



# **The Water, Energy, and Environment Nexus: Exploring the Intersections – The California Experience**

**December 2002**

A Global Green USA Policy Report  
*Exploring Cross-Cutting Issues  
of Public Policy and Resource Use*

***Report Contributors:***

**Matt Petersen** – Senior Editor,  
President and CEO, Global Green USA

**Robert Wilkinson** – Senior Editor,  
Chairman of the Board, Earth Island Institute

**Denise Lofman** – Editor and Author,  
Program Associate, Global Green USA

**Aimee Bower** – Researcher and Co-Author,  
Program Assistant, RAND

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## OVERVIEW

In October 2000, Global Green USA (GG USA) held the Fourth Annual Sustainability Symposium. The objective of the Global Green USA Sustainability Symposia is to address difficult environmental issues affecting California and the globe. The focus of the 2000 symposium was to better educate the public about the nexus between water and energy by highlighting the connections in California and in other locations around the globe. In the years following the Symposium, the importance of the water and energy nexus has gained further relevance with the exacerbation of global climate change and diminishing fresh water resources.

California provides an ideal setting to examine the relationship between water, energy, and the environment. The state has an elaborate water storage and conveyance system which transports water from wet areas to dry areas and has facilitated the irrigation of millions of acres of fertile farmland. California also consumes a tremendous amount of energy to make this possible. The Golden State is famous for its natural resources – mountains, oceans, and deserts – all of which effect or are affected by the generation of energy and the availability of water. Even as one of the top ten economies in the world, California is facing severe challenges regarding its large water and energy infrastructures. These challenges and their solutions provide valuable lessons to the rest of the world regarding how to sustainably manage water and energy resources.

A 1996 California deregulation plan that was meant to make electricity cheaper for consumers, instead resulted in skyrocketing utility bills, forced the state's largest utility to file for Chapter 11 bankruptcy protection, and sent the state's legislators into a contentious battle over how best to resolve what was commonly referred to as the state's "energy crisis." The first casualties occurred in the summer of 2000 - residents of San Diego were subjected to bills two and three times larger than normal. The crisis soon spread to other areas in the state: in December 2000, Northern California experienced rolling blackouts; in the spring of 2001, blackouts occurred in many parts of the state; and today, lingering uncertainty remains in the energy sector.

The solutions to water and energy management issues require that decision-makers, policy leaders, and the public better understand the relationship between water and energy and take the necessary steps to ensure the sustainable supply and use of these resources. **Global Green USA makes the following recommendations regarding the water, energy, and environment nexus:**

- **Encourage and enforce conservation and efficient use of water and energy in all sectors.**
- **Meet energy needs through expanding the use of renewable energy technologies.**
- **Improve stakeholder understanding and involvement in the management of water and energy resources both locally within California and internationally between California and Mexico.**

Educating the public, using new technologies, and increasing conservation and efficiency efforts will help to guarantee a stable and reliable water and energy infrastructure for future generations in California and throughout the world.

## INTRODUCTION

The objective of this paper is to explore the connections between water and energy, to bring awareness to some of the numerous ways these two valuable resources interact with and are dependent upon one another, and how their management affects the environment.

By focusing primarily on California as a case study, the Global Green USA Sustainability Symposium highlighted the difficulties of balancing the needs of diverse stakeholders and protecting valuable resources while providing reliable and safe supplies of both water and energy to agricultural, industrial,

and residential customers. Comments from the symposium panelists regarding privatization and water markets, the environmental impacts of water and energy use, renewable energy sources, and international issues connected to the demand for water and energy are included. The investigation of these complex relationships is necessary to inform local, national, and international policy decisions regarding the management of water, energy, and the environment as President Gorbachev noted in his keynote speech.

Water is essential to life, and a safe and reliable energy supply is necessary for society today. What will happen as both systems, which are so intertwined, become strained? In California the population is projected to grow 43 percent in the next 20 years, and major water supplies are already over-appropriated. Californians must learn to live within water supply limits.

In other places around the globe, particularly in Africa and the impoverished communities of South America and Asia, sustainable development is rendered difficult by lack of access to water and energy. In these cases, shortages are not caused by excessive demand or lack of appreciation of the value of the resources: people already use far less than the accepted minimum requirements for a healthy lifestyle, and they struggle every day to achieve even this. Rather, the shortages are caused by the lack of the necessary infrastructure, institutions, and finances to sustainably harness, maintain, and distribute the resources they have. Without reliable access to water, all one is left with is poverty and ill health; without access to energy, people are unable to take advantage of the opportunities offered by modern technology and are thus left behind.

