California's Water-Energy Nexus:

Pathways to Implementation

A White Paper by:

GEI Consultants

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This white paper was written by **GEI Consultants, Inc.** on behalf of the **Water-Energy Team of the Governor's Climate Action Team (aka "WET-CAT")** for the purpose of facilitating the on-going dialogue among policymakers and regulators as to the types of actions that can be taken by California's water sector to help achieve the state's aggressive resource efficiency, economic and environmental goals. Some of these actions are achievable now, under existing policies, rules and regulations; others will require modification.

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Preface

Energy is a cornerstone resource issue for the 21st century. California has set ambitious goals for increasing its renewable energy (33% by 2020), improving its distributed generation (12,000 megawatts (MW)) of local energy generation by 2020, and reducing its greenhouse gas emissions (20% by 2020). The investments California makes over the next few decades to improve energy efficiency, expand renewable sources of energy and reduce the use of fossil fuels will profoundly shape the State's future economy and quality of life.

In making these investments, California's water and wastewater agencies must be integral to the conversation. Why? Because, as a sector, water and wastewater agencies - both investor and publicly owned - rely on a significant share of California's energy supplies to treat and reliably deliver clean, safe, affordable water to homes, farms and businesses.

As a consequence of utilizing such a sizeable energy load, water and wastewater agencies are uniquely positioned to collaborate with and help California attain its energy efficiency, renewable energy and greenhouse gas reduction goals. For example, in many areas of the State, water and wastewater agencies may have the capacity through their lands, facilities and professional staff to generate significant new amounts of renewable energy through solar, biogas, wind and other sources. Others have the flexibility to consider feasible changes for when and how they use energy consistent with maintaining reliable water deliveries and public safety.

The tantalizing question for California is how can it partner with the water and wastewater sector to efficiently and cost-effectively contribute to the achievement of the State's goals and do this in a way that is sensitive to ratepayer concerns and respectful of the agencies' other management priorities? No one has yet performed a targeted study, although a very preliminary assessment coordinated through a collaborative effort of the Association of California Water Agencies (ACWA) and others suggests that the potential is large – and growing. However, the math speaks for itself. If 25% of the electricity used by water and wastewater agencies in California could come from renewable sources or was offset by energy efficiency investments, it would contribute 1,000 MW to the State's electric supply, the equivalent of building two new 500 MW central electric generation plants. If even a fraction of this electricity could be generated or saved during peak demand periods, the value to the State would be substantial.

Through this seminal white paper, GEI outlines the potential strategic role that water and wastewater agencies could play in helping to reduce the energy consumption embedded in the water services we deliver, increasing renewable generation and reducing greenhouse gas emissions. GEI summarizes key findings and recommendations from recent studies that suggest that water and wastewater agencies have unique characteristics that could be leveraged through appropriate partnerships to provide significant benefits to the State's electric system. This white paper is an important report on the water-energy nexus in California. We appreciate GEI's work in the preparation of this white paper.

It is important to recognize that not all water and wastewater agencies have the same options, opportunities or flexibility to consider feasible changes for when and how they use energy. From operational to fiscal to staffing concerns, a "one size fits all" approach to the State's water-energy programs and policies will not work. Water and wastewater agencies are responsible for ensuring that the actions they take to contribute to statewide goals are locally cost effective and supported by their ratepayers. For this reason, the information and recommendations in this white paper represent an important first step in securing the policy and infrastructure synergies that the energy-water nexus naturally promotes. While ACWA does not necessarily endorse every proposal included in this paper, we know we must be involved and proactive in following up on the opportunities and challenges identified by GEI.

There are two overarching conclusions from GEI's white paper. The first is that the choices that we – the water and wastewater agency sector – make to invest in energy efficiency and renewable energy generation, matter to California. The other is that it is rare to have so much opportunity for making such a positive and powerful impact – improvements in energy efficiency, renewable energy generation and reduction in greenhouse gases – concentrated into one sector. It is an opportunity that cannot be ignored. ACWA is ready to engage in the next step of dialogue regarding the opportunities and challenges presented by GEI in this report.

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Important Concepts

The decision as to whether and how avoided costs are computed and applied to any particular purpose is a policy choice

Avoided Cost – The economic value of a particular action that produces a benefit that can be expressed in terms of dollars saved. Avoided costs are used for many purposes. In California, avoided costs are used as the basis for evaluating the relative costs and benefits of a wide variety of policies, programs and practices. Avoided costs are also used to determine the level of incentives that could be provided to encourage participation in public policy initiatives, such as energy efficiency, demand response and production of renewable and other clean and/or distributed energy resources. Avoided costs are used for similar purposes by the water sector.

For California's water-energy initiative, avoided costs are the underpinning of regulatory policy with respect to whether and how energy embedded in water should be included in the evaluation of cost-effectiveness of the state's energy programs.

Cost-Effectiveness – A benchmark applied to determine whether or not a particular action is economically beneficial. Typically, a cost-effective action is one in which the benefits are deemed to at least equal or to exceed the action's costs. The specific factors and criteria used to determine cost-effectiveness vary by industry and by program-specific goals and objectives. Avoided costs are one of the key inputs to the cost-effectiveness evaluation. The specific methodology for determining cost-effectiveness of California's water-energy programs is currently being deliberated in multiple policy and regulatory forums.

Energy Embedded in Water – The sum of energy inputs along the segments of the water use cycle. Whether and how the value of energy embedded in water is measured and recognized depends upon the goals and objectives of specific policies and programs.

Energy Intensity – The amount of energy used to produce a particular product, or to perform a specific unit of work. In context of the water-energy nexus, energy intensity is used to compare the relative energy values of different types of water supply resources, typically expressed in kilowatt hours per acre-foot (kWh/AF) or per million gallons (kWh/MG). Energy intensity can also be used to express the amount of energy used to perform a specific unit of work, such as the number of kilowatt hours used to treat a unit of raw water to potable standards.

Marginal Cost – The cost to produce the next increment of a product or service. When used in water and energy resource planning, it is typically expressed as the incremental cost in $/unit to produce and/or deliver the next (marginal) resource, whether a gallon of water supply, a kilowatt or kilowatt-hour of electricity, or a therm of natural gas. In regulatory policy, marginal costs are often used to evaluate the relative costs vs. benefits of various resource, infrastructure, or operational choices. Depending upon the goals and objectives of any particular policy or program, marginal costs may be measured on an intra-marginal basis (i.e., the cost of the last unit used to meet demand), an extra-marginal basis (i.e., the cost of the next unit that will need to be acquired or produced to meet incremental demand), or the average of all resources used to meet demand within a specific time period.

Marginal Supply – The last unit of supply needed to meet demand for a product or service. On a short-run basis, the marginal supply is typically the last unit of resource – whether a water supply resource, a kilowatt hour, or a therm - used to meet demand. On a long-run basis, the marginal supply is typically the next unit of resource that will need to be acquired or produced to meet future demand.

Total Resource Cost (TRC) – The TRC is intended to represent the total net costs of a resource decision. The TRC is used by many regulatory jurisdictions as a means to evaluate the cost-effectiveness of various programs, measures, and strategies. In its broadest application, the TRC encompasses both direct and indirect costs and benefits to all stakeholders. In some cases, externalities such as broad, far reaching societal benefits may also be included.

TRC and other policies, rules and practices for determining the cost-effectiveness of regulated energy utilities' programs are presently being revisited by the CPUC through its Order Instituting Rulemaking 09-11-014 to Examine the Commission's Post-2008 Energy Efficiency Policies, Programs, Evaluation, Measurement and Verification, and Related Issues. One of the questions being considered by the CPUC is whether the avoided costs of energy embedded in water should be included in the cost-effectiveness evaluation of regulated energy programs.

Water-Energy Nexus – The interdependencies among water and energy resources and infrastructure. At a policy level, California considers the scope of its water-energy nexus to include climate-related impacts, including greenhouse gas emissions.

Water Use Cycle – A description of the movement of water from its source through conveyance, treatment, distribution, end-use, discharge, re-treatment, re-use and ultimate discharge. Unlike the "water cycle" which describes the natural hydrologic path of water, the "water USE cycle" describes the movement of water through managed infrastructure and end uses.

Acronyms and Abbreviations

ACEEE	American Council for an Energy-Efficient Economy
ACWA	Association of California Water Agencies
AF	Acre Feet
ASCE	American Society of Civil Engineers
AWE	Alliance for Water Efficiency
CAISO	California Independent System Operator
CalWEC	California Water and Energy Coalition
CEC	California Energy Commission
CIP	Capital Improvement Plan or Program
CPUC	California Public Utilities Commission
CRA	Colorado River Aqueduct
CSI	California Solar Initiative
CVP	Central Valley Project
DOE	U.S. Department of Energy
DWR	Department of Water Resources
EAP	Energy Action Plan
EPRI	Electric Power Research Institute
FIT	Feed-in-Tariff
GHG	Greenhouse Gas
IEPR	Integrated Energy Policy Report
IRWMP	Integrated Regional Water Management Plan
IOU	Investor Owned Utility
KWH	Kilowatt Hour
MG	One Million Gallons
MTCO2e	Metric Tons of CO2 Equivalents
MPR	Market Price Referent
MWH	Megawatt Hour
NEM	Net Energy Metering
NGO	Non-Governmental Organization
NSC	Net Surplus Compensation
POU	Publicly Owned Utility
PPA	Power Purchase Agreement
PPIC	Public Policy Institute of California
RAM	Renewable Auction Mechanism
Re-MAT	Renewable Market Adjusting Tariff
RES-BCT	Renewable Energy Self-Generation Bill Credit Transfer
RPS	Renewable Portfolio Standard
SGIP	Self Generation Incentive Program
SONGS	San Onofre Nuclear Generating Station
SWP	State Water Project
TOU	Time of Use
TRC	Total Resource Cost
WERF	Water Environment Research Foundation
WET-CAT	Water-Energy Team of the Climate Action Team
WRF	Water Research Foundation

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Executive Summary

Since the California Energy Commission (CEC) issued its landmark finding in 2005 – that water-related energy uses account for about 19% of all electricity and 30% of non-power plant natural gas used within the state - California's water and energy sectors have been collaborating on strategies for achieving the incremental resource, economic and environmental benefits that can be found at the intersection of water, energy and climate. In 2006, a multi-agency Water-Energy Team was established to assist the Governor's Climate Action Team in identifying and promulgating statewide strategies for reducing water-sector greenhouse gases (GHGs). About the same time, the CEC commenced development of its first water-energy research program. The California Public Utilities Commission (CPUC) conducted workshops to explore whether and how the water-energy nexus should be included in the state's regulated energy programs. Concurrently, the Department of Water Resources (DWR) commenced investigations as to how the linkages among water, energy and climate should be included in the state's water planning processes.

Since that time:

- The Water-Energy Team of the Climate Action Team (WET-CAT) adopted and is implementing a multi-agency water-energy strategic plan.[1]
- The CEC has substantially increased requirements for water and energy efficiency in buildings through revisions to the California Building Standards Code.[2]
- DWR now requires consideration of the water-energy nexus in competition for Integrated Regional Water Management Planning grants,[3] and has also included elements of the state's water-energy-climate nexus in the California Water Plan.
- The CPUC directed the state's energy investor-owned utilities (IOUs) to include the water-energy nexus in their 2013-2014 Energy Efficiency portfolios.[4]

1 WETCAT 2011-1 and 2011-2.
2 California Code of Regulations, Title 24.
3 DWR 2012.
4 CPUC Decision 12-05-015, Decision Providing Guidance on 2013-2014 Energy Efficiency Portfolios and 2012 Marketing, Education, and Outreach, California Public Utilities Commission, May 10, 2012.

While significant progress has been made over the past seven years, robust implementation remains challenging.

The single largest barrier to full integration of the water and energy sectors has its origin in a decades-long tradition of separate regulation of these two resources, both vital to the state. The practice of separate regulation evolved from an initial need to assure that public funds are appropriately and responsibly invested in the purposes for which the funds were authorized. In making those assurances, policies and practices were developed to measure the costs and benefits of various actions through the lens of a single resource, and within the regulatory and legislative constraints governing each separate funding source.

