Water-Energy Sector Summary
AB 32 Scoping Plan
GHG Emission Reduction Strategies

Sector Background

1) **The location and/or geographic extent of the sector as it would pertain to the Plan**

   Water and energy are integrally tied to California's economy. The Energy Commission estimates that approximately 19% of all electricity and 30% of non-power plant natural gas (i.e. natural gas not used to generate electricity) used in California is for the conveyance, treatment, distribution, and end use of water. Alternatively, 21% of the state's electricity is generated by clean hydropower.

   In an average year, California receives an estimated 200 million acre-feet (MAF) of water. An estimated 50%-60% of this water is "effective precipitation" that is absorbed by the environment, sustaining natural habitats, wetlands, and agricultural crops, or lost to evaporation. The remaining 40%-50% of the total annual water is considered "dedicated supply" that is managed , stored, distributed, or otherwise available for use. The three major uses of the dedicated supply are urban (11%), agriculture (48%) and environmental (41%). In consideration of these percentages, it should be recognized that water can be used by several users. For example, discharged urban wastewater may sustain downstream flows that support environmental constituents.

   In general, when a unit of water is saved, so too is the energy required to move, treat, deliver, use, and dispose of that unit of water. Strategies for this sector will address issues such as water recycling, water end use conservation and efficiency, reducing the energy required for water systems and using renewable energy in that system where practical. Location, elevation, water source, water use sector, water application, quality and energy source, among other factors, will be considered when addressing the water-energy interface.

2) **Unique considerations or issues with sector:**

   There are three unique challenges associated with climate change measures in the water sector.

   The first challenge is the requirement to maintain and protect water quality, including drinking water quality. The USEPA and the State Water Board have established water quality standards designated for waters of the US and waters of the State, and USEPA and the California Department of Public Health have established standards for drinking water. Energy is required to treat potable water and wastewater to protect public health and the environment. As knowledge of contaminants increases, it may be necessary to adopt more stringent standards for existing constituents or standards for new pollutants. Such actions will require treatment that could increase GHG emissions. Recognizing the public's interest in protecting water quality, the intent of the proposed measures is to ensure that water is developed and used in the most efficient manner, but climate change considerations cannot be a basis for lessening water quality standards.

The second unique dilemma posed by the water sector stems from the integrated use of water within the broader context of a watershed that is not defined by artificial boundaries. Along any given watercourse, water is repeatedly used, discharged, and used again by farms, cities, and the environment along the watercourse. The fundamental strategies for addressing climate change share a common objective of using water more efficiently. However, as an upstream entity becomes more successful at conservation, they will discharge less water potentially reducing the amount of water available to meet downstream needs.

Water rights in California are conditioned to specify when, where and how much water can legally be diverted. The amount of water an entity can take under a water right is based on permit requirements and may vary from year to year, depending on water availability and the demands of more senior water right holders. Climate change is expected to alter the seasonal availability of water, potentially reducing the water supply during periods when water rights have allowed the greatest diversions. As a consequence, future water may not be available for particular users under the terms of their water rights.

Sector Overview

3) Proposed emission reduction pathway for the sector

In February 2008, Governor Schwarzenegger issued a letter that laid the groundwork for innovative solutions to address water challenges in California. The letter identified such actions as conservation, improved water quality, and increased water storage. In each of these areas, the Governor directed state agencies to act within the bounds of their existing authority, but also welcomed new legislation to incorporate these goals into statute where necessary (e.g. 20% per capita reduction in water use by 2020). In addition, he directed DWR to expedite funding for groundwater storage projects throughout the state to improve water supply reliability. Consistent with the Governor's direction, the strategies and measures recommended by the WETCAT implement existing statutory authority where available, provide incentives where possible, and propose new legislation or regulation where necessary.

- DWR and the State Water Board have the authority to condition grants and loans on factors, such as a robust response to climate change.
- The State Water Board can incorporate climate change measures into waste discharge and water rights permits.
- The CPUC can include climate considerations in rate cases, and implement energy incentive funding in situations where such actions will reduce energy costs to ratepayers.
- The CEC has the authority to set conservation standards for water devices in the building code and, with the CPUC, approve broader use of renewable energy produced by water and wastewater agencies.
- Many public water utilities have joined the California Climate Action Registry.

4) The potential for leakage from the sector

There is a low probability of the public or private sector being able to outsource water supply and water quality, but there is some concern that a significant increase in the cost of water will contribute to the loss of water-using industries, such as agriculture and manufacturing. Currently, however, water is a relatively small percentage of the costs associated with most water-related industries.

5) Role of local, state, and federal government:

Water and energy are controlled, managed, delivered and directed by governmental boards, commissions and districts at the local, state and federal level. The primary agencies and their respective roles are briefly described below (*Provided by Lisa Beutler, Center for Collaborative Policy, California State University, Sacramento (March 2008)*:

The **Department of Water Resources (DWR)** is responsible for statewide water planning and management, flood protection, and dam safety. DWR also operates California's State Water Project (SWP), the largest State-built multipurpose project in the United States. The SWP was designed in the 1950s and 1960s and constructed during the 1960s and 1970s, with some later additions.

The **State Water Resources Control Board (SWRCB)** integrates water rights and water quality decision-making authority. The State Water Board was created by the Legislature in 1967. The Board has authority over both water allocation and water quality protection and oversees the many uses of water, including the needs of industry, agriculture, municipal districts, and the environment. There are nine Regional Water Quality Control Boards. The mission of the Regional Boards is to develop and enforce water quality objectives and implementation plans that will best protect the State's waters, recognizing local differences in climate, topography, geology and hydrology. Pursuant to the Porter-Cologne Water Quality Control Act, water quality control plans for each of the nine regions become part of the California Water Plan.