Our task is to act responsibly in the face of the growing international demand for water and energy, and the associated global environmental problems linked to climate change and diminishing freshwater resources. The way we use water and energy today and the innovative techniques we devise to improve efficiency in the future will assist in preserving the health of our planet and improving the lives of many of its people.

## **BACKGROUND INFORMATION**

### *California's Water Infrastructure System*

According to the California Energy Commission, roughly 15 percent of California's electricity comes from hydroelectric power - approximately 20 to 22 percent from large hydroelectric facilities and approximately 3 to 4 percent from small ones. The state's hydroelectric plants, located primarily in the Sierra Nevada range, have a total capacity of about 14,000 megawatts (MW). A portion of the hydroelectric power used in California comes from the Pacific Northwest. (California Energy Commission)

The numerous dams and hydroelectric plants that provide energy to the State of California are a product of the era of big dam construction. This era began with the construction of the Hoover Dam on the Colorado River, the largest public works project of its time, which was completed in 1936. Dams are only one part of the enormous water supply infrastructure that traverses the state. The three most significant water projects in California are the Central Valley Project, the Colorado River Aqueduct, and the State Water Project.

As Fiona Curtin, GG USA Sustainability Symposium panelist noted,

Southern California exists as it does today because of the Hoover Dam and the other water diversion structures which have transformed the state into a crisscross of pipes and canals, moving water at great expense from the Colorado River and from Northern

California into the parched South. This ingenuity has allowed Los Angeles to grow into a mega-city, Silicon Valley to host one of the world's richest high-tech centers, and the city of Los Vegas to bloom in the desert; but, as usual, there is a flip side.

The flip side is the long list of problems caused by dams: destruction of habitat, elimination of natural river flow, soil salination, reservoir sedimentation, channel erosion, increased water temperatures, and the devastation of fisheries, to name a few. In addition, there is increasing evidence that dam projects are actually net producers of greenhouse gas emissions. All large dams and natural lakes that have been measured emit greenhouse gases. Gases such as carbon dioxide and methane are produced through the decomposition of vegetation in the flooded area. It is not clear yet, however, how emissions may change over time, or how emissions from reservoirs compare with pre-flooding emissions. (The World Commission on Dams, 2000)

New dam construction in the United States has slowed dramatically for numerous reasons, including public opposition, environmental impacts, the enormous capital investment required, and the fact that many of the best sites have already been used.

#### *Energy Used in Transporting and Treating Water*

Getting water from its source to the end-user often requires a significant amount of energy. The energy costs of water use in California are high because of two primary reasons: 1) most of the demand is located a considerable distance from the source; 2) water is heavy and moving it is quite energy intensive. One acre foot of water weighs approximately 1357 tons. Both the State Water Project and the Colorado River Aqueduct must pump the water over mountain ranges to transport water to the local distribution systems. The State Water Project is the largest single user of electrical energy in the state. The SWP pumps water from the Delta to the southern San Joaquin Valley where the A.D. Edmonston Pumping Plant raises the water 1,926 feet to enter 10 miles of tunnels and siphons which traverse the Tehachapi Mountain range. It accounts for 2 to 3 percent of all the electricity consumed in California. The SWP uses an average of 5,000 GWh per year. Water must also be treated before being used. The California Energy Commission (CEC) states that "the total energy used to pump and treat this water [used in the state] exceeds 15,000 GWh per year, or at least 6.5 percent of the total electricity used in the state per year." (Anderson, 1999)

#### *The Energy Situation and Water Supplies*

In the same way that transporting, extracting, and processing water consumes large amounts of energy, the operation of power plants can consume large amounts of water. To address the state's energy shortage, numerous thermal power plants have been planned in the last 2 years and all of them will require fresh water for cooling. This raises the question, will the proposed solution to one problem result in aggravating another?

### **ENVIRONMENTAL IMPLICATIONS OF THE ENERGY AND WATER CONNECTION**

#### *Global Climate Change and Water Supplies*

The process of building a number of natural gas plants to expand the energy supply has increased California's dependence on fossil fuels and will also increase greenhouse gas emissions, further exacerbating global climate change. Recent studies in California have indicated that global warming may increase incidences of heat waves, droughts, floods, and fires in the state. Global climate change may also have potential devastating economic effects upon agriculture, fishing, timber, real estate, insurance, construction, and tourism industries. In addition, fresh water supplies and local air quality will be impacted due to higher temperatures.