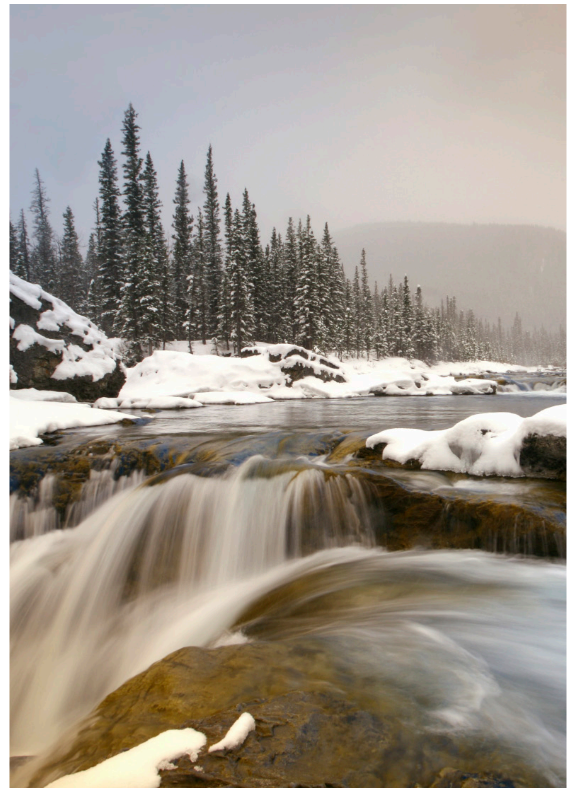
As California's programs have matured, the practices that were developed to assure responsible stewardship of public funds now hinder investments in cross-cutting programs. Maximizing the state's limited investments will thus require new policies, programs, methods and metrics that recognize comprehensive benefit streams across multiple resources, programs and markets.

Every dollar spent by water & wastewater agencies is an opportunity to integrate energy smart design and operations

The time is opportune for the state to proceed with comprehensive implementation of California's water-energy initiative. Every year, the state's water and wastewater agencies invest billions of dollars in system repairs, improvements and expansions. Every day, opportunities to affect water sector investment decisions are being missed. For each missed opportunity, there is a corresponding loss of energy savings and related reductions of greenhouse gas emissions.

The good news is that since California's water sector is investing billions of dollars every year, there are ample opportunities to influence their investment decisions. As the state considers strategies for maximizing these opportunities, it is important to understand the regulatory and other constraints on existing programs and funding sources, the types of cross-cutting measures needed to achieve the benefits of the water-energy nexus, and the types of revisions to historical policies, rules, regulations and practices that may be needed to enable full implementation.

California policymakers are presently seeking viable electric reliability measures that can be implemented in energy stressed southern California prior to summer 2013. One of the highest potential opportunities may be to provide incentives to water agencies to convert their pumps to dual-fuel (electric and natural gas). The cost of that conversion may not be cost-effective from the perspective of water ratepayers alone, and the CPUC's energy efficiency and demand response programs do not provide incentives for fuel switching. However, other agencies, such as the California Independent System Operator (CAISO) charged with assuring reliable operation of the California electric grid, may not be similarly constrained.



Harvesting the full benefits of the water-energy nexus will require new data, metrics, models and tools. In some cases, new technologies will be needed. In virtually all cases, funding will be needed.

Realizing the full potential of the state's water-energy nexus will not be simple. However, the opportunities to save significant quantities of valuable water and energy resources, to substantially reduce greenhouse gases, and to put California on the path to long-term water security and energy reliability are real, timely and compelling.

1

Introduction

The water and energy sectors are natural partners - their interdependencies are undeniable and significant. At the federal level, studies about the nexus between water and energy focused primarily on the pivotal role of water in achieving national energy security. California, still recovering from the widespread impacts of the 2000/2001 power crisis, focused its attention on reducing water-related impacts on energy resources and infrastructure.

In addition to natural interdependencies, there are many points of intersection between the water and energy sectors. Most water customers are also customers of water agencies' energy utilities. Water and energy infrastructure often traverse similar paths and may share rights-of-way. Water sector resource and infrastructure decisions have energy impacts, and vice versa. It therefore seems perfectly logical for water agencies and energy utilities to explore opportunities for joint planning and development. However, while there are many points of potential synergy, separate optimization of water and energy, driven primarily by separate regulation and funding, have created barriers to integrated optimization that must now be overcome.

Despite decades of separate jurisdiction, California's water and energy sectors have been working together collaboratively for the past seven years through a variety of stakeholder forums to advance understanding of the state's water-energy nexus.

- Formed in 2006, the Water-Energy Team of the Governor's Climate Action Team (WET-CAT)[5] is comprised of State and Federal agencies that are tasked with developing strategies for leveraging regional projects and programs to reduce greenhouse gases (GHGs).[6]
- The California Water and Energy Coalition (CalWEC)[7] was established in 2010 "… to collaboratively develop … approaches to providing a sustainable and cost-effective supply of water and energy in an environmentally responsible manner." Both water agencies and energy utilities participate in CalWEC, along with state agencies, industry associations, non-governmental organizations (NGOs), and a wide variety of other industry stakeholders. The national Water Research Foundation (WRF) is an active participant and sponsor of CalWEC.
- The Alliance for Water Efficiency (AWE), American Council for an Energy-Efficient Economy (ACEEE), Electric Power Research Institute (EPRI), Natural Resources Defense Council (NRDC), the Pacific Institute, Water Environment Research Foundation (WERF), and many other industry associations, research organizations, universities and NGOs now have their own water-energy initiatives.

The California Energy Commission (CEC) is credited for launching the state's water-energy initiative through its 2005 white paper, "California's Water-Energy Relationship",[8] and the inclusion of the water-energy nexus in its biennial Integrated Energy Policy Report that was issued that same year.[9] The CEC subsequently conducted several additional water-energy studies and launched its first water-energy research portfolio in 2007. Most recently, the CEC adopted changes to Title 24 Building Energy Efficiency Standards that include higher standards for both energy and water efficiency.[10]

The Department of Water Resources (DWR) recently issued draft Integrated Regional Water Management Grant Program Guidelines[11] that require regional planning agencies and organizations throughout the state to address the nexus of water, energy and climate

5 http://www.climatechange.ca.gov/climate_action_team/water.html
6 WETCAT 2011.
7 http://www.cal-wec.org/

8 CEC 2005-1.
9 CEC 2005-2.
10 http://www.energy.ca.gov/title24/2013standards/rulemaking/notices/2012-05-31_Draft_Adoption_Order.pdf.
11 DWR 2012.

through Integrated Regional Water Management Plans (IRWMPs). The comprehensive scope includes identifying water management actions that could reduce energy consumption and associated GHGs within the respective planning regions through changes to systems, facilities, processes, and end uses of water. The scope also includes identifying water sector opportunities to produce energy. These guidelines will determine the allocation of water planning grants that will be distributed throughout the state. Nexus principles were also integrated into the 2009 California Water Plan and the 2013 Update that is presently in progress.

On May 10, 2012, the California Public Utilities Commission (CPUC) issued a decision that was notable in two important respects:

1. The CPUC directed energy utilities, local government partners, and others to include the water-energy nexus in energy efficiency programs.
2. The CPUC also stated its agreement with the Association of California Water Agencies (ACWA) that energy savings from water-energy measures "… should include the embedded energy from all IOUs."[12]

While the CPUC's decision was a major win for the state's water-energy nexus, the decision did not address several policy and regulatory elements that are fundamental to CPUC regulated energy efficiency programs, leaving water agencies, energy utilities, and other market participants and stakeholders uncertain as to how that decision should be implemented. Stakeholders are presently filing comments in several CPUC proceedings that are grappling with those issues. Through one of these proceedings, the CPUC is considering changes to its policies, practices and procedures for determining the cost effectiveness of its energy programs. The water-energy nexus has been specifically identified as an issue that will be included in the CPUC's deliberations.[13]

In order to achieve true optimization of water and energy, changes will be needed to historical policies, programs, rules, regulation and legislation to allow and encourage the integration of these two resources. In California, there have been some successes – notably through building codes (CEC) and planning activities (DWR) where the issues of separate funding and regulations did not need to be directly engaged.

12 CPUC Decision 12-05-015, Decision Providing Guidance on 2013-2014 Energy Efficiency Portfolios and 2012 Marketing, Education, and Outreach, California Public Utilities Commission, May 10, 2012.

13 CPUC Rulemaking 09-11-014, Order Instituting Rulemaking to Examine the Commission's Post-2008 Energy Efficiency Policies, Programs, evaluation, Measurement and Verification, and Related Issues.

In other activities, however, such as the state's regulated energy programs, policies and practices deeply rooted in historical regulatory constraints are more difficult to overcome.

In order to now implement water-energy nexus programs in the CPUC's energy efficiency programs, several things will need to occur:

1. The CPUC needs to formally adopt a methodology for computing energy embedded in water.
2. Conforming changes will be needed to the CPUC's Standard Practice Manual and Energy Efficiency Manual to integrate the methodology for computing energy embedded in water.
3. The CPUC's energy efficiency potential studies will need to be updated to include energy embedded in water.
4. Energy efficiency programs will need to be revised to include embedded energy in water measures.
5. The CPUC's cost-effectiveness calculators and other methodologies and tools will need to be updated to incorporate the value of energy embedded in water.

Other state agencies also have important roles. In addition to the potential role of the CAISO in engaging the water sector to increase electric reliability, new state initiatives are being implemented every year that could have water-energy nexus implications.

On August 22, 2012, the state released its multi-agency 2012 Bioenergy Action Plan. Wastewater agencies have an important role in increasing statewide biogas production.[14]

This paper will describe high potential opportunities for the state to leverage the water-energy nexus to achieve its ambitious resource efficiency and environmental policy goals. It will also recommend some near-term actions that the state could take to transition historical programs based on separate regulation and investment to more comprehensive methods that accelerate the incremental statewide benefits that lie at the intersection of water, energy and the environment.

14 Bioenergy 2012.

2

California's Water-Energy Initiative

California's water and wastewater agencies are large users of electricity. The California Energy Commission's 2005 white paper, *California's Water-Energy Relationship,* found that 19% of the state's electric requirements, and about 30% of non-power plant related natural gas consumption were water-related – whether used by the water sector itself to collect, produce, treat and/or deliver water or wastewater, or to pump, heat or otherwise use energy during the consumption or application of water for outdoor or indoor uses.[15] Subsequent studies conducted on behalf of the CPUC indicated that of that amount, about 40% of water-related electricity – 8% of statewide annual electric consumption - is used by the water sector itself.[16]

15 CEC 2005-1.
16 CPUC Study 1, Appendix N.

The sheer quantity of electric use by any particular sector is not, in itself, indicative of energy efficiency potential. What distinguishes California's water sector is its ability to substantially change its electric footprint – both with respect to the amount of energy used for various purposes (energy efficiency) and the time and place of electricity use (demand response). California's water sector is thus uniquely positioned to help the state improve electric reliability while concurrently helping to meet the state's resource efficiency, renewable energy and greenhouse gas reduction goals.

California's Energy Resource Loading Order

In 2003, the state adopted a multi-agency Energy Action Plan[17] that established a "resource loading order" for the state. Energy efficiency was named as California's top priority energy strategy, followed closely by demand response and renewable/distributed energy.

California's water sector can help to change the state's electricity profile through all three of these priority actions. Specifically, water and wastewater agencies have the ability to significantly change the amount, timing and location of their electricity consumption through the following types of measures.