California Public Utilities Commission—The CPUC regulates privately owned, electric, natural gas, water, railroad, rail transit, and passenger transportation companies. There are about 130 private water utilities under CPUC rate regulation jurisdiction (and many more under general regulatory oversight) providing potable and irrigation water service to about 20%, or more than 6 million, residents of California. The CPUC requires the largest privately-owned water utilities (Class A utilities with at least 10,000 customers) to file a Water Management Program, which forecasts supplies and demand side management impacts out to a 20-year horizon. The CPUC's Water Action Plan provides policy guidelines for private utilities in many areas, including an emphasis on policies encouraging water conservation and efficiency, along with associated energy savings and greenhouse gas emissions reductions.

California Energy Commission—The State's primary energy policy and planning agency, has responsibility for forecasting, regulation, and development and promotion of technology.

California Department of Fish and Game—Regulates and conserves the state's wildlife and is a trustee for fish and wildlife resources (FDC § 1802).

California Department of Public Health—Regulates public water systems, oversees water recycling projects; permits water treatment devices, certifies drinking water treatment and distribution operators, supports and promotes water system security, provides support for small water systems and for improving technical, managerial, and financial capacity, oversees the Drinking Water Treatment and Research Fund for MTBE and other oxygenates, and provides funding opportunities for water system improvements, including funding under Proposition 84, Proposition 50 and the Safe Drinking Water State Revolving Fund.

California Department of Conservation—Provides services and information that promote environmental health, economic vitality, informed land-use decisions, and sound management of California's natural resources. This department also manages a state watershed program.

California Business Transportation and Housing Agency—Oversees the activities of 13 departments and several economic development programs and commissions. Its operations address financial services, transportation, affordable housing, real estate, managed health care plans and public safety.

California Coastal Commission—Plans for and regulates land and water uses in the coastal zone consistent with the policies of the Coastal Act.

California Department of Boating and Waterways—Develops public access to the waterways and promotes on-the-water safety, with programs that include aquatic pest control in the Sacramento-San Joaquin Delta; coastal beach erosion control, and grants for vessel sewage pumpout stations.

California Department of Food and Agriculture—Promotes food safety, protects public and animal health, and protects California from exotic and invasive plant pests and diseases.

California Department of Forestry and Fire Protection (CAL FIRE)—Manages and protects California's natural resources. Provides fire protection and stewardship of over 31 million acres of California's privately-owned wildlands and offers varied emergency services in 36 of the State's 58 counties via contracts with local governments.

California Department of Parks and Recreation (CA State Parks)—Manages more than 270 park units, which protect and preserve culturally and environmentally sensitive structures and habitats, threatened plant and animal species, ancient Native American sites, and historic structures and artifacts. Responsible for almost one-third of California's scenic coastline and manages many of the State's coastal wetlands, estuaries, beaches, and dune systems.

California Department of Pesticide Regulation—Regulates pesticide sales and use and plays a significant role in monitoring for the presence of pesticides and in preventing further contamination of the water resource.

California Department of Toxic Substances Control—Provides technical oversight for the characterization and remediation of soil and water contamination.

California Environmental Protection Agency—Restores, protects, and enhances the environment to ensure public health, environmental quality, and economic vitality.

California Integrated Waste Management Board—Manages the estimated 76 million tons of waste generated each year by reducing waste whenever possible, promoting the management of all materials to their highest and best use, and protecting public health and safety and the environment.

Central Valley Flood Protection Board—Plans flood controls along the Sacramento and San Joaquin rivers and their tributaries in cooperation with the U.S. Army Corps of Engineers.

Colorado River Board—Protects California's rights and interests in the resources provided by the Colorado River.

Delta Protection Commission—Responsible for preparation of a regional plan for the "heart" of the Delta.

Governor's Office of Emergency Services—Coordinates the activities of all State agencies relating to preparation and implementation of the State Emergency Plan, coordinates the response efforts of State and local agencies, and coordinates the integration of federal resources into State and local response and recovery operations.

Governor's Office of Planning and Research—Provides legislative and policy research support for the Governor's office. The State Clearinghouse coordinates the State level review of environmental documents pursuant to the California Environmental Quality Act (CEQA); provides technical assistance on land use planning and CEQA matters; and coordinates State review of certain federal grants programs.

Native American Heritage Commission—Its mission is to provide protection to Native American burials from vandalism and inadvertent destruction, provide a procedure for the notification of most likely descendants regarding the discovery of Native American human remains and associated grave goods, bring legal action to prevent severe and irreparable damage to sacred shrines, ceremonial sites, sanctified cemeteries and place of worship on public property, and maintain an inventory of sacred places.

Sierra Nevada Conservancy – is comprised of all or part of 22 counties and over 25 million acres the Region is California's principal watershed, supplying 65% of the developed water supply. The Conservancy initiates, encourages, and supports efforts that improve the environmental, economic and social well-being of the Sierra Nevada Region, its communities and the citizens of California.

State Lands Commission—Manages public trust lands of the State (the beds of all naturally navigable rivers, lakes, and streams, as well as the State's tide and submerged lands along California's more than 1,100 miles of coastline). The public trust doctrine is applied to ensure that the public trust lands are used for water-related purposes, including the protection of the environment, public recreation, and economic benefit to the citizens of California.