As a solution, David Freeman, Sustainability Symposium Panelist, suggested that,

In the discussion of water and energy, it is important to mention the development of sustainable and renewable sources of electricity: solar, wind, geothermal, and biomass. Energy production should not rely solely on fossil fuels. Instead, electricity should be generated primarily from the sun and wind. Government and society need to concentrate on making renewable energy the main source of energy. Fossil fuels continue to foul the earth and add more and more greenhouse gases to the atmosphere. Global climate change is going to cause real havoc and renewable energy needs to become the energy source of the mainstream population. This is the work of the next decade.

## **RECENT EVENTS AND LESSONS LEARNED**

In late March 2001, the California Independent System Operator (CAISO) issued an assessment of the energy situation in California. The report predicted that California would be experiencing shortages of energy during the summer and would therefore be subject to rotating blackouts. Energy shortages and rolling blackouts did not materialize - most likely due to a combination of factors including low temperatures and consumer conservation.

As Robert Wilkinson mentioned at the Sustainability Symposium, efficiency improvements can greatly enhance the sustainable use of resources and provide for environmental restoration.

There are great opportunities for cost-effectively improving the efficiency with which we use both water and energy. Sustainable use of these resources through demand management, conservation, and increased resource efficiency are possible. As resources are used more efficiently, environmental systems can be restored and managed sustainably.

### *Prices of Water and Energy*

A critical component of the interaction between energy and water is how price reflects (or fails to reflect) the amount of energy required to move water from the source to the consumer. Market mechanisms have historically been used to effectively encourage conservation and the efficient use of water and energy resources especially when markets like the energy market in California are not functioning properly. Panelists at the Global Green USA Sustainability Symposium, commented on the use of markets in the management of water and energy.

Mary Nichols noted:

Above the level of what is required for provision of life, all the decisions that are made about the use of resources are based on the cost of those resources. Many of the worst problems that are currently being faced regarding the misallocation of resources, including water, are derived from the fact that we do not charge what it costs to provide the service. So people use water to grow crops, for example, that they would never grow if they were paying the same price for that water that people pay for their water in the city and that people would pay for water for other uses. It is a foolish debate as to whether there is a role for economics or for the market or for the private sector in the water debate, as they are all already involved.

Mark Bernstein added:

There is a need for some market forces to operate on water because a price signal will establish water as an economic good. Water will not be considered a precious commodity if it is too cheap. People make decisions about resource use based on price, and as the price of water rises, individuals will use less.

The current situation in California with energy is fundamentally changing the way people make decisions on electricity, which is a good lesson for water. Industry in Southern California is frightened about price volatility in electricity, natural gas, gasoline, and diesel fuel. Businesses are willing to make different decisions today than they would have five or ten years ago, and the economics of alternative energy are becoming more and more cost effective. As industry takes into account risk and uncertainty in the future in energy, there is a value to resources that can be counted on like solar photovoltaics, wind, or fuel cells. The paradigm is changing in decision-making for energy. The goal is to now learn those lessons for water, bring some of the decision-making power to the end user through market forces. By empowering the end user, they may make different decisions that are more positive for the environment than they would have before in a regulated environment.

#### *Lessons Learned from Water and Energy Resource Management*

In addition to using market mechanisms to manage water and energy resources, Mary Nichols discussed how water planners are learning from the energy field.

One of the lessons that the water planners are finally beginning to learn from the energy field is that it not only matters how many units of water you have but when they are available to you. In the past, the state looked at water rights or water allocations in terms of acre feet or a million gallons or whatever units they were and if you had that number you either got what you were supposed to or you did not, but it was a fixed commodity. California is now able to work through some water conflicts because there is a recognition that fish are a stakeholder and that ecosystems have a right to water at certain times also. It is possible to move water around in ways that get it to the places that it is needed when it is needed without the total supply being lost in the process. And while that sounds like an incredible, common sense idea, it was not recognized in any way by water planners or by the legal system until recently. This is one example of how the structural systems for resources are changing as a result of the conflicts that are developing when we see that we cannot solve all of the problems at the same time unless there is flexibility. The solution principles for water management today recognize the tradeoffs inherent in water use and try to reduce some of the negative impacts inherent in the water supply system in the past.