17 EAP 2003.

Table 1. Types of Opportunities for California's Water Sector to Change Its Electric Footprint

State Energy Priorities	Water Sector Actions	Examples of Measures
State Priority 1: Energy Efficiency	Operations	• Increase pump efficiency • Shift timing of energy usage to non-peak periods
	Systems and Facilities	• Increase energy efficiency in systems and facilities • Increase water and wastewater treatment process efficiency • Increase operating flexibility through system modifications (e.g., by increasing storage and load shifting capabilities) • Reduce water leaks and losses
State Priority 2: Demand Response	Water Supply Portfolios	• Develop and use less energy-intensive water resources • Increase end user water conservation and efficiency
State Priority 3: Renewable/Distributed Energy	Customer Side Generation	• Self-produce electricity to offset purchases, especially hydro-power and biogas (co-)generation that are produced as a by-product of water and wastewater operations
	Utility Side Generation	• Produce excess electricity for sale to others, especially where beneficial to increase grid reliability and/or to help meet the state's renewable/clean energy policy goals

Every capital project undertaken by California's water and wastewater agencies to develop new water supplies; to maintain, repair and improve treatment and distribution systems; and to invest in their infrastructure represents an opportunity to integrate energy efficiency, demand response and distributed generation into their systems.

This versatility makes the water sector a valuable partner to the state's energy utilities and to the California Independent System Operator (CAISO) that is charged with maintaining electric reliability.

Notably, California's water sector invests billions of dollars in infrastructure improvements every year, both for new infrastructure and to expand or repair existing infrastructure.

In its infrastructure "report card," the American Society of Civil Engineers (ASCE) estimated that California will need to invest more than $9 billion in critical maintenance and repairs to water and wastewater infrastructure over the next 10 years.

- **The ASCE's estimates do not include investments needed to increase the capacity of existing facilities or to add new facilities to support load growth.**
- **The ASCE's estimates also do not include improvements needed for protection of water quality, such as urban runoff infrastructure or storm water improvements that are needed for both improved water quality and water supply.[18]**

In fact, despite substantial reductions in infrastructure spending in recent years due to economic pressures, California's water and wastewater agencies spend more than $10 billion every year for system improvements and expansions. This level of spending is expected to continue at comparable or higher rates for the foreseeable future. The Public Policy Institute of California (PPIC) estimates that total annual spending by California water and wastewater agencies exceeds $25 billion.[19]

The Water-Energy Nexus

At its most basic, "nexus" merely means that a relationship exists. The recognition that undeniable relationships exist between the nation's energy and water resources is not new – it has been recognized for decades, primarily in context of water's essential role in securing the nation's long-term energy future. Nor did California invent the "nexus" – twelve U.S. Department of Energy (DOE) national laboratories formed an Energy-Water Nexus Committee to investigate these issues prior to California's 2005 white paper. DOE, however, focused primarily on the need for water by the energy sector for energy production.

In 2005, Congress authorized funds for "… a Report to Congress on the interdependency of energy and water focusing on the threat to national energy production resulting from limited water supplies, utilizing where possible the multi-laboratory Energy-Water Nexus Committee." California, still recovering from the shocks of the 2000/2001 power crisis, chose to focus on reducing water sector impacts on the state's energy resources and infrastructure.[20]

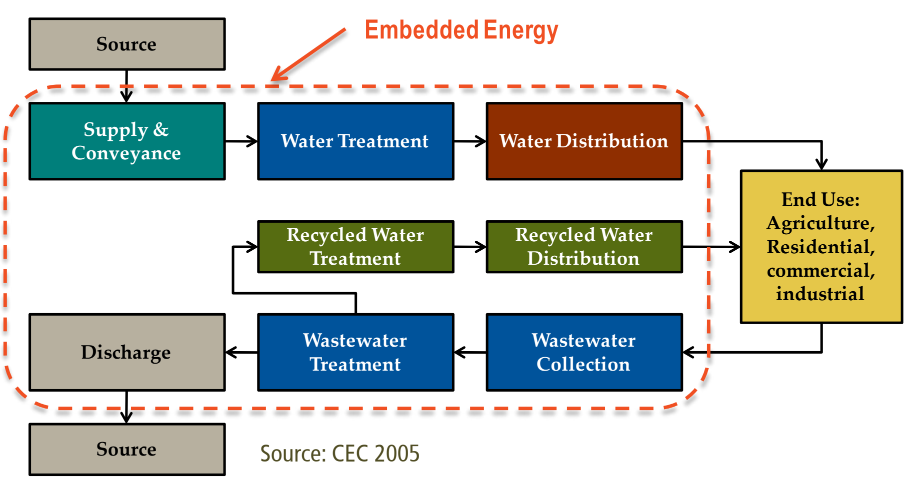
The primary finding of the CEC's 2005 white paper was that the interdependencies between California's energy and water sectors are large. The significance

18 ASCE California Infrastructure Report Card: http://www.ascecareport-card.org/reportcards.asp

19 PPIC 2012.

20 California included the impacts of power plant cooling on water supplies in its 2003 Integrated Energy Policy Report [CPUC 2003].

Figure 1. The Water Use Cycle

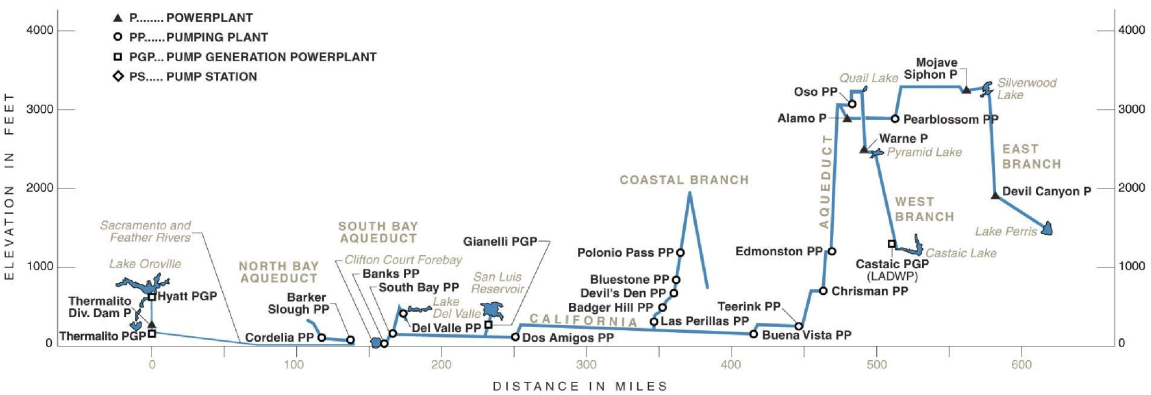


Source: CEC 2005

Energy embedded in water is the sum of energy input into water along the various segments of the water use cycle, from point of collection or production, to point of use, and from point of use to ultimate disposal back into the system (post-treatment).

Figure 2. Elevation Map of the California Aqueduct

Source: California Department of Water Resources



of the CEC's finding was not, however, just that the state's water-energy relationship was large – it was that although energy efficiency programs already target reductions of hot water, the state could potentially save energy more cost-effectively than traditional energy efficiency measures by saving **cold** water.[21] Key to recognizing the energy value of such potential water savings was the concept of *energy embedded in water.*

While the concept of *energy embedded in water* appears simple, it is not yet being explicitly employed in California's energy efficiency programs. Building standards, planning grants, and a wide variety of programs now include consideration of both water and energy efficiency. However, they all stop short of recognizing the value of *energy embedded in water,* which was the distinguishing element of the CEC's 2005 findings and recommendations. In addition to a lack of consensus among various parties as to whether and how that should be measured, there are several significant barriers to deploying this concept:

In order to properly compute the amount of energy embedded in water, all of the energy inputs must be counted - along all segments of the water use cycle, and across multiple entities. For example, one entity may collect a unit of water (Supply & Conveyance segment), and then transport it to another entity for treatment. Yet another entity may deliver the water to end use customers.

- **In the above example, the computation of energy embedded in that unit of water requires summing the energy inputs by three different entities.**
- **In some cases, the energy input to the water may have been provided in more than one energy service provider's service area.**

One of the most controversial issues associated with the computation of energy embedded in water is whether and how energy inputs by multiple entities and within multiple energy service providers' territories should be counted. Key to this discussion has been the high energy inputs needed to transport water from northern California to southern California – at one point, lifting large quantities of water more than 2000' over the Tehachapi Mountain range.

In its illustrative computations of *energy embedded in water,* the CEC included energy inputs by the State Water Project (SWP), a division of the state Department of Water Resources (DWR), to deliver water across the state via the California Aqueduct. The inclusion of SWP energy inputs in the embedded energy computation created angst among California's policymakers. In order to protect the energy ratepayers that pay into energy program funds, CPUC regulated energy programs require that energy incentives be paid to customers that contribute to the funds from which those incentives are paid. In addition, the CPUC's programs typically require the energy IOUs that it regulates to separately collect and invest energy ratepayer funds within each utility's service area.

The SWP is not subject to the CPUC's jurisdiction. To further complicate matters, SWP self-provides most of the energy used to transport its water, from areas of collection and production (primarily in northern California) to areas of use throughout the state (primarily in central and southern California). Therefore, reducing use of water imported to southern California that was conveyed via the California Aqueduct would not necessarily reduce water-related energy consumption in southern California; nor would it necessarily reduce the amount of electric demand that would need to be met in-region by the state's regulated energy utilities. In fact, reducing

21 CEC 2005-1.

imports via the California Aqueduct may, in some cases, increase regional electric demand. This could occur, for example, if imported supplies need to be replaced with energy intensive local supplies, even if the change in the region's water supply portfolio reduces electric demand on a statewide basis.

Since a significant portion of the CEC's illustrative embedded energy calculation was attributed to energy inputs by the SWP, the relevance in context of CPUC jurisdictional programs became unclear; and in many cases, had the effect of focusing stakeholder debates on the role of the SWP in the state's water-energy nexus, rather than on identifying opportunities to change the state's water-related electric profile.

It is important to recognize that California's water-energy nexus does not rely solely on energy inputs to transport wholesale water from northern California to southern California via the California Aqueduct. Although the SWP is certainly a critical facility and the energy used to transport water via the Aqueduct is an important factor in the state's overall electric requirements, the highest potential opportunities for California lie in understanding how the state's water and wastewater systems and operations can be reconfigured to help meet important state policy goals and objectives. These include increasing conservation and efficiency of both water and energy, reducing the energy intensity of water supply portfolios, increasing electric reliability through demand response, increasing the state's portfolio of renewable and clean distributed energy, reducing greenhouse gas emissions and other adverse environmental impacts – in short, the broad portfolio of measures and opportunities that are collectively needed to secure California's long term resource, economic and environmental future. The CPUC's Embedded Energy in Water Study 1 demonstrated that in fact, one of the highest potential measures for the state may be to change the timing and amount of electricity used for groundwater pumping in central and southern California.[22]

This paper describes high potential measures and strategies for reducing the California water sector's electric footprint and its associated GHGs, and the types of barriers that will need to be overcome to enable near-term implementation.

22 CPUC Study 1.

California's Water Use Cycle

The water use cycle characterized by the CEC[23] provides a useful framework for discussing the state's water-energy opportunities. This paper focuses on opportunities to affect energy use by the water sector itself, and not on energy used by water customers during the consumption of water, since it is the water sector use that constitutes energy embedded in water that is at the heart of California's regulatory water-energy nexus debate.

Water sector energy consumption, both electric and gas, occurs within three primary segments of the water use cycle:

- **Supply and Conveyance** – the collection and transportation of water to treatment systems and/or distribution centers;
- **Treatment** – of both water and wastewater; and
- **Distribution** – of potable and recycled water to end uses.

<u>Note:</u> Wastewater collection accounts for a very small portion of electricity use because most sewers use gravity to deliver sewage to treatment plants. Consequently, it is not addressed here.

Three factors need to be considered when identifying and prioritizing water sector actions:

1. The primary drivers of water sector energy consumption;
2. The energy intensity of various systems or processes; and
3. The extent to which the amount, timing and place of energy consumption can be changed.[24]

1. Primary Drivers of Energy Consumption

The CPUC's Energy Embedded in Water Studies[25] documented the primary drivers of electric demand and energy by segment of the water use cycle (see Table 2 opposite). Understanding these drivers helps to identify strategies and measures for reducing the water sector's electricity use by segments of the water use cycle.

23 See Figure 1 in this paper.

24 Note that this paper focuses on electric consumption. This does not mean that there are no opportunities for saving natural gas – only that most energy used by water and wastewater agencies is electric, and there is much less data available about water sector use of natural gas.