Federal Government

The **U.S. Bureau of Reclamation (USBR)** operates the Central Valley Project (CVP), the largest water project in California, and regulates diversions from the Colorado River.

Other federal agencies play important roles in the regulation and management of California's water resources:

Army Corps of Engineers—Plans, designs, builds, and operates water resources projects (navigation, flood control, environmental protection, disaster response, etc.).

Federal Energy Regulatory Commission (FERC)—Regulates the interstate transmission of electricity, natural gas, and oil. FERC also reviews proposals to license hydropower projects.

National Marine Fisheries Service (NOAA Fisheries)—Protects and preserves living marine resources, including anadromous fish.

National Park Service—Manages national parks, including their watersheds.

U.S. Bureau of Land Management—Manages federal lands.

U.S. Bureau of Reclamation—Constructs federal water supply projects and is the nation's largest wholesaler of water and the second largest producer of hydroelectric power.

U.S. Department of Agriculture (USDA)—Manages forests, watersheds, and other natural resources.

[USDA] Natural Resource Conservation Service—Provides technical and financial assistance to conserve, maintain, and improve natural resources on private lands.

U.S. Environmental Protection Agency—Protects human health, safeguarding the natural environment.

U.S. Fish and Wildlife Service—Conserves, protects, and enhances fish, wildlife, and plants and their habitats.

U.S. Geological Survey—Provides water measurement and water quality research.

Western Area Power Administration—Manages power generated by the Central Valley Project.

Public Agencies, Districts, and Local Governments

Local city and county governments and special districts have ultimate responsibility for providing safe and reliable water to their customers. In general, California has two methods for forming special districts that develop, control, or distribute water: (1) enactment of a general act under which the districts may be formed as set forth in the act, and (2) enactment of a special act creating the district and prescribing its powers.

Local and Regional Water Districts: Approximately 75 percent of the entities that operate or manage water systems and supplies in California are local public water districts, county water departments, city water departments or other special districts. According to the Water Education Foundation, some 600 special purpose local agencies provide water to California customers. Many of these local agencies also operate flood control and wastewater treatment facilities in addition to providing drinking water.

6) Public-private interface

In addition to public agencies, private entities may provide water supply. Mutual water companies, for example, are private, non-profit corporations that perform water supply and distribution functions similar to public water districts. Investor-owned utilities are also involved in water supply activities, sometimes as an adjunct of hydroelectric power development. These investor-owned water companies are regulated by the California Public Utilities Commission.

7) Interaction with other sectors

The Water-Energy Sector may have significant overlap with several of the other sectors being analyzed for the Scoping Plan. ARB should review the measures being proposed by the following CAT subgroups for emission reductions that intersect, if not completely overlap, those submitted by the Water-Energy subgroup: Agriculture, Energy, Forestry, Green Buildings, Land Use. Additionally there may be overlap in industrial sector strategies being considered by ARB.

8) Integration with regional, national, or global programs

Tribal Governments

Some Indian reservations and other federal lands have reserved water rights implied from acts of the federal government, rather than State law. When tribal lands were reserved, their natural resources were implicitly reserved for tribal use. Because reserved tribal rights were generally not created by state law, states' water allocations did not account for tribal resources. In the landmark *Winters v. U.S.* case in 1908, the U.S. Supreme court established that sufficient water was reserved to fulfill the uses of a reservation at the time the reservation was established. The decision, however, did not indicate a method for quantifying tribal water rights. Winters rights also retain their validity and seniority over State appropriated water whether or not the tribes have put the water to beneficial use. Only after many years did tribes begin to assert and develop their reserved water rights. In 1963 the U.S. Supreme Court decision *Arizona v. California* reaffirmed *Winters* and established a quantification standard based on irrigation, presupposing that tribes would pursue agriculture. Despite criticisms of the "practicably irrigable acreage" (PIA) quantification standard from various perspectives, the PIA standard provided certainty to future water development.

Quantifying water needs in terms of agricultural potential does not accurately show the many other needs for water. Even urban water quantity and quality assessments that look at the adequacy of the domestic water supply and sanitation do not provide a complete picture of tribal water needs. A large part of the tribal water needs are for in-stream flows and other water bodies that support environmental and cultural needs for fishing, hunting, and trapping.

The 1902 Reclamation Act provided for the establishment of irrigated agriculture and settlement throughout the Western states. Historical perspective indicates this policy was pursued generally without regard to Indian water rights or the 1908 Winters decision. In 1952 Congress passed the McCarran Amendment, which waived sovereign immunity and authorized the adjudication of federal water rights in stream adjudications brought in state courts. The court later ruled that state adjudications may also apply to Indian reserved water rights held in trust by the United States. In asserting their Winters rights, tribes have come into conflict with water-using development that grew out of substantial federal and private investment.

Costly litigation, negotiation, or both are the usual means of resolving Indian water disputes, and some cases can take decades to reach agreement. Some tribes request assistance from the federal government to pursue their water rights settlements, reminding concerned parties of the conflicting roles the federal government can assume on two or more sides of a judicial or administrative issue.

International Trade Agreements

Since January 2000 more than 140 World Trade Organization (WTO) member governments have been negotiating to further liberalize the global services market. The General Agreement on Trade in Services (GATS) is among WTO's most important agreements. It is a set of multilateral rules covering international trade in services. GATS recognizes "the right of Members to regulate, and to introduce new regulations, on the supply of services ... in order to meet national policy objectives." No international trade treaty now in effect or being negotiated by the United States prevents local, state, or federal government agencies from reviewing and regulating water projects that involve private companies with multinational ties. Such projects include desalination plants, water transfers, water storage projects (above and below ground), and wastewater reclamation projects. There is no conflict with international trade treaties as long as government regulations are applied to water projects involving multinational corporations in the same manner they are applied to water projects owned or operated by domestic companies or public utilities.