However, in looking at the bigger picture issues, there is no system of law or politics governing water that makes those tradeoffs very transparent. Some of the most difficult issues that California is facing now in providing a water infrastructure for the future have to do with the fact that the public is not well educated about where their water comes from. They are equally ignorant about where it could come from in the future, and what the various alternatives might possibly be. When people do have an opportunity to understand and to participate in those decisions, they are willing and ready to get engaged in installing water conservation and water efficiency equipment in their own homes. The citizens of Los Angeles made the decision to save Mono Lake even though many of them have never even seen it because they were made aware of the problem. The process is extremely challenging, and it takes time to bring the players to the table and make people aware of the fact that they are going to have to change the way that they do business.

## **CONCLUSION**

As the California experience illustrates, the nexus between water, energy, and the environment is complex. The state is not alone in its difficulties in managing water and energy; the situation of



increasing demand and changing priorities is apparent throughout the globe, as are the examples of how sustainable management of these valuable resources can be enacted. Robert Wilkinson explains:

Societies around the world are grappling with new ways to govern and utilize these finite resources. Mikhail Gorbachev, as early as ten years ago, raised the importance of openness and restructuring with water. The question of governance goes to what is the role of markets? What are the roles of values that people have? What is the intersection of people's values expressed in the political realm, the social realm, and the value in a monetary sense that we put on water? Today, these are the issues being raised in California with the CalFed process and the Colorado River. They effect the way we manage water in Los Angeles. These same questions need to be answered in countries around the world.

There are some wonderful examples of solutions. Mono Lake, located in the eastern Sierra Nevada in California, shrank from more than 80 square miles to approximately 60 from 1941 to 1994. The water was being diverted to Los Angeles via the 275 mile-long California Aqueduct. In order to protect this natural resource, Los Angeles agreed (with encouragement from the courts) to reduce its use of Mono Lake water through water conservation and public outreach programs. The Mothers of East L.A. and other groups in the city got engaged and created a program that provided multiple benefits for the community. The project protects Mono Lake, creates jobs, builds community in the inner cities, saves water, reduces wastewater, saves energy, saves on air impacts, and promotes the sustainable use of resources.

Currently, California faces myriad challenges: managing the energy system to meet demand at acceptable prices without diminishing air quality; maintaining a water delivery system which is being stretched as it provides water to agriculture, industry, and residents in the face of climate change; and providing the resources needed to protect the environment. The lessons learned today in California are valuable tools for other societies, as nations and regions grapple with the complex infrastructure and management issues of water and energy throughout the world.

## **FINAL RECOMMENDATIONS AND GUIDING PRINCIPLES**

As a case study, California provides an opportunity to begin to understand and discuss the issues of the water-energy nexus - both lessons and solutions can be drawn from this diverse, dynamic state. Global Green USA proposes that the following recommendations and principles guide future decisions regarding water and energy resource use.

### *Recommendations*

#### **Encourage and enforce conservation and efficient use of water and energy in all sectors.**

As the population of California grows, there will be increasing demands for water and energy. Demand-side management practices and public outreach and education will be absolutely essential to ensure a long-term safe and reliable supply of water and energy resources.

#### **Meet energy needs through expanding the use of renewable energy technologies in order to reduce greenhouse gas emissions and climate change impacts on the fresh water supply in California.**

Encourage investment in renewable energy and transition California away from the use of fossil fuels for power production.

**Improve stakeholder understanding and involvement in the management of water and energy resources both locally and internationally.** Mexico and the Western US should work together to solve energy and water conflict issues now, before new gas power plants are built along the Mexico/California border. California must consider the impacts of new natural gas power plants on water supplies and the resulting need for additional energy to pump water. These local and international issues will only become more profound over time. Provide opportunities for education for the general public regarding these stakeholder processes.

#### *Guiding Principles*

In taking these actions, the state should adopt a set of guiding principles for sustainable water and energy resource use.

- Recognize that the public requires an understanding of the true cost of water and energy use in order to impact water and energy consumption rates.
- Investigate methods to make the costs of the use of these resources more apparent to the public (pricing of water and energy).
- Encourage the continued development and increasing use of technological innovations in water and energy efficiency and renewable energy.
- Develop participatory, multi-stakeholder processes that lead to the development of better water and energy management practices within local communities and between states and the US and Mexico.
- Ensure the environment has a right to water. In an effort to restore threatened ecosystems and maintain sustainability in California, the timing and delivery of water for agriculture, industry, residential and other uses should be flexible and balanced. Both humans and the environment should receive the water needed to sustain life.
- Be mindful that policy actions intended to improve the supply or use of one resource can negatively impact the management/supply of other resources (e.g., building more power plants to increase the energy supply could dramatically increase the demand for water).
- The ultimate task is to act responsibly in the face of the growing demand for water and energy, and the associated global environmental problems of climate change and diminishing freshwater resources.