25 CPUC Studies 1, 2 and 3.

Table 2. Key Drivers of Timing and Quantity of Electric Consumption by California's Water Sector[26]

Agency Type	Segment of Water Use Cycle	Primary Energy Drivers
Water	Collect and Produce Water Supplies	• Pumping: distance, elevation, volume, head/pressure, friction • Volume Treated • Treatment Technology
	Distribution and Conveyance of Water Supplies	• Pumping: distance, elevation, volume, head/pressure, friction
	Treat Water for End Use	• Volume and Quality of Source Water • Treatment Technology • Treatment Process (e.g., single vs. multi-stage)
Wastewater	Wastewater Treatment	• Volume and Quality of Influent • Level/Type of Treatment
	Wastewater Disposal	• Pumping: distance, elevation, volume, head/pressure, friction

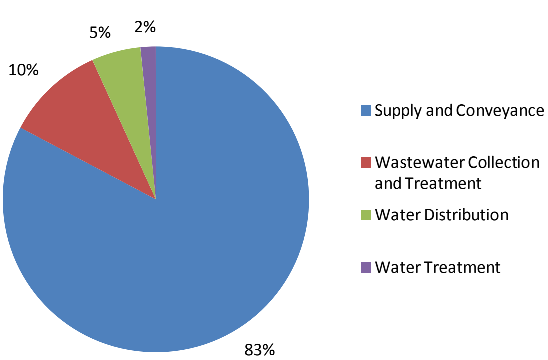
26 CPUC Study 2.

As noted earlier, in addition to understanding the primary drivers of electricity consumption, the amount of electricity used for various types of functions and the ability to affect the amount of electricity used is important to designing effective water-energy nexus programs.

2. Amount of Energy Used by System or Function

Figure 3 shows the approximate amount of annual energy consumed in California within each segment of the water use cycle.

Figure 3. Annual Water-Related Electric Consumption by Segment of the Water Use Cycle[27]



The Supply and Conveyance segment of the water use cycle accounts for 83% of the water sector's total embedded electric requirements – nearly 16,000 gigawatt hours[28] - more than 6.3% of the state's total electricity requirements. The primary driver of electricity used by the Supply and Conveyance segment is the need to transport large volumes of water across the state - in some cases, across hundreds of miles and thousands of feet of elevation.

Treatment (Water and Wastewater) and Distribution (Potable and Recycled Water) account for the remaining 17% of electricity used by California's water sector. The primary drivers of electricity consumption in these segments are related to the systems, processes and technologies needed to treat water and wastewater to the quality required by laws and regulations for application to the targeted beneficial uses, and the pressures needed to deliver treated water and recycled water to end users over distances and elevations.

3. The Extent to Which the Amount of Energy Consumed Can Be Changed

As noted earlier, it is simply not enough to know that the water sector uses large quantities of electricity. In order to prioritize strategies for changing electricity consumption by the water sector, the range of energy intensities experienced in each segment of the water use cycle, and by system and function, must be understood. Thereafter, the extent to which the energy intensity of a particular water or wastewater

27 CPUC Study 1, Appendix N.

28 Ibid.

agency's systems or operations can reasonably be changed must be examined. Once technically viable options have been identified, appropriate programs and strategies can be developed.

The largest range of energy intensities occurs within the Supply and Conveyance segment, where the energy intensity of various water supplies ranges from nil (for large surface reservoirs that rely on gravity to transport water supplies) to as much as 4,000 kWh/AF for high energy intensity supplies such as seawater desalination and certain segments of the State Water Project. The range of energy intensities observed in the Treatment and Distribution segments of the water use cycle are not as dramatic. Nevertheless, here as well, design and operational choices can result in significant energy savings.

Opportunities for changing the water sector's electric footprint are described below for each segment of the water use cycle.

Supply and Conveyance

The Supply and Conveyance segment of the water use cycle accounts for 83% of all electricity consumed by the water sector. The Supply and Conveyance segment also has the largest range of energy intensities.

Multiple studies have documented the amount of energy embedded in various types of water. The primary drivers of energy intensity in water supplies are:

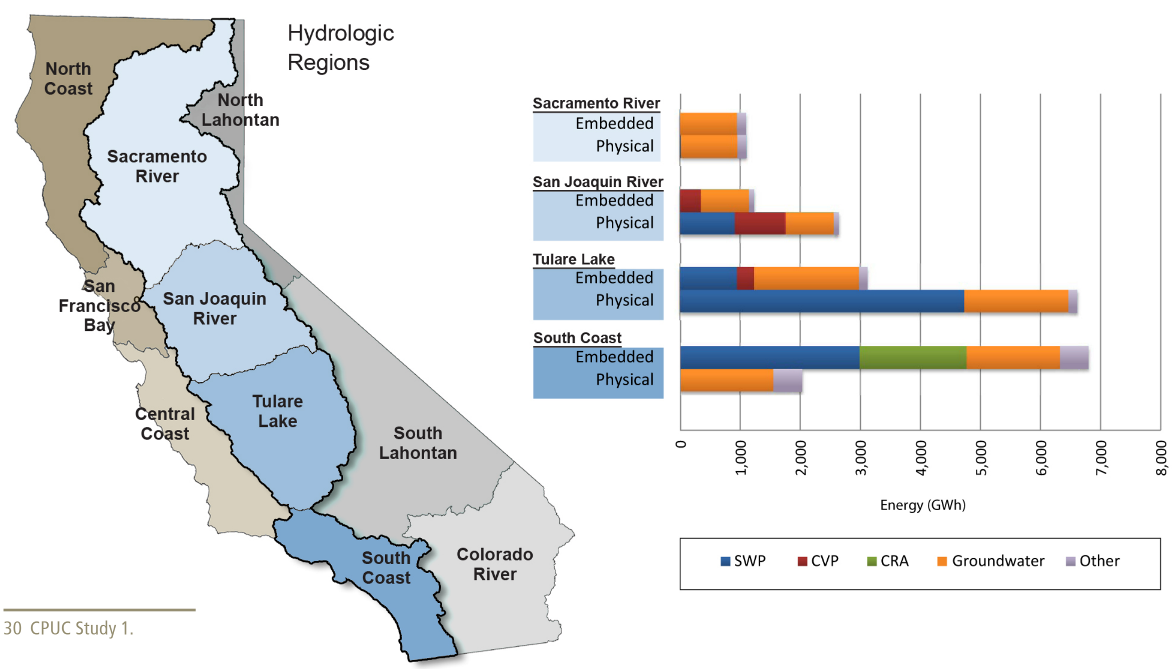
- Distance from point of collection or production of a water supply, to the point of its use;
- Changes in elevation over which water must be transported; and
- The amount of energy needed to produce a usable water supply from an otherwise unusable water source (e.g., desalination of brackish groundwater or seawater).[29]

CPUC Study 1 highlighted the distinct regional differences between "physical" and "embedded" energy within the state's Supply and Conveyance segment. Specifically, because of the nature of California's water resources and infrastructure, energy is often input to water supplies within one region, but the water is consumed within another region. Thus, decisions about regional water supplies can have significant impacts on the state's overall electric profile.

Figure 4 compares the amount of energy consumed by the Supply and Conveyance segment within

29 Various water-energy studies have accounted for treatment energy differently – some included all treatment energy in the Treatment segment, others included a portion of treatment energy in the Supply and Conveyance segment. Consistent with CPUC Studies 1 and 2, this paper deems Treatment energy as the amount used by water treatment plants to increase the quality of raw water supplies to the level needed to meet the beneficial uses for which they are intended. The amount of energy needed to "produce" water, whether for groundwater pumping or for desalination of brackish and seawater that would otherwise not be usable, is included in the Supply and Conveyance segment.

Figure 4. Embedded vs. Physical Energy in Water by Hydrologic Region[30]



30 CPUC Study 1.

a hydrologic region ("physical" energy) with the accumulated amount of energy input to water supplies from point of source through to consumption across multiple hydrologic regions ("embedded" energy). The state's energy embedded in water is highest in southern California, especially within the South Coast (SC) and Tulare Lake (TL) hydrologic regions. Water transported via the California Aqueduct from northern California to southern California accounts for a significant portion of the embedded energy in South Coast, but much of the energy embedded in water consumed in South Coast is actually input to the water in the Tulare Lake region.

The important message conveyed by Figure 4 is that electric use by the Supply and Conveyance segment is directly related to decisions about which water supplies will be used to meet demand within each hydrologic region.

The ability of an agency to change its electric footprint by changing its water supply portfolio depends on many factors, including water supply availability, water rights, transactions and prices. It may also depend on the suitability of the quality of a water supply option for its intended use(s), and the incremental cost of treatment infrastructure and operations that may be needed to treat any optional water resource for the targeted end use(s).

The statewide electric profile of the Supply and Conveyance segment is also complicated by the ability of water agencies to store water in surface and groundwater banks during periods of high water supply availability, and to call upon those supplies when needed; and by the ability of water agencies to enter into multi-year transactions for transfers and exchanges with water purveyors throughout the state. These complexities make it more difficult to predict the water sector's electric use profile – i.e., it does not necessarily follow that water sector electric use will increase during dry years in any particular hydrologic region. However, it is this flexibility that makes the water sector an interesting partner for demand response.

Treatment

On a relative basis, much less electricity is used for treatment – about 12% of the water sector's annual electric consumption is used for treating water (2%) and wastewater (10%). In addition, the range of energy intensities experienced for treatment is not as significant as for the Supply and Conveyance segment. Consequently, while there are means to change the amount of electricity used for water and wastewater treatment, significant energy reductions will be more difficult to achieve. This does not mean that changes should not be pursued in this segment of the water use cycle – only that opportunities should be sought to leverage on-going investments in system improvements and expansions to assure that energy-smart design and operations are integrated on a continuous basis.

Distribution

The Distribution segment of the water use cycle accounts for 5% of all electricity used by the water sector. It is used primarily for distribution of potable water to end use customers, since wastewater primarily flows downhill via gravity.[31] Just as for water conveyance, the amount of energy needed for distribution varies with the quantity of water that is being distributed, and the distance and elevations over which that water must be distributed. Just as for the treatment segment, opportunities to affect decisions within the distribution segment of the water use cycle should be incorporated into water sector capital improvement plans on an ongoing basis.

Recycled Water Distribution System

31 In some cases, wastewater booster pump stations are needed to transport sewage to the wastewater treatment plant.

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3

State Priorities 1 and 2: Energy Efficiency and Demand Response

California has one of the most aggressive clean energy programs in the U.S. Given an average annual investment of $1 billion for the most recent three year energy efficiency program period (2010-2012),[32] it is not surprising that the American Council for an Energy-Efficient Economy (ACEEE) named California as the national leader in energy efficiency for four consecutive years: 2007-2010.[33, 34]

32 CPUC Decision 09-09-047
33 ACEEE 2011, Figure ES-1. Summary of Overall State Scoring on Energy Efficiency, p.vi.
34 In 2011, California lost the first place spot to Massachusetts. Although California's 2011 investment in energy efficiency dwarfed all other 49 states, ACEEE scored California lower than Massachusetts on Combined Heat and Power, and State Government Initiatives.

In its Long-Term Energy Efficiency Strategic Plan (Plan),[35] the CPUC identified a number of strategies for key sectors. The Plan did not, however, include any embedded energy in water measures, since the Plan was issued before completion of the CPUC's water-energy pilots.

Subsequent to issuance of the CPUC's Plan, several activities were conducted to expand the body of knowledge about the state's water-energy nexus. These activities included several studies by the CPUC to increase understanding of the relationships between the state's water and energy resources and infrastructure.[36] In addition, the CPUC directed the state's investor-owned energy utilities to conduct pilot projects to evaluate the relative costs and benefits of different types of embedded energy in water measures.[37, 38]

The foregoing efforts resulted in the following significant findings about statewide electricity use by the water sector:

CPUC Finding 1: During summer months, energy used for groundwater pumping exceeds that of the State Water Project, the Central Valley Project, and the Colorado River Aqueduct, combined.

