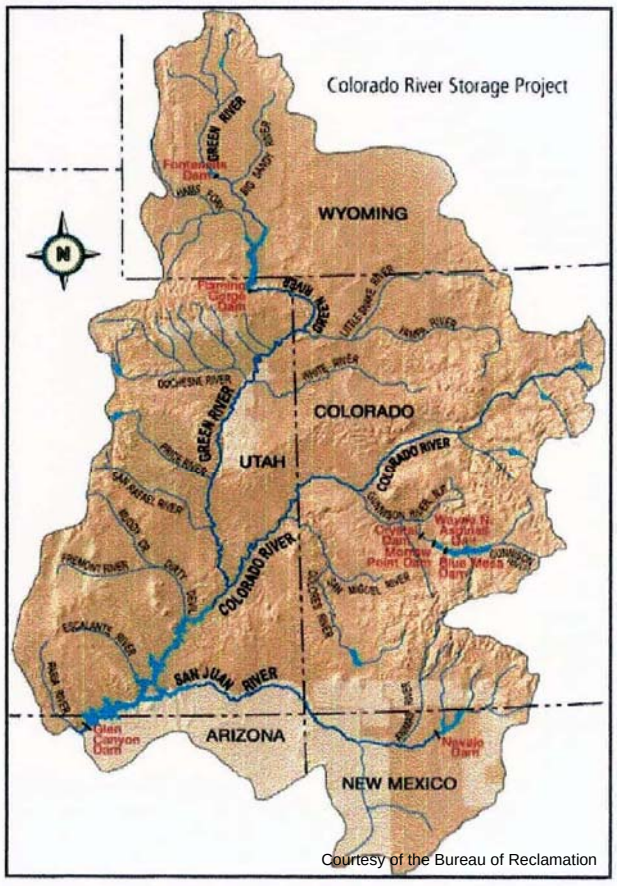
Colorado River Storage Project

CRSP reservoirs have a total storage capacity of 34 million acre-feet and generate enough electricity to supply nearly 6 million homes.

Bringing power to the nation was cause for optimism during the darkest of days. During the Great Depression, for example, one newspaper hopefully predicted that all Americans would one day have electricity. At the time, only 10 percent of Americans outside major cities had electricity.

Fifty years ago, Congress passed the CRSP to develop the water and power resources of the Upper Colorado River Basin. Today, these reservoirs are vital to the existence of towns, cities, industry and agriculture in the West. The CRSP authorized the construction of Glen Canyon, the Aspinall Unit, Flaming Gorge and Navajo dams for the purpose of:

> regulating the flow of the Colorado River, storing water for beneficial consumptive use, making it possible for the States of the Upper Basin to utilize, . . . [their compact apportionments,] providing for the reclamation of arid and semiarid land, for the control of floods, and for the generation of hydroelectric power, as an incident of the foregoing purposes . . . . 43 U.S.C. § 620.

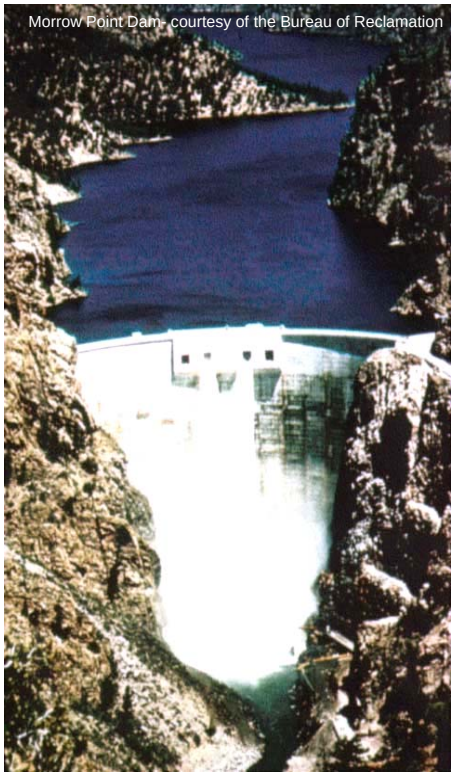


The CRSP inludes dams in three states and provides long-term water storage and hydropower.