9) Consideration of longer-term goal for 2050

To date, emphasis has been on actions to achieve the greatest possible reduction of GHG emissions from the water sector. However, under current, most optimistic expectations of climate change, the envisioned change in water availability will warrant greater consideration of actions to mitigate the adverse consequences of climate change, such as dilution and assimilative capacity, in-stream flows, water temperature, and similar water characteristics that potentially impact beneficial uses.

Emission Reduction Strategies

10) Description of the sector's emission reduction approach

The Water-Energy subgroup developed five basic strategies for reducing GHG from this sector: two in water reuse (water recycling and urban water reuse); end-use water conservation and efficiency; reduction of the energy intensity of the water system; and renewable resources development.

Within those strategies, seven specific measures are being proposed as shown in the following table:

Strategy	Measure
Water Recycling	Require water recycling plans at wastewater treatment plants in regions that import water and/or where water recycling would require less energy than other sources.
Urban Water Reuse	Increase infiltration, expand use of low impact development (LID), capture dry weather flows.
End Use Water Conservation & Efficiency	Promote greater implementation of water conservation measures, including best management practices, to improve efficiency

Energy Intensity of Water System	Implement cost effective energy efficiency measures in water system infrastructure projects
	Construct a valuation and protocol methodology for the measurement and verification of efficiency and conservation activities/programs
	Conduct research and demonstration projects that explore ways to reduce the energy intensity of the water use cycle and better manage the energy demand of the water system.
Renewable Resources Development	Develop renewable energy projects that can be co-located with existing water system infrastructure

Specific details regarding each of these measures, including timelines, implementation and enforcement issues, and any known co-benefits can be found in the measure analysis submissions from the WETCAT.

11) How were emission reduction measures developed or evaluated?

The Water-Energy Subgroup of the CAT has met on a regular basis since late 2007. The team is comprised of representatives from the following agencies and Departments: Resources, Cal/EPA, ARB, DWR, SWRCB, CEC, CPUC, DOC, DFG, and CALFED.

The subgroup solicited input from its member agencies and stakeholder groups. The stakeholders provided suggested reduction measures during two workshops co-sponsored by SWRCB and DWR, which were held on August 23 and October 3, 2007, the Plenary Session of the California Water Plan Update on October 22, 2007, and the Public Advisory Committee of the Update on March 20, 2008.

The measures that were selected for submission were determined to have either a high probability of providing substantial GHG emission reductions in the near-term, or could lay the ground work for substantial reduction in future years.

12) Ensuring real, permanent, quantifiable, verifiable, and enforceable reductions

For the three strategies that have quantifiable GHG reductions, the metric for measuring successful implementation is included in the measure analysis submitted for the reduction strategy.

13) Existing controls resulting in emission reductions and co-benefits

Currently, the law requires communities to use recycled water if it is available, but this requirement has not resulted in significant progress to achieve the statewide water recycling goals. In 1992, urban water agencies throughout the state signed an MOU to create the California Urban Water Conservation Council and develop voluntary best management practices to be implemented over a ten-year period. The conservation goals of the Council members are far from being realized.

14) Early Action Measures, Discrete Early Action Measures, CAT Early Action Measures

The following are excerpts from the Climate Action Team's Early Action Report, outlining measures that are reflected in the submission from this subgroup:

- Water Use Efficiency: DWR will adopt standards for projects and programs funded through water bonds that would require consideration of water use efficiency in construction and operation. This strategy is expected to result in GHG emissions reduction of 1 MMTCO2E by 2020. This strategy was updated as part of the WETCAT submittal to CARB for the Scoping Plan.
- State Water Project: DWR will evaluate the State Water Project (SWP) energy resources and include feasible and cost-effective renewable energy in the SWP's portfolio. As DWR completes a GHG assessment through membership with the Climate Action Registry, and investigations of cleaner energy sources to replace reliance on the Reid Gardner power plant (see below), the SWP will be able to significantly reduce its GHG emissions. The GHG emissions reductions from this strategy are still to be determined.
- Cleaner Energy for Water Supply: In renewing energy supply contracts for the State Water Project, it is DWR's goal not to renew contracts supplied by conventional coal power generation. One specific example of this is DWR's ownership interest in the Reid Gardner power plant near Las Vegas, Nevada. Upon expiration of the contract in 2013, DWR will not extend its ownership interest in the Reid Gardner plant. The GHG emissions reductions from this action are still to be determined.

15) Public Solicitation Measures

The WETCAT has solicited input through numerous public outreach events through DWR State Water Plan sessions, State Water Resources Control Board meetings and workshops, and presentations to various water sector agencies and organizations. This work builds upon public meetings and workshops focusing on water-energy held by the CEC and

CPUC over the past few years. The WETCAT maintains a record of meetings and outreach sessions.

16) Expected reductions from the overall sector approach

Reductions have been quantified for three of the measures: water recycling plans at wastewater treatment plants; developing energy efficiency measures in water system infrastructure projects; and, renewable resource development. Please see the measure analysis submissions for specific reductions for each of these measures.