CPUC Finding 2: The primary drivers of the Supply and Conveyance segment of the water use cycle are regional water demand and the location of water supplies needed to meet that demand.

CPUC Finding 3: Energy intensity of retail water and wastewater agency functions is highly variable.

CPUC Finding 4: Electricity use by the water sector is higher than the California Energy Commission's initial estimates.

CPUC Finding 5: Water loss control is believed to represent significant cost-effective opportunities for water-related energy savings.

The results of the CPUC's studies and pilots help to frame the discussion of the water-related energy efficiency and demand response measures that follow. Three types of strategies will be described:

- Changes to Water Supply Portfolios,
- Changes to Systems and Facilities, and
- Changes to Operations

Changes to Water Supply Portfolios

Changes to water supply portfolios can have significant impacts on both the timing and the amount of electricity consumption within each of the state's ten hydrologic regions. For all of the reasons mentioned previously; i.e.,

- The Supply and Conveyance segment of the water use cycle accounts for 83% of all electricity used by the state's water and wastewater agencies;
- The primary drivers of water sector electricity use are the distance and elevations over which

35 CPUC EE Plan.
36 CPUC Studies 1, 2 and 3.
37 CPUC Pilots.
38 Assembly Bill 2404 [Saldana, 2008] required that the CPUC report the results of the embedded energy in water pilot programs to the Legislature. The CPUC plans to provide the results of its water-energy pilot projects that were reported in the Evaluation, Measurement and Verification (EM&V) report that was issued in March 2011. [CPUC Pilots]

water supplies must be pumped for delivery to water users, and the quality to which water must be treated before it can be used for the purposes for which it is being collected, produced and/or delivered; and

- Various water supplies have distinctly different locational and energy intensity profiles,

the water sector can change both the timing and the magnitude of its regional electric footprint, merely by changing its decisions with respect to which water supplies will be used within which regions, and during which seasons.

Accelerating water sector investments can yield significant savings of energy and GHGs

There are two primary types of strategies in the Supply and Conveyance Segment:

1. Changes to Water Supply Portfolios that alter the timing and amount of energy used in various locations; and
2. Reconfiguring Systems and Operations to enable shifting both the time and location of water-related energy use.

High potential opportunities include:

1. Reducing the Energy Intensity of Water Supply Portfolios
2. Reducing Summer Pumping Loads
3. Reducing Water Losses

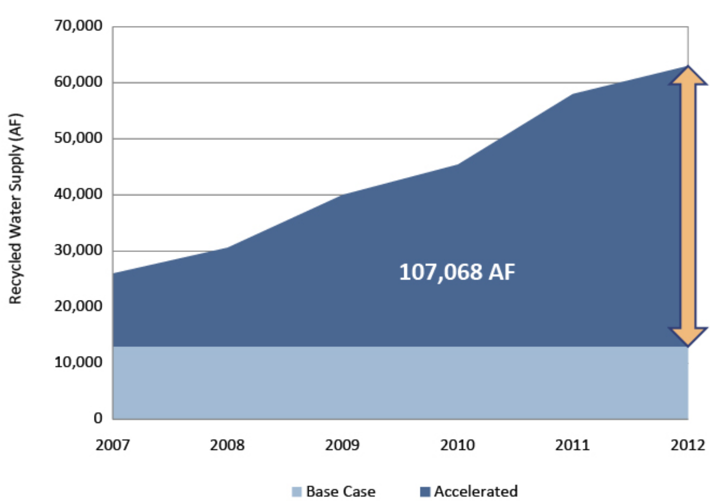
Below is a description of high potential opportunities for changing California's electric footprint and profile through water supply portfolio strategies.

Water Supply Strategy 1: Reducing the Energy Intensity of Water Supply Portfolios

Changes to water supplies can be of many types. Some will have local impacts, others may have regional impacts. For example:

- Local Energy Impacts: Water agencies may displace use of higher energy intensity local water supplies with water conservation, efficiency, recycled water and storm water.
- Regional Energy Impacts: Water agencies may reduce water supply imports from other regions. This may reduce energy used in other regions to transport and/or treat the water; however, it may then increase use of local energy supplies.

Figure 5. The Energy Efficiency and Greenhouse Gas Benefits of Recycled Water



Note: Short-run avoided water supplies were primarily comprised of a combination of SWP imported water and reduced local groundwater pumping.[40]

40 Ibid.

A study conducted in 2008 by the California Sustainability Alliance suggested that a rational proxy for valuing the energy and GHG benefits attributable to increased development and use of recycled water in southern California was seawater desalination, the statewide long-run marginal water supply. The approach to using the long-run marginal supply to value the avoided cost of resource efficiency measures is consistent with the CPUC's current methodology for evaluating the cost effectiveness of its energy efficiency programs. This approach results in an estimated energy benefit of 3,400 kWh/AF of incremental recycled water, and an average GHG benefit of 1.3 MTCO2e/AF.[39]

39 CSA 2008.

Notably, four of the six high priority measures identified by the Water-Energy Team of the Governor's Climate Action Team (WET-CAT) are related to changing water supply portfolios[41]:

- Water Use Efficiency
- Recycled Water
- Water Systems Efficiency
- Storm Water Reuse

Just as energy efficiency is the state's highest priority energy resource, water conservation and efficiency is deemed to be the most cost-effective, lowest energy intensity, and highest priority water resource.

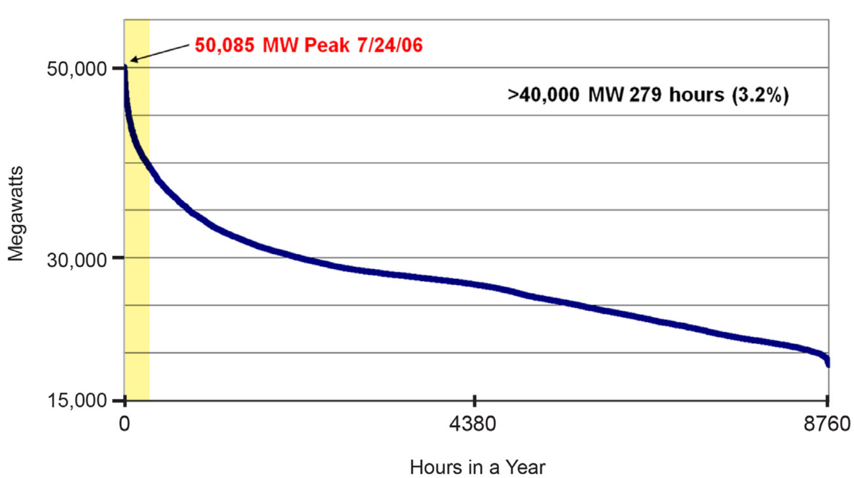
Recycled water is often deemed the second highest priority resource. In addition to being a valuable local supply that can displace high energy intensity imported water supplies, most of the energy embedded in the supply portion of recycled water is deemed to occur during the wastewater treatment process. The amount of energy embedded in recycled water is thus measured on the basis of the incremental energy needed to treat the water to a higher quality than that needed to meet regulatory requirements for effluent discharge, and/or the amount of energy needed to deliver recycled water from the point of its production to designated end use customers.

Through 2006, the Inland Empire Utilities Agency (IEUA) discharged about 43,000 AF per year of tertiary treated (recyclable) water into the Santa Ana River. That water could have been applied to beneficial uses, if IEUA had a means of delivering that water to qualified end users. In 2007, IEUA adopted a Three Year Business Plan for accelerating its investments in recycled water infrastructure with a goal of being able to beneficially use all of its recyclable water by 2010. That schedule has slipped due to economic pressures; but as of August 2012, 44,000 AF of IEUA's 50,000 AF of recyclable water has been connected. Figure 5 illustrates the incremental water, energy and GHG benefits achieved by IEUA's strategy to accelerate the beneficial use of its recyclable water.

Since IEUA's incremental recycled water was recaptured from tertiary treated wastewater that would otherwise be discharged to the Santa Ana River, the energy intensity of the water itself is deemed to be nil. Consequently, by accelerating its capital investments in recycled water infrastructure, IEUA increased production of low energy intensity local water supplies (0 kWh/AF) for the parched Chino Basin, while concurrently avoiding the amount of energy embedded in higher energy intensity water supplies that were no longer needed. Additional benefits were realized through reductions in GHGs associated with the avoided energy of the displaced water supplies.

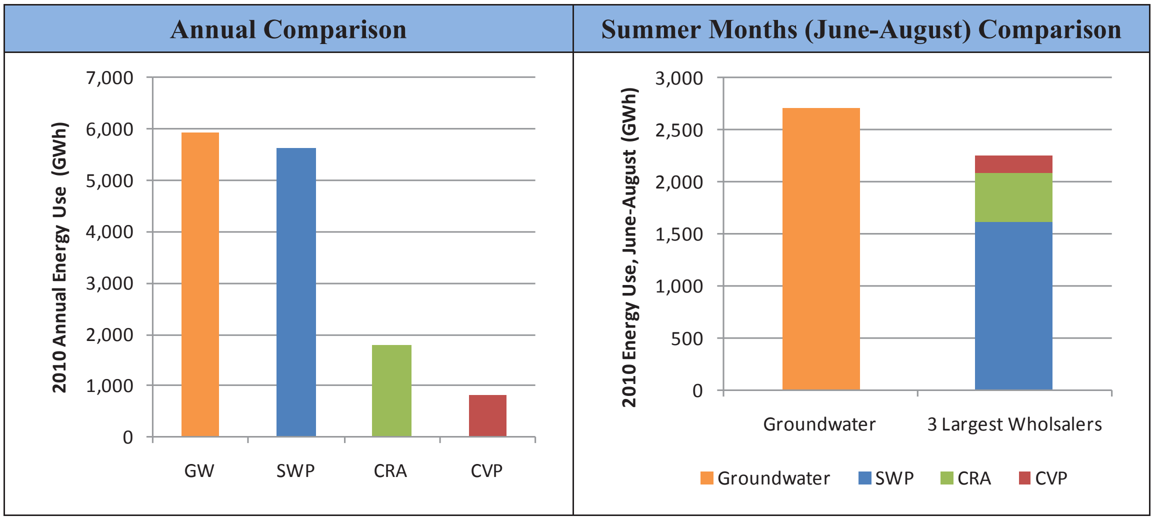
Deferring water sector electric use during the highest 50 electric demand hours could yield substantial statewide energy, economic and GHG benefits

Figure 6. California's Load Duration Curve



41 The 5th and 6th WET-CAT priorities are Renewable Development and Funding: http://www.climatechange.ca.gov/climate_action_team/water.html

Figure 7. Comparison of Energy Used for Groundwater Pumping vs. SWP, CRA and CVP[42]



42 CPUC 2010-1, Figure ES-2. Groundwater Energy Use Comparison, p.6.

Had IEUA not accelerated development of its recycled water infrastructure, the incremental water, energy and GHG benefits achieved by the ability to displace higher energy intensity water supplies with low energy intensity recycled water would have been lost. Significant energy efficiency and greenhouse gas benefits can also be achieved by using other lower energy intensity local supplies such as conservation, efficiency and storm water.

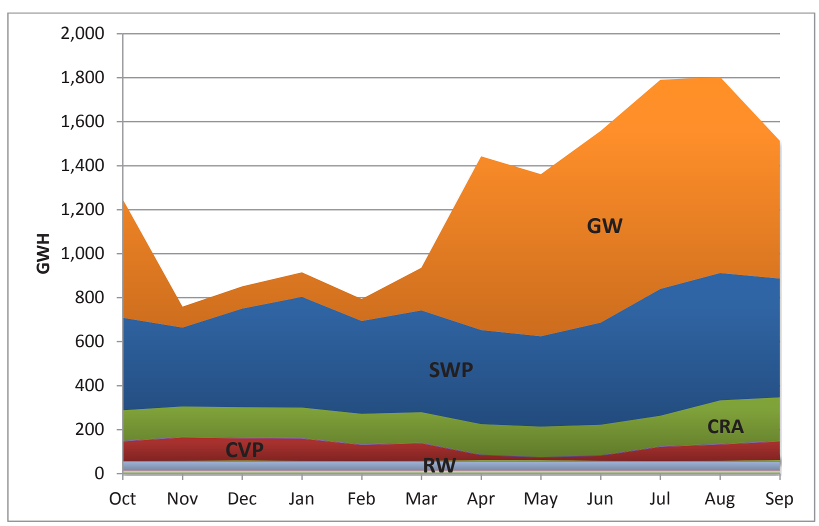
Water Supply Measure 2: Reducing Summer Pumping Loads

Over the past ten years, California's peak annual electric demand has ranged from about 45,000 MW to a high of 52,000 MW. As shown by the load duration curve in Figure 6, during 2006 about 10,000 MW was needed for only 3% of the hours. About half of that amount – 5,000 MW – was needed for barely 50 hours.