CRSP reservoirs changed the arid landscape. Power illuminated the West. With water and power available, towns sprang up and flourished. Productive fields and orchards are now irrigated with the water conserved by reservoirs and used for power production. Recreation has also flourished. Boating and fishing on CRSP reservoirs infuses millions of dollars into local economies. And rafting, kayaking and fly-fishing have become popular activities downstream of the reservoirs.

The CRSP reservoirs have a total storage capacity of 34 million acre-feet and generate enough electricity to supply nearly 6 million homes. Roughly 25% of the nation's food is grown on land irrigated by the Colorado River.

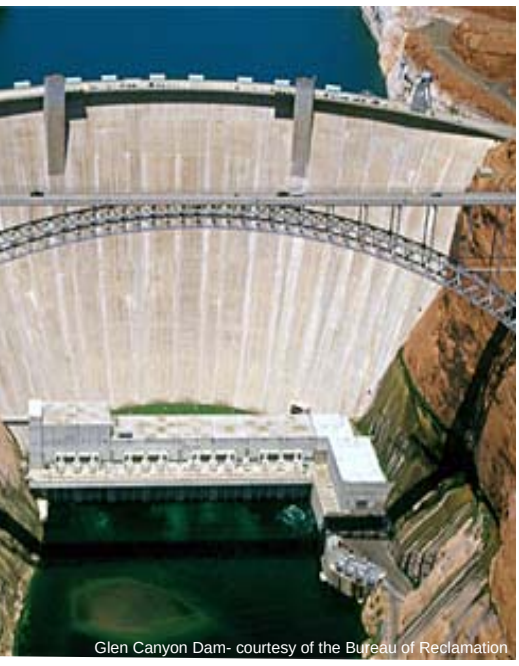
The CRSP power features include generators, substations, and transmission lines. So long as operations do not "affect or interfere with" the interstate water compacts, or contracts there under, Congress mandated that these water projects "produce the greatest practicable amount of power and energy that can be sold at firm power and energy rates." 43 U.S.C. § 620(f).


Morrow Point Dam- courtesy of the Bureau of Reclamation

Glen Canyon Dam, located near Page, Arizona, is the largest of the CRSP projects. Lake Powell, behind Glen Canyon Dam, stores 26,215,000 acre-feet of water when full. Lake Powell is not only a recreational gem in the desert; it provides vital insurance against drought. More than 25 million people in seven states now rely upon water from Lake Powell for survival. Completed in 1963, Glen Canyon has eight generators for a total of about 1300 MW, which is more than 70% of total CRSP generation. It would take up to 3.5 million tons of coal, or 11 million barrels of oil, to generate the same amount of power from Glen Canyon Dam.

Flaming Gorge Dam, located near Vernal, Utah, is on the Green River, a major tributary of the Colorado River. Flaming Gorge has three units with a capacity of about 152 MW. Navajo reservoir in northwest New Mexico and southwest Colorado has a capacity of 547 MW. The Aspinall units include three re-regulating reservoirs and generating plants along the Gunnison River near Gunnison, Colorado. These re-regulating reservoirs can ramp up and down quickly to meet changing demands with little effect on stream flows. They have a total capacity of 275 MW. Blue Mesa is the first dam on the river and has two units producing about 97 MW. Morrow Point is the second dam in the series and consists of two generators producing a total of 146 MW. Crystal is the final dam and has one 32 MW generator.


Crystal Dam- courtesy of the Bureau of Reclamation


Glen Canyon Dam- courtesy of the Bureau of Reclamation

These and other participating projects use CRSP revenues from the Upper Colorado River Basin Fund to help repay project costs that are beyond the ability of irrigators to repay. Guided by the CRSP Act and the complex bundle of laws that govern water and power in the Colorado River Basin (the Law of the River), the Bureau of Reclamation operates CRSP reservoirs on a monthly and yearly basis for water storage and power production, while Western guides generation and sells power on a daily and hourly basis.

