



Carpe Diem

WESTERN WATER &
CLIMATE CHANGE

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A PROJECT OF EXLOCO

Peak Water, Peak Energy, Climate Crisis: The Collision Ahead

A Carpe Diem Policy Brief

This Carpe Diem - Western Water & Climate Change Project policy brief explores the policy implications arising out of the dynamic relationship between climate change, energy, and water played out across a western landscape that will also experience significant demographic changes. We hope that the work of the Carpe Diem's recently launched **Water, Energy & Climate Change Initiative** will result in a suite of potential management priorities and policies. The central and most important goal of this initiative is to inform and encourage national, regional, and state policies that support aggressive investments in both energy and water conservation and efficiencies. More specific recommendations will emerge as the work of the Carpe Diem Project's leadership network continues.

Water Use and Energy Use are Inextricably Linked.

Climate change and population growth are already affecting water supplies and water use in the western United States, and these effects are expected to accelerate in the latter half of the 21st Century. An equally dramatic transformation will occur in the energy sector, especially if there is a systematic effort to lower greenhouse gas emissions by replacing carbon-producing forms of energy with non-carbon-producing forms. Nearly all forms of energy production use large quantities of water and affect its quality. By the same token, water uses require significant amounts of energy for pumping, conveyance, treatment, distribution and end use, as well as wastewater treatment. Climate change effects on both of these resources will be intertwined and are likely to shape regional and national policies in both areas.

The **Carpe Diem - Western Water & Climate Change Project** has launched the **Water, Energy & Climate Change Initiative** to develop new, integrated responses to these interconnected challenges. Climate change scientists have broken new ground in recent years, and some responses are being considered, but to date, no integrated strategy has been developed. Carpe Diem is bringing together key leadership from various sectors across the West to assess the current and projected impacts, to identify potential policy and management responses, and to develop joint actions and new policies.

The **Carpe Diem - Western Water & Climate Change Project** is a broad-based network of over 600 experts, decision makers, and scientists dedicated to addressing the unprecedented challenges that the impacts of climate change on water resources pose for the American West. By linking leaders and integrating state-of-the-art climate-change science with the needs of a range of stakeholders, the Project incubates new initiatives and promotes sustainable management practices and policies that provide water security for people, ecosystems, industry, and food production.

Two Key Policy Issues

There are as many potential policy implications as there are details about the water, energy, and climate change relationship. However, two overarching points about policy stand out starkly.

First, a failure to address the dynamic interplay of energy, climate change, and water issues in an integrated way would have extremely problematic results. For example, policy changes to promote certain types of renewable energy development in order to ameliorate the effects of climate change may help solve one problem, but without careful consideration, additional problems could be created in the form of adverse impacts on water resources and on the social, economic, biological, and environmental qualities that depend on wise water policy choices.

Second, focusing decisive policy efforts on energy and water conservation and efficiency now will reduce the risk and cost of all other options as well as provide greater flexibility and more choices for resource managers in the long term. Energy conservation and efficiency can pay significant dividends for western water resources, and a serious program to implement more efficient uses of water can have important energy conservation outcomes. These results will create breathing room as the region reacts to the uncertain effects of climate change and population growth.

The positive aspect of this message should not be lost. Policy choices and incentives that integrate energy and water planning with an emphasis on efficiency and conservation could balance the American West's future energy demands and water needs. It is especially important to transform the broader policy context across the West in a way that supports thousands of local actions involving citizens, local entities, and local markets. The climate change challenge can be transformed into a dynamic opportunity to make significant progress in both energy and water conservation throughout the American West, benefitting both the economy and the environment.

Climate Change and Patterns of Water and Energy Supply and Demand

Climate change effects on both water and energy will be interrelated and are likely to shape regional and national regional policies in both areas.

It is important at the outset to describe the intertwined nature and extent of water and energy issues to underscore why the two overarching policy principles introduced above are so critical — why policy has to grapple with the integrated nature of the energy-water relationship and, especially, the extent and magnitude of the problems that we can avoid by an aggressive effort at energy and water conservation.

Direct physical effects of climate change on water and energy resources

The most-studied, and therefore best-understood, aspect of the problem so far is how climate change will affect the American West's water supplies, even if the magnitude of the changes is uncertain. The corresponding direct effect on energy production can be summarized as follows:

- Climate change has already altered, and will continue to alter, the western water cycle, affecting where, when, and how much water is available for all uses, including energy production.
- Specifically, the West is likely to experience significant changes in the timing, amounts, and forms of precipitation (with different experiences in different regions), leading to shifts in the timing, amounts, and variability of runoff and resulting water supplies.
- In certain parts of the West, especially the Southwest, precipitation and runoff may be reduced overall, a situation that will be compounded by greater evaporative loss due to increased temperatures and rising demand from current uses and expected population growth. Models show the possibility of lower low-water years, and a frequency and duration of low-water years greater than the historic data range.
- Throughout the mountainous West, there will likely be a significant shift from snow to rain, with resulting reductions in the amount of water that comes in the form of natural storage — snowpack — especially in lower-elevation areas with warmer mid-winter temperatures. Even if overall precipitation is not less, the reduced snowpack and resulting lower spring runoff will severely stress water storage and management systems.
- In areas where snowpack storage has historically dominated, runoff will continue to shift to earlier in the spring; thus, stream flows will be lower and warmer in the late summer and fall, with associated challenges for both out-of-streambed uses (e.g., irrigation) and instream uses (summer and fall flows that support necessary biological conditions for threatened and endangered species).
- Reduced flows will also result in new or increased surface and groundwater quality and ecological issues, especially increased temperatures; other direct water quality implications are less certain.
- Reduced flows could also shift more water demand to ground water resources, with associated effects on aquifer levels and increased pumping (and energy) requirements.

- Possibly just as significant, there will be an increase in water resource volatility and uncertainty — a greater and more unpredictable divergence of supplies from the historic range, placing additional burdens on water systems already stressed by population growth.
- By altering the amount, timing, and variability of natural snowpack storage, runoff, and flows, climate change will directly affect the timing, amount, certainty, and value of hydropower generation, one of the most significant sources of carbon-free energy in the western United States, and one that is the principal electricity source in certain areas.

Direct physical effects of climate change on water and energy demand

At the very same time that climate change directly affects western water supplies and energy production, the temperature changes associated with climate change in particular will have direct effects on energy and water demand in ways that are fairly obvious but need to be stated.

- Rising temperatures will reduce winter demand for electricity and other forms of heat energy, especially in the Pacific Northwest, but will also result in increased summer demand in all areas at precisely the time that summer flows will be reduced or more variable under most scenarios. Thus, summer hydropower generation in the West will be reduced and become less certain, especially under current storage and operating guidelines.
- Water demand generally increases with higher temperatures throughout the West. The expected temperature effects of climate change have obvious implications for water demand just when flows and water supplies may be more problematic or reduced. The Pacific Northwest, with its historic winter energy-use peak, may be trending toward an equal summer peak, which would be a dramatic change.

The transformative effects of climate change policy on the western energy industry

Policies aimed at slowing and then reversing greenhouse gas emissions, and therefore aimed at reversing the effects of climate change, will focus on the energy sector of the economy. The result will be regulatory effects, either through direct regulation or cap and trade schemes, or some combination of both; cost and pricing effects; and subsidies. Regulation will also be

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designed to create consumer-choice effects that will alter energy production, energy choices, and energy use; reduce or slow the increase in demand for energy; bring changes in transportation and land-use patterns; and, especially, substitute non-carbon forms of energy for carbon-producing forms. Continued rapid expansion in the development and use of wind power will be the most likely but not the only result. This transformation has serious implications for western water resources that need to be taken into account in forming climate-change energy policy.

Policy Implications of the Dynamic Relationship among Climate Change, Energy, and Water in The West

Water demands related to energy production could increase dramatically with the expanded development of non-carbon renewable resources or less-carbon-producing fossil-fuel resources.

A set of climate change, energy, and water policy issues arises out of the factors highlighted above. These are roughly grouped into the categories presented below. All will be influenced by demographic change. At a minimum, policymakers and resource managers will need to know much more about the full energy costs of various water uses, about the water consumption demands and water quality effects of different forms of energy development and use, and how these relationships, costs, and effects will change over time as the climate changes.

Water needs of new electrical energy production

Water demands related to energy production will shift and, in some cases, could increase dramatically with the expanded development of non-carbon renewable resources or less-carbon-producing fossil-fuel resources. The effects will be seen both in the production of energy through the deployment of the technology (e.g., concentrated solar or geothermal) and in the production of alternative fuels for some of these sources (e.g., biofuels). The potential for adverse effects on water quality is also manifest.

- **Hydropower generation.** Issues include (a) shifts in the timing, amounts, certainty, and value of hydropower generation as the timing and volume of runoff water supplies change and as energy demand and associated wholesale power markets change; (b) demands for new water storage to help optimize hydropower generation in reaction to the loss of natural snowpack storage and to capture more of the reduced or uncertain flows; (c) proposals for new hydro, especially small-scale hydro, for retrofitting turbines onto existing dams, and for increasing the generating capability or efficiency of existing hydro, with attendant implications for water resources; and (d) greater demands to use the flexibility of existing hydropower resources to balance other intermittent renewable resources such as wind, with attendant pressures on water resources and their biological values.
- **Pump storage.** The West has seen a number of plans and policy initiatives for new pump storage projects. These are typically net energy users, but they can be used to help match generation from wind resources and hydropower to peak demand.
- **Wind power.** Wind power will be the major addition to the West's renewable resource portfolio. It carries less significant implications for water use and water policy than most of the others, except for the water demands of other energy sources needed to balance the variability of wind generation.
- **Solar power.** Concentrated solar developments represent a potentially large demand for scarce water supplies, particularly in the desert Southwest, and may also increase temperatures in water returned to streams to the detriment of aquatic habitats.