17) Public health effects—Effects on air quality

California currently faces numerous water quality challenges, to both drinking water and ambient water quality. There may also be more stringent requirements for water quality in the future. Conflicts and tradeoffs between energy usage and water quality in treatment plant operations can also endanger public health. Therefore, the goal cannot be zero increase in emissions in the future, but rather a net reduction using more efficient systems overall.

18) Environmental justice impacts

The WETCAT has solicited input through numerous public outreach events through DWR State Water Plan sessions, State Water Resources Control Board meetings and workshops, and presentations to various water sector agencies and organizations. In particular, meetings with the Water Plan Advisory Committee of the State Water Plan have emphasized outreach to environmental justice community organizations. The WETCAT maintains a record of meetings and outreach sessions.

Recommendations contained in the DWR's *California Water Plan Update 2005* and the California Energy Commission's *2005 Integrated Energy Policy Report (IEPR)*, re-iterated in the *2007 IEPR*, form the foundation of the water energy strategies and measures. These recommendations and the analyses on which they are based were developed in an open and public process that included public outreach and extensive input from various stakeholder groups such as water agencies, Tribes, consultants, academics and environmental organizations. As part of the process for developing these strategies and measures, the WETCAT is consulting with several of these same stakeholders and organizations. In addition, these strategies and measures will be discussed as part of the 2009 State Water Plan process and at regularly scheduled meetings of the State Water Resources Control Board.

Summary and Conclusions

GHG emissions attributed to the water sector are emitted from power plants that generate the electricity needed to pump, convey, treat, use, and discharge water throughout the State. Consequently, the best way to reduce GHG emissions from the water sector is to reduce the amount of water used, improve energy efficiency related to water use, and/or to obtain water from cleaner energy sources. To realize this objective, the proposed WETCAT strategies address water recycling, recharge, reuse, end user conservation and efficiency, efficiency of water systems, and increasing the use of renewable energy in the water sector.

Regulatory authority exists within multiple agencies to implement many of the proposed strategies and measures. As just one example, opposition to water recycling should be expected from those water agencies that would be required to install equipment and infrastructure.

Challenges unique to the water sector include (1) actions that may be necessary to comply with water quality standards that would produce GHG emissions, (2) enhancement of water conservation and recycling that may adversely impact downstream uses; and (3) in the event of diminished future water supplies, water right disputes may arise due to reduced water availability.

Climate Action Team
Water-Energy Sector Sub Group
Scoping Plan Measure Development and Cost Analysis

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Climate Action Team
Water-Energy Sector Sub Group
Scoping Plan Measure Development and Cost Analysis

The purpose of this document is to provide the public with information about options considered and analyzed by the Climate Action Team (CAT) Sector Sub Groups for Air Resources Board's consideration and potential inclusion in the Scoping Plan. This information should be drawn from the Measure Analyses previously developed by each Sub Group and submitted to the California Air Resources Board.

1. Measure: Implement cost effective energy efficiency measures in water system infrastructure projects

2. Water-Energy Team Agencies:

Department of Water Resources, State Water Resources Control Board, California Energy Commission, and California Public Utilities Commission

3. Measure Description

To meet the needs of Californians, the state's water systems include natural and man-made facilities for the capture, storage, conveyance, treatment, distribution and re-use of water, requiring energy at nearly every step. Consistent with the recommendations of the *California Water Plan Update 2005* and *2005 and 2007 Integrated Energy Policy Reports*, this measure seeks to reduce the magnitude[1] and intensity[2] of the California's water systems through the further implementation of energy efficiency measures (more efficient technologies, re-operation and or re-design) in infrastructure projects.

<u>Overview</u>

California's water and energy systems are inextricably linked – using water to make electricity and using energy to operate water systems. Approximately 19 percent of the state's electricity is generated from clean, renewable hydroelectricity produced in-state and the Pacific Northwest. Approximately 19 percent of the state's electricity is consumed by conveying, treating, distributing and using water. In the context of the state's total electricity usage, the California Energy Commission's preliminary estimates of total energy used to pump and treat this water as exceeding 15,000 GWh per year, or at least 6.5 percent of the total electricity used in the California annually.[3] Improving the overall efficiency of moving and treating water in California's water systems (local, regional and statewide) represents a significant opportunity to reduce the energy intensity of water used in the state and thus reduce the emissions associated with this intensity.

[1] Total energy consumed by a particular segment of the water use cycle. Peak demand is usually measured in megawatts and annual consumption in kilowatt-hours or megawatt hours.
[2] Total energy consumed per unit of water to perform a water management-related action, such as desalting, conveyance, etc… This demand is usually measured in kilowatt-hours per million gallons.
[3] http://www.energy.ca.gov/pier/iaw/industry/water.html

Approximately 75 percent of the entities that operate or manage water systems and supplies in California are local public water districts, county water departments, city water departments or other special districts. According to the Water Education Foundation, some 600 special purpose local agencies provide water to California customers. Many of these local agencies also operate flood control and wastewater treatment facilities in addition to providing drinking water. Approximately six million Californians are served by private, investor-owned water utilities. These companies are regulated by the California Public Utilities Commission which monitors operations and service and sets water rates. Suppliers with more than 3,000 customers are required to develop and maintain urban water management plans.

Many California communities rely on local water supplies for all or a portion of their demand. The source of these local supplies can be from either surface water bodies such as lakes, rivers or reservoirs or from groundwater resources. About 30 percent of California's total annual water supply comes from groundwater in normal years, and up to 60 percent in drought years, which requires pumps to lift this water to the surface.