The Federal Power Act provides that federal power will be offered for sale to public, municipal and rural electric customers first and then the remaining power, if any, to profit making utilities like investor-owned utilities. All of the CRSP power is now allocated among these "preference" customers. Power revenues pay the bills for reclamation projects in the West. Power also pays for the federal investment in power facilities as well as annual operations and maintenance, interest on the federal investment, and the federal investment in irrigation facilities beyond the ability of irrigators to repay – currently more than 95 percent. In return for a $974 million federal investment in the Upper Basin's CRSP power features, the Treasury will receive more than $5 billion in power revenues: a 500% return on investment. Power revenues also pay for environmental programs like salinity control projects, the Upper Basin Recovery Implementation Program for endangered fish species (RIP), and the Glen Canyon Adaptive Management Program.

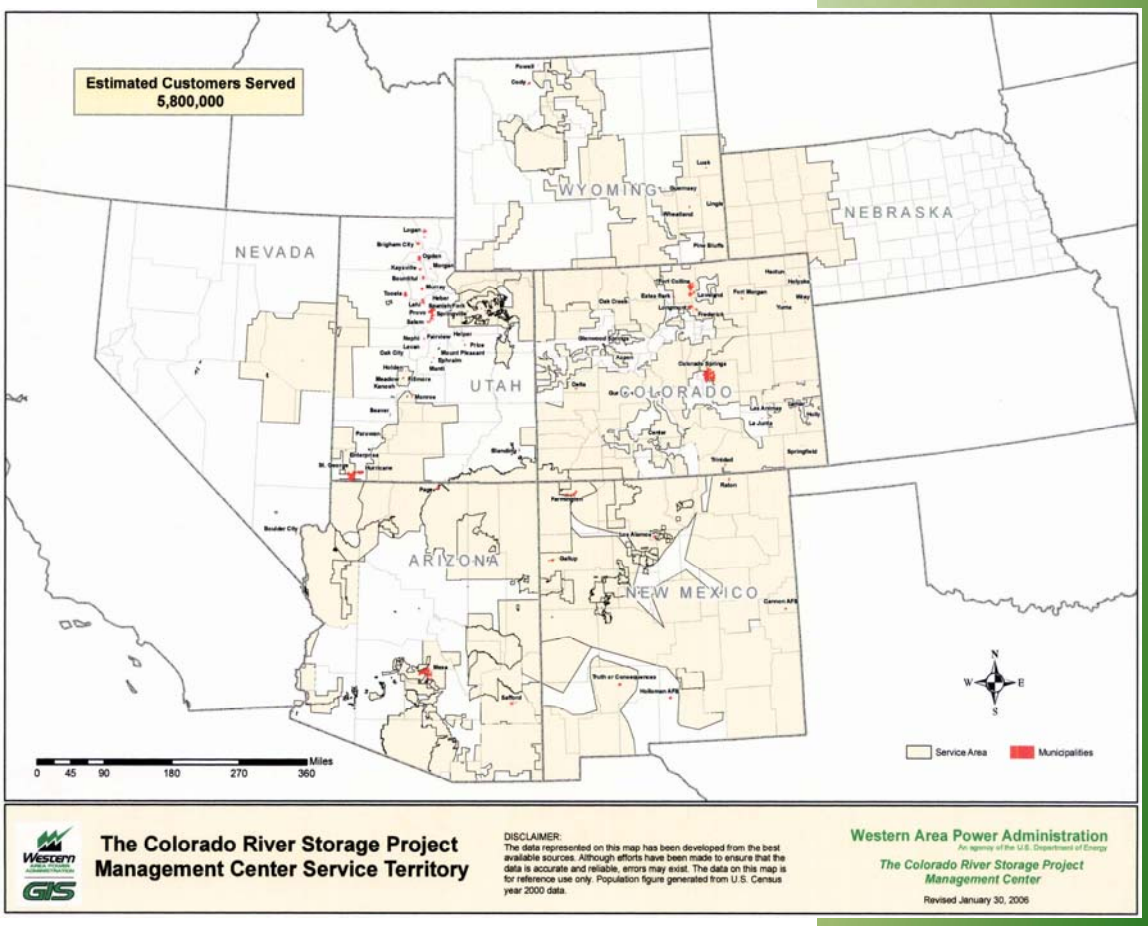
CRSP Customers

CRSP customers include rural electric associations, generation and transmission cooperatives who wholesale to associations, federal facilities, universities, state agencies and Native American Nations. CRSP power serves about 50% of the residential and tribally owned business electrical needs of all of the Native American Nations in these states. Some of the power produced by CRSP facilities supplies energy to, among others, the Navajo, Hopi, Shoshone, Ute and Apache Nations.

by Harold Carey Jr.