## **APPENDIX A - PANELIST BIOGRAPHIES**

### **MARK BERNSTEIN, RAND**

Dr. Mark Bernstein is currently Co-Director of RAND Environment at the Santa Monica-headquartered research organization. In this role, he is working to develop RAND's expertise on energy and environmental issues, including the role of technology innovation in reducing greenhouse gas emissions, and the role of energy efficiency in economic productivity. Until June of 1998, Bernstein was the Senior Energy Policy Analyst for the White House Office of Science and Technology Policy in the Executive Office of the President. While in this position, he helped create a public-private partnership with the housing industry to establish the Partnership for Advancing Technologies in Housing, or PATH program. He also spent 7 years on the faculty of the University of Pennsylvania and as Director of the University's Center for Energy and the Environment.

### **FIONA CURTIN, GREEN CROSS INTERNATIONAL**

Fiona Curtin is Coordinator of the Green Cross International Water Program, which includes projects in the Middle East, Eastern Europe, South America and Southern and West Africa. Fiona joined GCI in 1999 to research and author the recently-completed "National Sovereignty and International Watercourses" study, which was a component of the World Water Vision for the 21<sup>st</sup> Century Conference. Prior to joining Green Cross, Curtin worked for three years for the United Nations High Commissioner for Refugees. She holds an undergraduate degree from Oxford University and a Masters degree in International History and Politics from the Graduate Institute of International Studies at the University of Geneva.

### **DAVID FREEMAN, LOS ANGELES DEPARTMENT OF WATER AND POWER**

David Freeman was the General Manager of the Los Angeles Department of Water and Power (LA DWP), the nation's largest municipal utility, at the time of the symposium. Significant achievements under his leadership include launching a \$54 million Public Benefit Program which includes renewable energy, electric transportation initiatives, solar power programs, tree planting at schools, energy efficiency and low income assistance. He also initiated the Green Power for a Green Los Angeles program, which combines renewable energy sources with energy efficiency. Freeman's vast experience during his 20-year career includes top positions at the Tennessee Valley Authority, the lower Colorado River Authority and the Sacramento Municipal Utility District. Freeman has also served in various high-level government positions including being an energy advisor to President Jimmy Carter, an energy consultant to the U.S. Senate Commerce Committee, and head of the energy policy staff in the White House Office of Science and Technology Policy.

### **MARY NICHOLS, CALIFORNIA SECRETARY FOR RESOURCES**

Mary Nichols is the California Secretary for Resources. Appointed by Governor Grey Davis in 1998, Secretary Nichols oversees 21 state departments, including the Departments of Conservation, Fish and Game, Forestry and Fire Protection, Parks and Recreation, Water Resources, and the California Coastal Commission. She is one of California's pioneering environmental lawyers, initiating some of the first test cases under the Federal Clean Air Act and California air quality laws. She has also served as senior staff attorney and director of the Los Angeles office of the Natural Resources Defense Council; Executive Director for Environment Now, a Los Angeles-based private foundation; and has been appointed to positions with the California Air Resources Board and the US Environmental Protection Agency.

### **ROBERT WILKINSON, ROCKY MOUNTAIN INSTITUTE**

Robert Wilkinson is a Senior Fellow of the Water Program at the Rocky Mountain Institute and a Lecturer at the University of California, Santa Barbara's Environmental Studies Program. Wilkinson's teaching and research focus is on environmental policy issues, water and energy policy, climate change impacts, and sustainable communities. Over the past decade Wilkinson has worked extensively in Western Europe and in every country of Central Europe from Albania, through the Baltic States, and throughout the former Soviet Union, including Siberia and Central Asia. He recently returned from a visit to the Three Gorges Dam on the Yangtze River in China. In addition to teaching and research work, he is an advisor to the California Department of Water Resources for the state's water plan. He is also coordinating the California Regional Climate Impact Assessment for the US Global Change Research Program and the White House Office of Science and Technology Policy.

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