Others also rely on imported supplies to augment local resources. With two thirds of the state's precipitation falling in the North and two thirds of California's water demand occurring in the South, California has developed an elaborate and nearly statewide man-made conveyance system. The eight large water projects that transport water in California are the State Water Project (SWP), the federal Central Valley Project (CVP), the Los Angeles Aqueduct, the Hetch-Hetchy Aqueduct, the Mokelumne Aqueduct, the Colorado River Aqueduct, the All-American Canal, and the Coachella Canal. The State and federal projects require substantial pumping to transport water from the Sacramento to the Central Valley, the San Francisco Bay Area, and Southern California. Reservoirs also generate electrical energy, and water projects are most often net producers of electrical energy.[4]

The SWP, the nation's largest state-built conveyance system, includes 21 lakes and reservoirs, 34 storage facilities, 29 pumping and generating plants, and 700 miles of canals and pipelines.[5] The SWP consumes an average of 9,000 gigawatt hours (GWh) annually, to serve California's agricultural and urban requirements, and generates 5000 GWh of clean hydroelectricity. The Metropolitan Water District of Southern California (MWD) imports water into Southern California from Northern California's delta via the SWP and the Colorado River via Colorado River Aqueduct. Southern California's entitlement to 4.4 million acre-feet of Colorado River water, is primarily used by agriculture in the Imperial and Coachella Valleys. As a wholesale water supplier, MWD delivers water to districts that serve 18 million customers in Los Angeles, Orange, San Diego, Riverside, San Bernardino and Ventura counties.

Prior to most uses, surface water supplies require treatment, as do many groundwater supplies. Depending on the extent of treatment needed, the amount of energy needed will vary. This is also true of wastewater that requires treatment prior to discharge to land or a water body. As for recycled wastewater, the type of end uses (e.g., irrigation, industrial processes) that water is put to determines how much wastewater treatment is required.

All water systems experience losses, whether the result of leaks or other factors. The Federal Energy Management Program estimates water distribution systems losses (leakage, evaporation, seepage) of 10 percent and cumulative system losses of up to 25 percent.[6] DWR audited 47 water utilities in California and found an average loss of 10 percent and a range of 5 to 30 percent.[7]

[4] http://www.energy.ca.gov/pier/iaw/industry/water.html
[5] http://www.publicaffairs.water.ca.gov/swp/swptoday.cfm
[6] Federal Energy Management Program 2001
[7] DWR Office of Water Use Efficiency, http://www.owue.water.ca.gov/leak/faq/faq.cfm

Examples of efficiency improvements that can be made to water systems include:

- Reduce process energy requirements
- Replace or retrofit aging or antiquated equipment with more efficient technologies (variable speed drives, more efficient pumps)
- Repair or replace leaking or damaged pipes, equipment
- Improve electrical load manage through scheduling or control modifications.
- Add system flexibility with storage.

In addition, AB 809 provides that an incremental increase in electricity generated from a hydroelectric facility as a result of efficiency improvements is an eligible renewable energy resource, regardless of the electrical output of the facility, as long as the following conditions are met: the increase does not adversely impact instream beneficial uses or change the volume or timing of streamflow; the facility has a water quality certification or is exempted from such; the facility was operational before 2007, the improvements are initiated as of January 1, 2008 and are not the result of routine maintenance; and all of the increase results from a long-term financial commitment by the retail seller.

Emissions are associated with the energy (electricity, diesel and natural gas) that is needed to pump, pressurize, desalt, filter, move and treat water. In addition, emissions are also associated with the treatment processes required for wastewater streams. Methane emissions from wastewater are the result of organic material decomposing under anaerobic conditions as well.

Current estimates of the energy intensity associated with various components of the state's water systems are listed in the table below. The amount of energy varies not only for the segment of the process required to transfer a water supply from its source to the end use, but also where that water end use occurs. Additional efforts are underway to further examine these regional differences and provide even more refined estimates of the energy intensity of the state's systems.

	Indoor Uses		Outdoor Uses	
	Northern California kWh/MG	Southern California kWh/MG	Northern California kWh/MG	Southern California kWh/MG
Water Supply and Conveyance	2,117	9,727	2,117	9,727
Water Treatment	111	111	111	111
Water Distribution	1,272	1,272	1,272	1,272
Wastewater Treatment	1,911	1,911	0	0
Regional Total	**5,411**	**13,022**	**3,500**	**11,111**

Source: *Refining Estimates of Water-related Energy Use in California*

Affected Entities

The Department of Water Resources operates the state's largest water system, the State Water Project (for more information please see http://www.water.ca.gov/swp/). The Central Valley Project is operated by the US Bureau of Reclamation (for more information please see http://www.usbr.gov/dataweb/html/cvp.html). Hundreds of other smaller systems are operated by the state's numerous public and private water agencies, municipal water agencies and sanitation districts.

Environmental Justice, Small Business, Public Health, Leakage and CEQA

Recommendations contained in the DWR's *California Water Plan Update 2005* and the California Energy Commission's *2005 Integrated Energy Policy Report (IEPR)*, re-iterated in the *2007 IEPR*, form the foundation of the water energy strategies and measures. These recommendations and the analyses on which they are based were developed in an open and public process that included public outreach and extensive input from various stakeholder groups such as water agencies, consultants, academics and environmental organizations. As part of the process for developing these strategies and measures, the WET-CAT is consulting with several of these same stakeholders and organizations. In addition, these strategies and measures will be discussed as part of the 2009 State Water Plan process and at regularly scheduled meetings of the State Water Resources Control Board.