Most of Western's agreements are 20-year contracts that guarantee firm power supplies. And most (85%) of CRSP customers are members of the Colorado River Energy Distributors Association (CREDA). CREDA is a non-profit organization established in 1978 to represent CRSP customers in working with the Bureau (as the generating agency of the CRSP) and Western (as the marketing agency of the CRSP). CREDA was established *"to preserve and enhance the availability, affordability, and value of Colorado River Storage Project (CRSP) facilities while promoting responsible stewardship of the Colorado River System."* CREDA members are all non-profit entities that serve over 4 million consumers in Arizona, Colorado, Nevada, New Mexico, Utah and Wyoming.

CRSP facilities supply affordable electricity to, among others, the Navajo, Hopi, Shoshone, Ute, and Apache Nations.



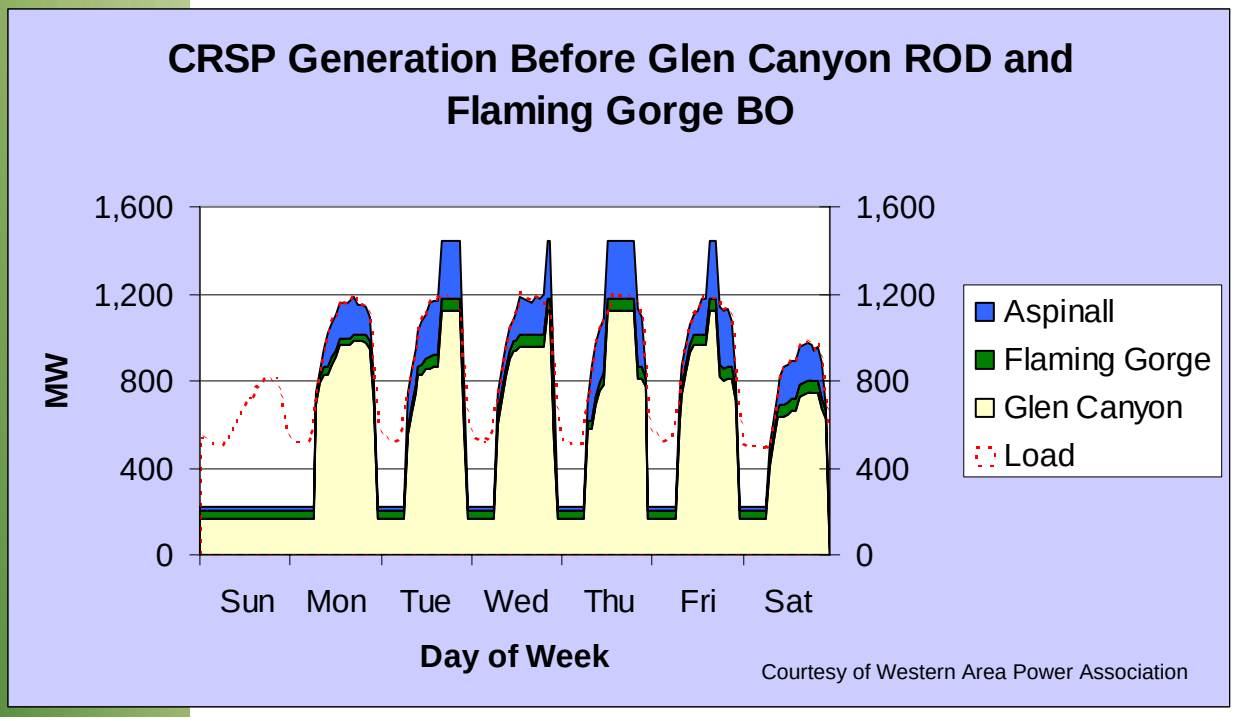
Restrictions on Hydropower Production

Environmental restrictions may call for holding water when power demands are high and releasing water when demands are low, reducing the ability to produce power .