Assuming that water sector electricity requirements can be related to peak demand on a pro-rata basis, water sector electric demand may be about 4,000 MW. Although the amount of water sector electric demand that could be reduced or shifted to non-peak periods has not yet been determined, given that water systems have tremendous potential to change both the location and timing of electric used in the Supply and Conveyance segment, it seems likely that California's water sector can contribute significantly towards increasing the state's electric reliability while also reducing the number of large fossil power plants needed to meet the state's peak electric demand.

In fact, one of the major findings from CPUC Study 1 was that energy used for groundwater pumping during summer peak demand months exceeds the amount of energy used for pumping water via the State Water Project (SWP), Central Valley Project (CVP), and the Colorado River Aqueduct (CRA), combined (see Figures 7 and 8).

Figure 8. Monthly Energy Consumption for the Supply & Conveyance Segment (CY2010)[43]



43 CPUC 2010-1, Figure ES-1. Monthly Energy Consumption in 2010 by California Water Supplies, p.5.

Some agencies are able to shift major portions of their pumping loads to non-critical peak periods, while others cannot. The study sample in the CPUC's Embedded Energy in Water Studies was not sufficient to determine how much of California's summer groundwater pumping is already being shifted to non-critical peak periods, nor was there enough information to determine the amount of demand that could be feasibly reduced with changes to water systems and operations. There is sufficient information, however, to indicate that the potential for demand reduction is likely significant.

Strategies for reducing both the timing and amount of electricity used for groundwater pumping include:

- Increasing surface storage capacity (reservoirs, tanks, pipelines, etc.) at critical points in water agencies' systems to enable deferring groundwater pumping to non-critical peak periods.
- Installing dual fuel pumps that enable switching to natural gas when groundwater pumping during critical peak periods cannot be deferred.
- Replacing summer groundwater supplies with lower energy intensity local water supplies such as water conservation and recycled water during peak electric months (summer), in order to defer groundwater pumping to non-peak months.

The primary barrier to switching from electricity to natural gas is compliance with increasingly stringent air quality regulations. The good news is that significant advances in emissions controls for internal combustion engines may be on the horizon, creating the possibility that fuel switching could become a viable option in the foreseeable future. In addition, sophisticated economic dispatch systems combined with automated controls can enable some level of dual fuel pumping even without technology and/or regulatory changes.

Eastern Municipal Water District (EMWD) uses dual electric-natural gas pumps that enable switching to natural gas pumping during summer peak demand periods. The dual fuel pumps are operated in accordance with a complex economic dispatch model that reduces operating costs while assuring compliance with the South Coast Air Quality Management District's (SCAQMD) stringent regulations.[44]

44 http://emwdemployees.org/emwdgoesgreen.html

Water Supply Measure 3: Reducing Water Losses

Within the Supply and Conveyance segment of the water use cycle, substantial amounts of water are "lost" through a variety of means, including evaporation, pipeline leaks, and reservoir and canal seepage. Every unit of water that is "lost" in the system and must be replaced by additional water supply resources has potentially significant energy implications for the state.

The primary means for substantially reducing losses in the Supply and Conveyance segment include:

- Covered water storage (e.g., reservoir covers and tanks);
- Detecting and repairing pipeline breaks and leaks; and
- Lining reservoirs and canals to reduce seepage.[45]

45 California Department of Water Resources website: http://www.water.ca.gov/wateruseefficiency/agricultural/

Reductions of losses in other segments of the water use cycle, including treatment and distribution, are also beneficial. In fact, the CPUC's water-energy pilots found that one of the most cost-effective means for saving energy by saving water may be through reducing losses within water distribution systems,[46] whether on the water agency side or the customer side of the water meter.

Strictly from a water supply perspective, system losses do not necessarily equate to losses of water. Seepage may, for example, return water supplies through groundwater recharge. From an energy perspective, however, surface water supplies that become groundwater supplies have accompanying energy impacts. It is precisely this multi-dimensional characteristic that distinguishes water-energy measures from single resource programs.

Changes to Systems and Facilities and Changes to Operations

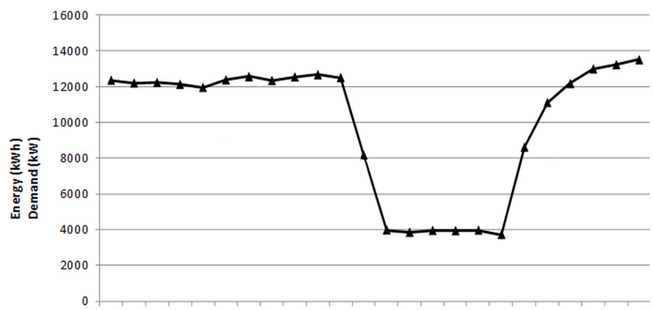
There are many different types of opportunities for increasing the energy efficiency of water and wastewater systems and facilities. These range from simple pump efficiency optimizations within water and wastewater treatment plants and distribution systems, to building redundancy into systems that enable improved scheduling of loads and reducing electric consumption during peak periods. Another strategy is to reduce the energy intensity of water and wastewater treatment processes.

In addition to constantly seeking efficiency improvements to systems and processes, water and wastewater agencies sometimes have the ability to shift the timing of their electricity use, both on an hourly and a seasonal basis. In order to maximize load shifting, water and wastewater systems must be designed with operational flexibility in mind.

Inland Empire Utilities Agency (IEUA) has two wastewater treatment plants that are linked by sewers, enabling shifting treatment loads from one plant to another. During the 2001 energy crisis, IEUA was able to re-route flows to reduce its electricity use during peak demand periods.[47]

Figure 9 shows that when the system design supports flexible operations, price signals work. Multiple water and wastewater agencies that participated in the CPUC's Embedded Energy in Water Study 2 exhibited the below load profile during summer weekdays.

Figure 9. Illustrative 24 Hour Load Profile of a Combined Water and Wastewater System[48]



46 CPUC Pilots.

47 IEUA.

48 CPUC Study 2.

Summary of Potential Energy Efficiency and Demand Response Measures

Table 3 summarizes the primary types of potential actions that the water sector could implement to reduce energy consumption and/or statewide peak electric demand. The measures are presented in accordance with the state's energy resource loading order.

Table 3. Energy Efficiency and Demand Response Measures

<table>
<tr><th colspan="2">Energy Efficiency & Demand Response</th><th>Examples of Potential Measures</th></tr>
<tr><td rowspan="3">Priority 1: Energy Efficiency</td><td>Reduce Energy Intensity of Water Supplies
Displace high energy intensity resources with lower energy intensity water supplies, both on locational and seasonal/time-of-use bases</td><td>• Increase water conservation and efficiency to the maximum possible extent
• Increase development of lower energy intensity local water supplies such as surface water storage, recycled water and storm water</td></tr>
<tr><td>Reduce Energy Intensity of Systems and Facilities
Identify system retrofits that could reduce conveyance system energy requirements</td><td>• Optimize system hydraulics to reduce energy intensity of water and wastewater pumping and treatment operations, including maximum use of gravity
• Reduce energy intensity of water and wastewater treatment systems, processes and technologies
• Reduce friction-related energy losses in water conveyance systems such as tunnels, pipelines, aqueducts and canals
• Optimize anaerobic digestion and alternative sewage treatment processes
• Reduce wet weather pumping and associated wastewater treatment loads</td></tr>
<tr><td>Reduce System Losses
Reduce losses of energy embedded in water that is lost due to leaks</td><td>• Use smart meters, acoustic listening devices, and other tools and technologies for early leak detection and prevention
• Line canals and reservoirs, and cover open reservoirs to reduce water supply losses if not readily recoverable through groundwater recharge</td></tr>
<tr><td>Priority 2: Demand Response</td><td>Increase Ability to Shift Electricity Time-of-Use
Identify changes to supply and conveyance design and operations that increase system flexibility for demand response and peak load reductions</td><td>• Increase water storage (tanks, reservoirs, pipelines, etc.) to increase the ability to defer water pumping to off-peak periods
• Reduce groundwater pumping during summer peak energy periods if/when feasible
• Switch to natural gas, biogas, and other types of energy resources to support pumping and treatment during summer peak energy periods that cannot be deferred</td></tr>
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4

State Priority 3: Energy Production

Water and wastewater agencies typically either own or have rights to extensive facilities, lands and rights-of-way that can be used to develop electric generation facilities - both to meet their own electric loads, and potentially to also become net exporters of electricity. This section also addresses production of biogas as a by-product of the wastewater treatment process, with the understanding that some biogas is used for heating to offset purchases of natural gas, instead of producing electricity.

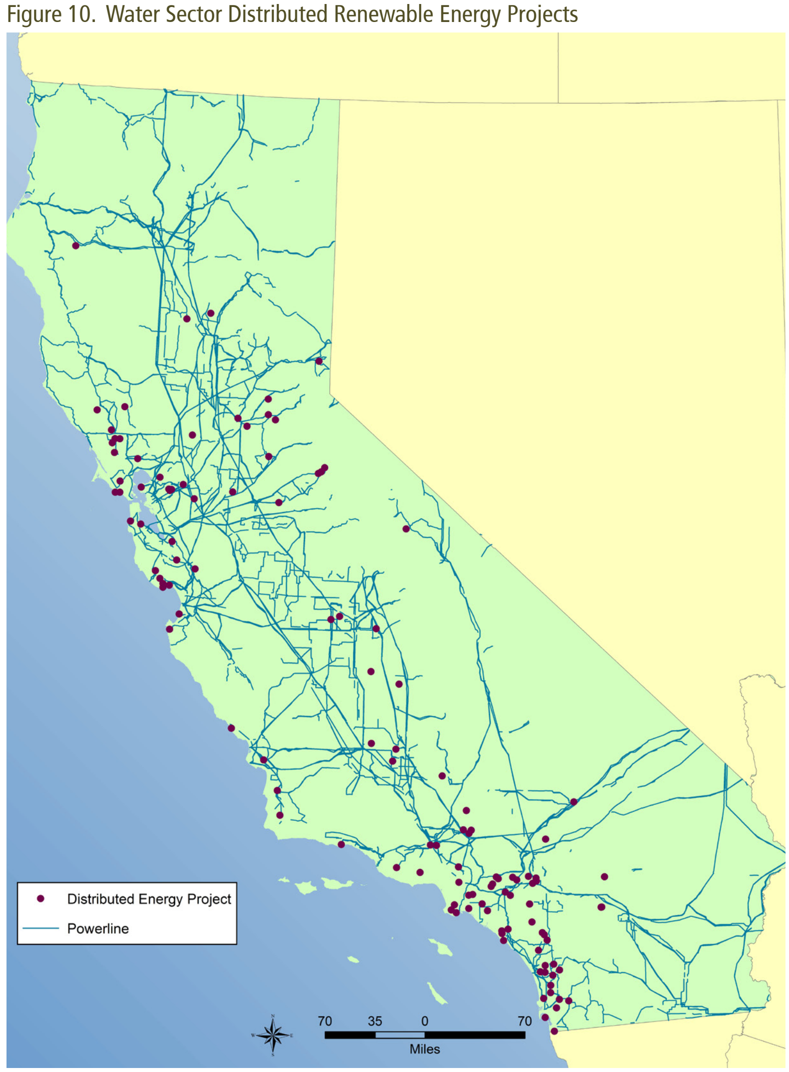
Customer-Side Generation

Water and wastewater agencies can self-produce renewable and other clean energy to help offset all or a portion of their electricity requirements. The primary types of renewable energy that fit within the scope of the state's water-energy nexus are those that occur as a by-product of water delivery and treatment processes; i.e., in-conduit hydropower and biogas. However, water and wastewater agencies are also early adopters of fuel cells, advanced micro-turbines, solar photovoltaics, and small wind projects. Some water and wastewater agencies have also investigated the potential for geothermal heating and cooling.