Improvements to the state's water infrastructure and treatment processes may increase benefits to water customers through improved water quality and deliverability. Since this measure seeks the implementation of cost-effective actions, costs to consumers will be consistent with expected benefits. In no way do any of these proposed strategies or measures diminish the state's responsibility to maintain or enhance water quality, beneficial water uses, and environmental stewardship.

At this time, no issues of leakage have been identified.

Specific activities that may result from this measure may be considered a project under CEQA as defined by Public Resources Code section 21065 and further in California Code of Regulations, Section 15378 of Article 20. An evaluation for possible exemption (as defined in Title 14, California Code of Regulations, Articles 12.5, 18 and 19) or the need to produce an environmental assessment will be required once the specific activities are identified. At this time, however, it is too speculative to determine the application of specific CEQA requirements.

Related Objectives

Maintaining a well functioning and reliable water infrastructure system ensures that California has quality water where and when it needs. Reducing the energy demand of these systems through efficiency measures, while lowering GHG emissions, will also lower overall costs to the state. To the extent that these measures also can minimize water losses (leakage), more water can then be made available for beneficial uses.

Measure Metrics

The magnitude or amount of energy demand for the state's water systems is usually defined in gigawatt-hours per year. Energy intensity of any segment of the system to collect, extract, convey, treat or distribute water is usually measured in kilowatt-hours per million gallons.

<u>Measure Goals and Potential Implementation Approaches</u>

<u>Measure Goals:</u>

The goal of this measure is to achieve potential energy efficiency improvements in the collection, extraction, conveyance, treatment and distribution of the state's water systems. Inasmuch as water-related energy conservation is a new area of study and program development, the full potential of energy efficiency that can be achieved in the state's various water systems (local, regional and statewide) has not yet been assessed. However, modest targets may be considered.

Previous studies suggest that the water-related energy use is approximately 19 percent of total electricity demand in California and of this, 41 percent is associated with water systems while 59 percent is associated with water end uses (*2005 IEPR* and *Refining Estimates of Water-related Energy Use in California)*. Assuming that this is a consistent pattern, this represents about 53,428 GWh in 2006 (19 percent of 281,200 GWh as reported in the *2007 IEPR*) for all water related energy use or approximately 22,000 GWh to collect, extract, convey, treat and distribute water in California. Setting a target of a 10 percent reduction from 2006 levels would yield a savings of 2,200 GWh and a reduction of 20 percent would yield a savings of 4,400 GWh per year. This reduction in electricity consumption would in turn reduce the GHG emission associated with this amount of electricity generation. An assessment of actual potential is needed to determine if such targets are reasonable. For purposes of this measure, these proposed targets will be used to estimate potential GHG reductions.

<u>Implementation Approaches:</u>

As mentioned above, the potential for energy savings in the state's water systems has not fully been assessed. However, to implement this measure and achieve even modest goals for GHG emission reductions, several actions can be taken.

<u>Assess Reduction Potential</u> – Please see Measure 2 (developing evaluation, measurement and verification tools) and 3 (regarding PIER sponsored research and development exploring the water and energy nexus) associated with this Water-Energy Measure.

<u>Require and Promote Efficiency Improvements</u> - Require all water system-related capital improvement and infrastructure projects seeking public funds to evaluate the potential direct and indirect energy impacts of their project proposal and associated GHG emissions. Currently, Assembly Bill 1420 (Laird, Chapter 628, Statutes of 2007) places certain conditions on water management grants and loans made to urban water supplies, including but not limited to, conservation measures as of January 1, 2009, but it doesn't require an evaluation of related GHG emissions or possible reductions. Require proponents for these projects to demonstrate inclusion of all cost-effective energy efficiency measures consistent with the project goals. If no such measures are included, the project justification must include a discussion of energy efficient measures evaluated and reasons they are not being pursued.

To promote development of less energy intensive water management options, consistent with state policies to pursue conservation and efficiency, encourage all water purchase contracts, transfers and exchanges as well as new supply development projects to demonstrate the implementation of all cost effective conservation and efficiency measures to reduce overall water demand prior to approval DWR and local agencies.

<u>Technical Assistance</u> – The state should provide technical assistance for sponsors of water system infrastructure projects to identify opportunities for energy efficiency improvements that can be implemented. This may also include facilitating consultations between these project

proponents and local electric and natural gas utilities many of whom have programs that can be used to a all provide comments on potential energy efficiency measures or renewable opportunities associated with infrastructure projects. Energy utilities should also be allowed to invest in "system" based energy efficiency measures such as re-operation and re-design to optimize system operations (much like existing "Saving by Design" programs for buildings).

Financial Assistance & Incentives - Provide financial support to encourage water system operators to re-design, re-operate or replace antiquated, inefficient system components to maximize energy efficiency as well as improve water quality. To the extent possible, leverage available funds for both water conservation and energy conservation for multi-purpose projects.

Information and Outreach Programs – Disseminate available information regarding energy utility programs that can support energy efficiency improvements at water-related sites and within systems. Conduct public workshops and participate in seminars and conferences to discuss available technologies and practices that conserve water and energy resources as well as improve efficiencies.

4. Technology

As mentioned above, the water systems rely on various technologies to move and treat water. In some cases, simple replacement of equipment such as pumps and motors with newer and more efficient models will achieve the desired objective. In other cases, additional engineering re-design or re-operation of the systems may be needed to optimize the performance of the equipment.

This measure assumes that improvement will be made in the treatment processes and the associated technologies over time needed to meet water quality standards, such as filtration, disinfection and desalting that lower overall energy intensity of these processes.