- **Nuclear power.** If the region decides that nuclear power should be part of a non-carbon energy portfolio, water demand and quality issues will arise both in plant operation (demands for cooling water, elevated temperatures in water returned to streams) and in uranium mining.
- **Geothermal power.** New geothermal developments based on deep hot water and hot rock resources may be the most likely new energy resource developed in some parts of the West after wind. Effects on both surface and groundwater supplies and quality are uncertain but likely.
- **Natural gas.** The use of natural gas is likely to increase in the near future as a less-carbon-producing replacement for coal. Production opportunities range from conventional wells to coal-bed methane, with differing and increasing demands on water supplies, aquifer levels, and water quality. Increasing use of new fracturing and other sophisticated recovery techniques, some involving chemicals quite harmful biologically, have particularly troubling implications for contaminating groundwater supplies and making it unavailable for other purposes.
- **Biomass fuels.** Growing biomass for fuel is a potentially big draw of water for production, with attendant water quality issues from the waste stream.
- **Coal with carbon sequestration.** If carbon sequestration techniques ever prove commercially viable, investments and development will follow, with implications for water supplies and quality from mining, energy production, and carbon sequestration activities.
- **Energy conservation and distributed generation (such as local solar).** A comparative analysis is needed of the water demands of manufacturing, installing, and using energy conservation, efficiency, and distributed generation strategies. Policymakers need to analyze and encourage efficiencies in energy use that also save water, e.g., greater use of energy- and water-efficient appliances.

Water implications for transformations in transportation methods and fuels

Policies and actions that reduce the carbon footprint of transportation will have spillover effects on water use and water demand. In particular, it is important to consider:

- The water costs of policies and investments aimed at replacing internal-combustion, fossil-fuel cars and trucks with similar vehicles that use different technologies, such as plug-in electric hybrids, with their attendant increase in electricity demand and associated effects on water; biofuels; natural gas vehicles; and hydrogen fuel cells and other new technologies.
- The comparative energy and water effects of replacing transportation miles currently handled by internal-combustion, fossil-fuel cars and trucks with mass transit and other forms of transportation, as well as policy changes that reduce transportation needs through land use or workplace changes.
- The impact of population growth, with more people commuting longer distances and using greater amounts of energy for their transportation needs, which could offset new policies and actions to reduce the carbon footprint of transportation.

Energy demands of changing water uses

The ways we use water always have energy implications. The expected changes in water supply and the transformation needed in the energy sector require that the energy demands of capturing, treating, pumping, conveying, and using water must also come under scrutiny, as should the policy environment in which these things take place. Climate change effects and policies will have implications for the energy cost of delivering and using water in every industry and economic sector. In general, the challenge will be to find and support efficiencies in water uses that also save energy, just as we look for and support efficiencies in energy use.

- Great opportunities exist in public agency and municipal water use. For example the single largest user of energy in California is the State Water Project. As other projects to move and treat water now being planned throughout the West come on line, California will no longer be an unusual case.
- Water and energy savings can be realized in some large irrigated agriculture operations, especially those using the energy-intensive methods of high-head pumping and/or delivering irrigation water long distances.
- As western temperatures increase, resulting in greater evaporative losses, greater reliance may be placed on groundwater storage and recovery with its increased pumping, treating, and conveyance requirements.
- To the extent desalinization becomes a viable source of freshwater supply, the energy demands will be significant along the coast, as will be the potential water quality impacts from the salt waste stream.

Implications and Recommendations: Water, Energy & Climate Change Policy

The challenge will be to find and support efficiencies in water uses that also save energy, just as we look for and support efficiencies in energy use.

Climate change policy reform movements are active in some regions of the American West, nationally, and globally, but a clear direction has not yet emerged. As we have noted, two policy considerations are particularly critical:

First, policy reform can succeed in addressing the challenges and evolving demands posed by climate change and population growth *only* through a broadly integrated approach that encompasses climate change policy, energy policy, and water policy. Failure to link these issues will almost certainly result in disruptions in both water and energy supplies.

Second, focusing and maximizing our policy efforts now across the American West and the nation on energy and water conservation and efficiency will have mutually reinforcing positive effects. Developing and acting on integrated water and energy policies with an emphasis on conservation and efficiency will:

- Reduce the risk and cost of all the other options for dealing with the uncertain effects of climate change and population growth on energy and water resources.
- Protect and improve the western economy at the same time.
- Provide greater options and flexibility for policymakers in the long term.

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Exloco, founded in 2000, works to advance pragmatic, innovative solutions to environmental sustainability challenges in the western United States. Partnering with social change organizations, public agencies, venture philanthropists, and corporations, Exloco develops networks of decision makers to research and analyze key issues and provides an outcome-focused process to craft innovative strategies and solutions for a healthy and vibrant West. [www.exloco.org]



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