In July 2009, a collaboration of agencies including ACWA, the California Association of Sanitation Agencies (CASA), Metropolitan Water District of Southern California (MWD), Pacific Gas and Electric Company (PG&E), Southern California Edison (SCE), the California Energy Commission (CEC), and the California Public Utilities Commission (CPUC) conducted a survey of the potential of California's water sector to help the state meet its aggressive clean and renewable energy goals through distributed renewable energy. The goal of this survey was to inform energy resource managers and decision-makers about the opportunities and benefits of renewable energy development co-located with water and wastewater infrastructure.[49]

The data collected by ACWA was supplemented with independent research conducted by GEI Consultants. GEI then mapped the data to illustrate the potential locational reliability benefits to the state's electric grid by harnessing the electric production capabilities of the water sector. Since water and wastewater agencies build infrastructure to serve customers, it is logical that water infrastructure and its associated electric requirements tend to cluster around areas of high electric demand. This relationship is depicted in Figure 10.

Figure 10. Water Sector Distributed Renewable Energy Projects



49 CEC 2011.

Production of Excess Electricity

Water and wastewater agencies that have access to substantial lands and rights-of-way may have opportunities to develop excess electricity for export to the grid. Many wastewater treatment facilities produce biogas as a by-product of sewage treatment processes. Several agencies have also embarked upon initiatives to increase biogas production through co-digestion and bio-waste diversion projects.

As public agencies charged with stewardship of public funds and resources, California's water sector is naturally risk averse. Consequently, although there may be opportunities for water and wastewater agencies to build merchant scale renewable and other electric production facilities on their lands, the economic risks must be manageable. At a minimum, the water sector is unlikely to develop excess energy unless it can be assured a reasonable return on its investments and minimal financial and operating risks to its customers and constituents.

Summary of Potential Energy Production Measures

Table 4 describes the types of measures that could be taken by the water sector to increase electricity production where beneficial to alleviate local grid impacts and increase statewide electric reliability. Electricity production measures are primarily of two types: self-production of electricity to help offset a portion or all of a water or wastewater agency's loads, and production of excess electricity for sale to others.

Table 4. Electricity Production Measures

Electricity Production		Examples of Potential Measures
Priority 3: Renewable Energy	Water Energy Recovery: Maximize energy recovery from water and wastewater collection and transport systems (i.e., in-conduit hydropower)	• Increase development of in-conduit hydropower at outfalls, pressure reducing stations, and other points within water and wastewater systems where excess pressure can be harnessed
	Wastewater Energy Recovery: Maximize energy recovery from wastewater treatment operations (e.g., biogas from sewage digestion)	• Advance sewage treatment process improvements that increase biogas production • Develop technologies & processes that enhance biogas fuel value and production by combining with other bio-feedstock (e.g., forest biomass, agricultural waste, dairy and other animal wastes, food processing waste, etc.) • Improve technologies that condition ("clean-up") biogas to pipeline quality gas • Develop models and tools that assist wastewater treatment operators in determining the optimal amount of on-site biogas storage capacity needed to meet peak electric demands with biogas generation
	Produce Excess Electricity: Encourage water and wastewater agencies to produce excess electricity to help meet the state's Renewable Portfolio Standard and Greenhouse Gas (GHG) reduction goals	• Identify opportunities to support grid integration of intermittent renewable resources (e.g., wind & solar) by: » Increasing storage and peaking capacity (both hydropower and biogas generation) » Developing pumped storage facilities • Assess potential of modifying existing surface storage facilities to maximize energy production & increase load following capabilities

Figure 10 was prepared by GEI Consultants from data collected and compiled by the collaboration led by ACWA in 2009, and updated with GEI's independent research from publicly available data in 2011 and 2012. Since the focus of this white paper is on voluntary water-energy measures that could be implemented by California's water sector, data from publicly owned combined water and power utilities were not included in this map, as they are required by state law to develop and/or purchase renewable energy resources as a portion of their electric supply portfolio.

5

Findings and Recommendations

California's water sector invests billions of dollars every year in operations, maintenance, improvements and expansions of water and wastewater systems and facilities. These investments are expected to continue at a comparable pace for the indefinite future. Every dollar invested by the water sector presents an opportunity to increase the integration of energy efficiency, demand response, renewable and clean, distributed energy into water and wastewater systems, facilities and operations.

Water and wastewater facilities tend to be located in or near areas of high electric demand. Consequently, all actions taken by water and wastewater agencies to moderate their electric footprint can improve local and regional electric reliability.

By modifying its water resources, systems, facilities and operations, California's water sector can, where economically viable, substantially change its electric footprint. No other sector has as much potential to reduce summer peak demand, especially within energy challenged southern California. The water sector also has the ability to change the amount, time-of-use and seasonality of electricity use within each of the state's ten hydrologic regions by changing the locational mix of water supplies.

Importantly, electricity used for summer groundwater pumping is substantial and tends to coincide with periods of high electric demand. This means that shifting the timing of groundwater pumping can result in significant benefits to the state through enhanced statewide electric reliability and avoided investments in new electric infrastructure. Assuming that water sector electricity requirements can be related to peak demand on a pro-rata basis, water-related electric demand may be as high as 4,000 MW. Shifting just half of that demand to non-peak periods could reduce the need for up to four 500 MW central electric generation plants. Substantial benefits would accrue to the state if water sector electric use could either be deferred or replaced with non-electric solutions during at least the 50 highest electric demand hours of every year.

While the potential magnitude of energy savings and demand reductions in the treatment and distribution segments is not as large as in the Supply and Conveyance segment, these also present opportunities for energy efficiency and demand response, as well as opportunities for renewable energy production. Thoughtful design and periodic reviews of systems and processes in conjunction with routine system planning present frequent opportunities to leverage water sector capital investments.

While water and wastewater agencies are interested in helping the state achieve its electric reliability, resource efficiency and clean energy goals, their first obligation is to achieve their mission of providing a safe and reliable water supply and/or wastewater treatment and recycling. In this respect, the water sector is no different than any other industry segment, including the energy sector itself. However, given the compelling potential for substantial statewide energy benefits, a vibrant dialogue between the state's water and energy sectors is warranted.

It is important that these issues be engaged sooner than later. While water agencies have indicated willingness and interest in maximizing the energy benefits of their resources, infrastructure and operations, the incremental costs of capital improvements that will be needed to realize these benefits are often prohibitive. Further, some solutions may require regional coordination of water supplies and operations that lie beyond "business as usual." Consequently, absent any meaningful intervention, the water sector will continue expending billions of dollars every year on critical water and wastewater infrastructure that has not been optimized from

The water sector is uniquely positioned to bring near-term relief and long-term reliability to energy-stressed areas of the state

a statewide energy perspective. As demonstrated by IEUA, accelerating water sector investments in recycled water and other critical water resources and infrastructure can yield incremental energy savings and associated reductions of GHGs that would otherwise be forever lost.

Several state agencies: the California Energy Commission (CEC), California Public Utilities Commission (CPUC), Department of Water Resources (DWR), Air Resources Board (ARB) and State Water Resources Control Board (SWRCB) are engaged in a variety of activities intended to work in concert to advance the state's water-energy initiative. The California Independent System Operator (CAISO) may also have a significant role in developing programs that encourage water and wastewater agencies to increase demand response capabilities in reliability challenged areas throughout the state.

In order to achieve the full benefits of the state's water-energy nexus, policy and regulatory barriers to recognizing the full value of energy embedded in water will need to be alleviated. New analytical methods, metrics, technologies and business models will also be needed.

The following actions would help put the state on the path to comprehensive implementation of the state's water-energy initiative.

Recommendation 1: Increase Water Sector Demand Response Capabilities

The extended outage of the San Onofre Nuclear Generating Station (SONGS) has heightened recognition of the need to accelerate building diversity and resilience in the state's energy resources and infrastructure. Presently, the state's policymakers and regulators are bracing for the possibility that SONGS may not be returned to service until after summer 2013. Even without SONGS, the state's policymakers have been preparing for a potential need to retire or replace up to 15,000 MW of fossil generation by 2020.[50]

Table 5 describes high potential energy efficiency and demand response strategies that could be implemented by the water sector, and the key barriers that will need to be overcome.

Table 5. High Potential Water Sector Energy Efficiency and Demand Response Strategies[49]

Strategy	Demand Response Measure	Primary Barriers	Recommendations
Increase operational flexibility	Increase storage (reservoirs, tanks, pipelines) to enable deferring pumping, treatment and other water-sector electric use to non-peak periods and seasons	Capital investments needed Some storage facilities (e.g., surface storage) may require long lead times for permitting	**Near-Term:** Provide incentives for storage solutions that can be implemented prior to summer 2013. **Long-Term:** Proactively integrate demand response capabilities into water sector Capital Improvement Programs.
Fuel switching	Use natural gas and/or biogas to reduce use of electricity during critical peak periods	Incremental investments needed for dual fuel equipment and infra-structure Air quality regulations limit emissions from combustion engines	**Near-Term:** Provide incentives for cost-effective dual-fuel systems that can be implemented prior to summer 2013. **Long-Term:** Accelerate development of technologies that increase fuel efficiency and reduce air emissions from combustion engines.
Coordinate water supply operations	Maximize regional use of lower energy intensity local water supplies during summer months	Individual water agencies may not have sufficient diversity within their own portfolios to make a difference	Encourage strategies that can achieve unrealized potential for collaborative development of incremental water conservation and efficiency, recycled water and storm water.

50 CEC2011.

Voluntary, incentive-based programs can provide timely, efficient mechanisms for reducing energy consumption, improving energy efficiency, and integrating operational flexibility into water and wastewater systems for demand response. Key to successful implementation of the above measures is strategic design of economic incentives. Traditional energy utility programs are not presently in synch with water sector needs in two important ways:

- **Basis for Measurement.** Existing demand response programs typically compensate participants on the basis of demonstrated reductions in electric demand by comparing this year's electric requirements to the prior year. This approach is not well suited to water-related energy consumption which varies significantly from one year to the next with changes in hydrology.
- **Performance Period.** Water and wastewater agencies continually reassess their systems, and plan and schedule system improvements and expansions over multiple years. The timeline for planning, design, financing and construction of water sector infrastructure improvements often exceeds three years. This is problematic for energy utility programs that offer incentives for measures that can be implemented within 2-3 year program periods.

To remedy this problem, existing energy efficiency program evaluation protocols would need to be modified to recognize year over year changes in hydrology, water treatment processes and changing supply sources. In addition, energy utilities would need to be able to reserve and carry forward energy incentives needed to implement cost-effective water-energy opportunities in water agency capital improvement plans over multi-year periods sufficient to permit, finance, design and construct the targeted improvements.

Recommendation 2: Recognize the Value of Energy Embedded in Water

About 40% of the state's water-related electricity requirements are consumed by the water sector itself. The remaining 60% is attributable to electricity used by water customers during the consumption or use of water that often requires pumping, filtering, pressurization and/or heating.

This paper focuses on the 40% of electricity used by the water sector itself, because it is this portion of energy that becomes the energy embedded in water that can be avoided by reducing water consumption, both hot and cold. California's energy programs already have the ability to invest in reductions of hot water consumption, where the energy inputs and efficiency benefits are more clearly identifiable. California's energy programs do not yet recognize the portion of energy that is embedded in the water itself – so-called "cold water savings" – not because the embedded energy cannot be calculated, but because of regulatory protocols that do not presently allow the computation of energy savings across multiple entities and multiple energy service providers.