Fly fisher downstream of Glen Canyon Dam - by Terry Gunn, courtesy of the Bureau of Reclamation

Reservoir construction stored water and produced power but also changed river conditions. Rather than turbulent spring floods followed by low summer and winter flows, reservoirs now store and conserve water for release throughout the year. Clear, cool water and consistent flows below dams create some of the nation's best trout fisheries. But these non-native sport fish replaced native fish like the Colorado pike minnow, razorback sucker, humpback chub and bonytail chub, which are now listed under the Endangered Species Act (ESA).

Federal environmental laws like the ESA, the Clean Water Act and the National Environmental Policy Act (NEPA) present significant challenges to the generation of hydropower resources in the CRSP. Some cite these laws as justification to operate reservoirs to mimic pre-dam conditions. This undermines the purposes for which the reservoirs were constructed. For example, reservoir releases to mimic pre-dam floods, or move sediment, often bypass power turbines and waste the opportunity to produce hydropower.



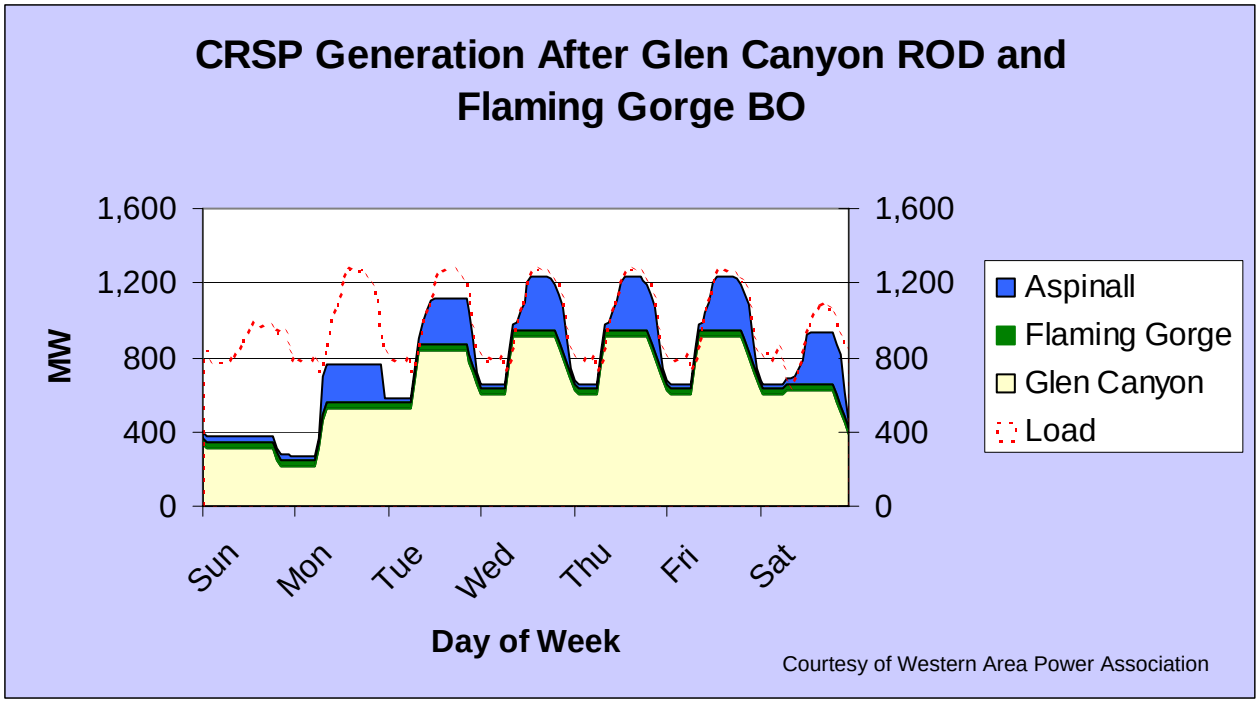
Courtesy of Western Area Power Association

Glen Canyon Dam- courtesy of the Bureau of Reclamation

In the 1980's, for example, litigation nearly brought power production at Glen Canyon Dam to a halt. Eventually, this resulted in an approximately 14-year, $104 million study of the environmental effects of Glen Canyon Dam operations. This amounted to more than twice the cost of the construction of Flaming Gorge Dam in 1963. Subsequent restrictions on reservoir operations required the release of stored water when power usage and demand is lowest. As a result, Glen Canyon lost over 30% of its capacity or enough power to serve over 250,000 homes (approximately 390 MW).

Since these restrictions were placed on Glen Canyon, the Aspinall Unit reservoirs in Western Colorado now provide up to 50% of the peaking power in the CRSP system. But an ongoing EIS process, recreational demands, and related flow recommendations for the listed fish species, could place even more restraints on power. Environmental restrictions may call for holding water when power demands are high and releasing water when demands are low. For example, biological opinions (BOs) and records of decision (RODs) on Glen Canyon and Flaming Gorge have severely impacted hydropower production. And flow recommendations for the Gunnison River could eliminate the ability to produce this renewable energy when it is most needed. Fortunately, flow recommendations are only one way of achieving environmental benefits. Others include carefully-managed reservoir operations that protect hydropower generation. For example, in wet years, water at risk of spill could be bundled and released to move sediment and improve habitat for native fish downstream. In this way, the reservoirs can still store water and produce renewable hydropower. The alternative, operating reservoirs in a way that mimics pre-dam conditions, would compromise the purposes for which these federal treasures were constructed and would be devastating to the towns, communities, and Native American Nations that rely on them.

When environmental restrictions, drought, or other restraints affect hydropower production, Western must purchase replacement power to meet its contractual obligations from the energy market which may include nonrenewable resources. This results in additional environmental impacts and higher power prices. In 1998, Western estimated the cost of environmental restrictions at $44 million per year. During the summer of 2000, when Glen Canyon reduced hydropower generation for humpback chub, the cost of replacement power was $32 million. From 1999 to 2004, Western spent nearly half a billion dollars (nearly $100 million per year) to purchase replacement power. These costs are borne by power customers through their power rates. The Bureau and Western must carefully consider all of these issues when considering new operational regimes for CRSP reservoirs. They must also abide by the purposes for which these reservoirs were created and authorized some fifty years ago.



Conclusion

One of the biggest challenges in the coming years will be developing, and maintaining, power generation sufficient to meet the needs of millions of people in the West. Maximizing the use of renewable resources, like hydropower from CRSP reservoirs, will become even more important. Hydropower offers perhaps the best balance between providing for the nation's power needs while protecting the environment. By carefully managing reservoir operations during years of good hydrology, the Bureau and Western can accomplish environmental benefits without affecting the purposes for which Congress authorized these unique water and power resources.

Hydropower offers perhaps the best balance between providing for the nation's power needs while protecting the environment.

Acknowledgements

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Reader Survey

We value your comments. Please take a moment to fill out our reader survey. Please cut out and fax ((602) 748-1345), or send to: CREDA, c/o Reader Survey, 4625 S. Wendler Drive, Suite 111, Tempe, AZ 85282. Thank you.

On a scale from 1 (poor) to 5 (exceptional), please rate the following:

1. The subject was informative _____

2. The material was well organized _____

3. The material was easy to understand _____

Please respond to the questions below (attach additional pages if necessary):

4. Of the topics presented, what would you like to learn more about?

_____

5. Would you like to see more hydropower production from existing or new reservoirs?

_____

6. Should hydropower be severely curtailed for certain environmental goals?

_____

Even if communities would face higher energy prices and a higher risk of flooding?

_____

7. If hydropower production can be used as much as possible while maintaining (rather than enhancing) certain habitat for endangered fish species, should it be?

_____

8. Do you support environmental restrictions on hydropower production if they cost consumers and taxpayers: $1 million per year?_____ $10 million per year?_____ $50 million per year?_____

9. Additional Comments?

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Colorado River and Vermilion Cliffs - by Terry Gunn, Courtesy of the Bureau of Reclamation

CREDA

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