Without an approved methodology for valuing the amount of energy embedded in water, the state's investor-owned utilities cannot provide incentives to water and wastewater agencies that recognize the full value of energy input to water resources along all

Table 6. Options for Computing Energy Embedded in Water

Basis for Computing Energy Embedded in Water		Intra-Marginal		Extra-Marginal		Average	
		Short-Run	Long-Run	Short-Run	Long-Run	Short-Run	Long-Run
Entity	Single Water or Wastewater Agency						
	Multiple Water and/or Wastewater Agencies						
Jurisdictional or Geographic Boundaries	Climate Zone						
	Hydrologic Region						
	Energy Utility's Service Area (Single or Multiple)						
	Statewide						

segments of the water use cycle. As a consequence, measures that could otherwise become cost-effective may be left on the cutting floor.

The CPUC is presently conducting several proceedings in parallel that are addressing a wide variety of issues related to improving the effectiveness of the energy utilities' customer programs, including the determination of cost-effectiveness of water-energy nexus measures. There are many different ways to calculate the embedded energy in water. Choices range from computing the energy embedded in short-run average or marginal supplies, to long-run average or marginal supplies. The selection of which resources are ultimately avoided by implementation of any particular measure may be intra- or extra-marginal.

Table 6 illustrates the range of potential approaches to computing energy embedded in water. The actual methodology(s) selected may vary for different purposes. Ultimately, the "right" choice is the one that is most likely to achieve the targeted policy goals and objectives. Sufficient data exists today to support any of the foregoing computations. There is no scientific reason why one computation is better than another – it is a policy choice.

Recommendation 3: Simplify the State's Renewable and Distributed Energy Programs

Net Energy Metering (NEM), Renewable Energy Self-Generation Bill Credit Transfer Program (RES-BCT), Feed In Tariffs (FITs), the Renewable Auction Mechanism (RAM), the California Solar Initiative (CSI) incentives, Self-Generation Incentive Program (SGIP) – all of these separate programs collectively comprise a complex maze of options which, while intended to encourage participation by water and wastewater agencies and other energy customers, primarily confound and bewilder. In addition to far too many and too complicated programs, these programs change frequently, with the result that keeping current as to which program to use for which purpose requires significant investments of both staff time and expert advisors. That, in itself, is a major deterrent.

The state and all market participants – the CPUC, the utilities, their customers, and independent power producers – would benefit significantly from streamlined and simplified programs and processes. Some of the most buildable sites in California are owned or controlled by public agencies that are naturally risk averse. These public agencies would likely be more willing to produce excess energy for sale if the terms and conditions of power sales agreements were less confusing and less risky from a financial perspective.

Table 7. California's Renewable/Distributed Energy Programs

Type of Program	Program Name	Program Description	Features
Incentives	Self Generation Incentive Program (SGIP)	Provides contribution ($/watt) towards capital costs of qualified projects	Some types of SGIP projects can be combined with NEM
	California Solar Initiative (CSI)	Provides contribution towards capital costs ($/watt or $/kWh)	Some types of CSI projects can be combined with NEM
Wheeling	Net Energy Metering (NEM)	Allows customers to meet all or a portion of their electric requirements with qualified generation resources on an average annual load basis (i.e., without a need to match generation to load on a real time or time-of-use basis)	• NEM credits the full bundled electricity price towards qualified on-site customer generation, up to the amount of the customer's annual electric requirements • Most NEM projects pay little or no charges for grid interconnection
	Renewable Energy Self-Generation Bill Credit Transfer (RES-BCT)	Allows Local Governments to connect up to 50 meters to "Eligible Renewable Generating Facilities", each no more than 5MW in capacity	• Each Benefiting Account must be TOU metered • Cannot use NEM, sell output, or participate in Demand Response programs
Energy Sales	Net Surplus Compensation (NSC)	Allows NEM customers to elect to be compensated for excess energy at the end of a 12 month period, rather than roll it over to the next 12 month period	Compensation is based on each utility's Default Load Aggregation Point (DLAP) price
	Feed-In Tariff (FIT)	Provides a mechanism for IOUs to purchase output from eligible small renewable generation (presently < 3 MW in size)	Compensation is based upon a renewable market adjusting tariff (Re-MAT)
	Renewable Auction Mechanism (RAM)	Bid price auction mechanism for procuring output from renewable distributed generation projects >3MW and <=20 MW in size; uses a standardized contract mechanism	Bid price, selected on a "least cost, best fit" basis for different resource types (e.g., base load vs. intermittent)
	Bi-Lateral Contract	Negotiated power sales/purchase agreement	"Reasonableness" benchmarked to Market Price Referent (MPR)

Recommendation 4: Leverage Complementary State Initiatives

As a leader in resource efficiency and environmental responsibility, California has many policies and programs that represent potential points of synergy and leverage with the water-energy nexus. Some have been described in this paper; there may be many others. Several strategies that have been deployed to-date deserve special mention:

- Continually raising the bar for water and energy efficiency through Codes and Standards (e.g., Title 24 Building Energy Efficiency Standards);
- Requiring inclusion of the water-energy-climate nexus in Integrated Regional Water Management Plans (IRWMPs) as a condition of obtaining planning grant funds; and
- Including water-energy nexus programs in CPUC-regulated energy programs.

Other opportunities may also be possible:

- Developing special demand response programs that target near-term water sector actions to alleviate energy reliability risks during summer 2013 and beyond;
- Integrating water-energy-climate nexus compliance elements into additional grant funding opportunities; and
- Sharing data, tools, methods and metrics among multiple state programs when beneficial to increase understanding of the water-energy nexus and to accelerate its comprehensive implementation.

Water Treatment Plant

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Conclusions

The water sector has unique capabilities for substantially changing the amount, time and place of its electric consumption. Some potential water sector actions will require changes to historical supplies, facilities and operations. Some will require revisions to policies, laws, rules, regulations, programs and practices. Most actions will likely also require incremental investments, some of which may not be within either the budget or the scope of a water or wastewater agency's authority.

Financial incentives are an important policy tool for encouraging voluntary adoption of high potential water-energy nexus strategies. The purpose of water-energy incentives is not to give anyone a "free ride" – it is to provide a mechanism for co-funding targeted improvements that are expected to produce important benefits to the state that may not be captured if not evaluated conjointly.

With encouragement from the CEC, water-energy nexus stakeholders first looked to the CPUC where the synergies between water and energy resources are very clear, and existing resource efficiency programs are mature. However, the CPUC is not the only forum in which the water-energy nexus has been or should be engaged. Clearly, the CAISO is a major stakeholder, as are the CEC, DWR, SWRCB and ARB. There may be others.

Non-financial incentives can also be effective policy mechanisms for obtaining support for a wide variety of programs. Numerous jurisdictions reported success in increasing voluntary participation from the real estate sector in green building programs by offering expedited review and approval of permits. There may well be a parallel within the water sector.

Since the CEC issued its water-energy white paper in 2005, discussions have focused primarily on whether the water-energy nexus should be incorporated into various state programs. Seven years later, the state has signaled through multiple actions that the answer is "yes." From this point forward, the state should shift its focus to the following fundamental questions.

1. What types of water-energy measures and strategies will produce the highest benefits for the state overall?
2. What barriers and hurdles will need to be overcome to implement these measures and strategies?
3. Who are the key stakeholders whose support will be needed to overcome those barriers, and what are their respective roles in paving the way to statewide implementation?

As the state embarks upon this path, it will be important to start with a blank sheet of paper. While there has been a lot of conversation over the past seven years, an open dialogue between the water and energy sectors that fully explores the universe of possibilities has not yet been engaged. To truly understand the breadth of possibilities, the state will need to first set aside all preconceived notions based on prior dialogues that focused largely on what was possible, within existing policy, regulatory and other constraints.

By first setting aside all known barriers and hurdles, the water-energy nexus can provide a basis for establishing a new framework for optimizing the state's limited investments across multiple resources, programs and markets. The new decision-making frameworks, metrics, methods and tools developed for water-energy programs and measures can set the stage for additional cross-cutting programs that have not yet even begun to be formulated. The ultimate goal is to find the points of intersection and overlaps, leverage the points of synergy, and close the gaps, with the aim of achieving the state's resource and environmental goals as cost-effectively as possible.

True optimization of the state's water and energy resources will require new policy frameworks and investment mechanisms

References

AB2404 — **Assembly Bill 2404 [Salas 2008],** Energy efficiency: water efficiency programs.

ACEEE 2011 — ***The 2011 State Energy Efficiency Scorecard,*** American Council for an Energy Efficient Economy (ACEEE), October 2011.

Bioenergy 2012 — ***2012 Bioenergy Action Plan***, Natural Resources Agency, Department of Food and Agriculture, California Environmental Protection Agency, California Air Resources Board, California Public Utilities Commission, California Energy Commission, Department of Forestry and Fire Protection (CAL FIRE), CalRecycle, and the State Water Resources Control Board, August 22, 2012.

CAISO 2011 — ***Annual Report on Market Issues and Performance (2011),*** California Independent System Operator (CAISO), April 2012.

CEC 2003 — ***Integrated Energy Policy Report,*** California Energy Commission, CEC-100-03-019, December 2003.

CEC 2005-1 — ***California's Water-Energy Relationship,*** California Energy Commission, CEC-700-2005-011-SF, November 2005.

CEC 2005-2 — ***Integrated Energy Policy Report,*** California Energy Commission, CEC-100-2005-007CMF, November 2005.

CEC 2011 — ***Integrated Energy Policy Report,*** California Energy Commission, CEC-100-2011-001-CMF, 2011.

CEC 2012 — ***Publicly-Owned Electric Utilities and the California Renewables Portfolio Standard: A Summary of Data Collection Activities,*** CEC-300-2005-023, November 2005.

CPUC EE Plan — ***California Long-Term Energy Efficiency Strategic Plan,*** California Public Utilities Commission, September 2008.

CPUC Study 1 — ***Embedded Energy in Water Studies, Study 1: Statewide and Regional Water-Energy Relationship,*** GEI Consultants and Navigant Consulting for the California Public Utilities Commission, August 31, 2010.

CPUC Study 2 — ***Embedded Energy in Water Studies, Study 2: Water Agency and Function Component Study and Embedded Energy-Water Load Profiles,*** GEI Consultants and Navigant Consulting for the California Public Utilities Commission, August 31, 2010.

CPUC Study 3 — ***Embedded Energy in Water Studies, Study 3: End-use Water Demand Profiles,*** Aquacraft for the California Public Utilities Commission, April 29, 2011.

CPUC Pilots — ***Embedded Energy in Water Pilot Programs Impact Evaluation,*** ECONorthwest for the California Public Utilities Commission, March 29, 2011.

CSA 2008 — ***The Role of Recycled Water in Energy Efficiency and Greenhouse Gas Reduction,*** California Sustainability Alliance, May 2008.

DWR 2009 — ***California Water Plan Update,*** Department of Water Resources, 2009.

DWR 2012 — ***Draft 2012 Proposition 84 and 1E IRWM Guidelines,*** Department of Water Resources, July 2012.

EAP 2003 — ***California Energy Action Plan,*** adopted by the Consumer Power and Conservation Financing Authority, the California Energy Commission, and California Public Utilities Commission on May 8, 2003.

IEUA 2007 — ***Recycled Water Three Year Business Plan,*** Inland Empire Utilities Agency, November 2007.

IEUA 2010 — ***Recycled Water Three Year Business Plan Update,*** Inland Empire Utilities Agency, September 2010.

PPIC 2012 — ***Water and the California Economy,*** Public Policy Institutes of California, May 2012.

UCB 2004 — ***Introduction to Water in California,*** Carle, David, Berkeley: University of California Press, 2004.

WETCAT 2011-1 — ***Climate Change and the Water-Energy Nexus: Statewide Opportunities to Reduce Greenhouse Gases and Adapt to a Changing Climate,*** Water Energy Team of the Climate Action Team, 2011.

WETCAT 2011-2 — ***Water Energy Strategy 2012-2014,*** Water Energy Team of the Climate Action Team, December 2011.

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