5. Statutory Status

To require all water system-related capital improvement and infrastructure projects seeking public funds to evaluate the potential direct and indirect energy impacts of their project proposal and associated GHG emissions will require new legislative authority.

6. Implementation Steps and Timeline

SWRCB/DWR establishes energy efficiency evaluation criteria for projects seeking funding under Proposition 50 and Proposition 84 programs.

December 2008

California Public Utilities Commission/California Energy Commission publish a summary of electric and natural gas utility programs available to water system operators for energy efficiency improvements.

June 2008

Additional implementation steps and associated timelines to be identified at a later date.

7. Greenhouse Gas Emission Reductions

A 10 percent reduction by the water sector for conveyance, treatment and distribution electricity demand from 2006 levels would yield a savings of 2,200 GWh and a reduction of 20 percent would yield a savings of 4,400 GWh per year. These numbers can be used as an interim proxy to estimate GHG emission reductions until such time as a more definitive potential assessment can be conducted.

8. Costs and Cost Savings

At this time, investment costs and associated cost savings have not been calculated.

9. Other Benefits

Implementation of this measure may also result in the reduction of costs to operate various segments of the water conveyance and treatment systems. Other benefits experienced by water system and treatment operators that have implemented energy efficiency measures include improved treatment performance, thermal energy recovery, increased operational capacity, extended equipment life, and shifting demand off-peak (http://www.energy.ca.gov/process/water/watersupply.html).

10. References

"California's Water-Energy Relationship", Prepared in support of the 2005 IEPR, November 2005, http://energy.ca.gov/2005publications/CEC-700-2005-011/CEC-700-2005-011-SF.PDF

"California Water Plan Update 2005", Department of Water Resources, Bulletin 160-05, December 2005.

"Refining Estimates of Water-related Energy Use in California, Prepared for the Energy Commission by Navigant Consulting, Inc., PIER Final Project Report, December 2006, CEC-500-2006-118.

"Water Action Plan", California Public Utilities Commission, November 9, 2005.

http://www.water-ed.org/watersources/

http://www.owue.water.ca.gov/urbanplan/index.cfm

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The purpose of this document is to provide the public with information about options considered and analyzed by the Climate Action Team (CAT) Sector Sub Groups for Air Resources Board's consideration and potential inclusion in the Scoping Plan. This information should be drawn from the Measure Analyses previously developed by each Sub Group and submitted to the California Air Resources Board.

1. Measure: Construct tools and protocols to evaluate, measure, and verify the energy impacts of water system and end use conservation and efficiency activities/programs.

2. Water-Energy Subgroup Agencies:

California Public Utilities Commission, California Energy Commission, Department of Water Resources, State Water Resources Control Board

3. Measure Description

To accurately assess the amount of potential Greenhouse Gas Emission reductions that are possible from implementing either water-related efficiency and conservation measures or developing low carbon intense water related renewable resources, various tools are needed to evaluate, measure and verify in more detail the amount of energy saved at various stages upstream and downstream of the conservation or efficiency activity or effort.

<u>Overview</u>

Recently several studies have characterized the relationship between the water and energy sectors. The Energy Commission's estimates that approximately 19 percent of California's electricity demand and 32 percent of the non-generation related natural gas demand is associated with the state's water system and end uses of water. However, additional work is needed to determine, in more detail, the energy embedded in water supplies regionally and locally and assess the potential energy savings of specific efficiency and conservation measures. From this information that breaks down the energy impact at steps along the water use cycle that result from any water-related conservation or efficiency efforts. This basic information can then be used by a variety of agencies to track the effectiveness of their efforts and estimate the potential for GHG reductions.

In the fall of 2006, the (California Public Utilities Commission) CPUC directed the four largest investor owned energy utilities (IOUs) to partner with water agencies to implement jointly funded programs to maximize embedded energy savings from water efficiency and conservation measures. $10 million dollars was earmarked for these efforts. The IOUs filed applications in January 2007 seeking approval for one-year pilot programs with partner water agencies. In December 2007, the CPUC approved a total of $6.37 million for modified pilot programs that the utilities will implement in partnership with several water agencies, the evaluation of those pilot programs, and foundational studies to help the Commission understand more accurately the relationship between water savings and the reduction in energy use, and the extent to which those reductions vary across different water agencies. In January 2008, the CPUC issued a Request for Proposals to evaluate, measure and verify (EM&V) embedded energy savings that result from the pilots. In addition, the CPUC will be conducting the following statewide studies as a part of the water-energy pilot program:

> 1) a Statewide/Regional Water Energy Relationship Study designed to establish the relationship between annual climate and hydrology variation, regional and statewide water demand variations and statewide energy use by the water system, and
>
> 2) a Water Agency/Function Component Study which includes a redefined Load Profile Study designed to establish detailed annual and daily profiles for energy use as a function of water delivery requirements within the California water system.

Results of the pilot program EM&V and the statewide studies will be useful to further improve the tool that has been developed for purposes evaluating cost effectiveness of water saving measures in the pilot programs. In collaboration with the California Energy Commission, State Water Resources Control Board and the Department of Water Resources, the CPUC and its consultants will undertake these studies and will participate in the development of the EM&V tools that may be applicable statewide.

Affected Entities

Affected entities include:

The Department of Water Resources; State Water Resources Control Board and its Regional Boards, the California Energy Commission, and California Public Utilities Commission.

Results of the pilot projects will be studied to develop these tools and therefore, the pilot participants will also be affected.

Tools to be developed by this measure will be targeted for use by consultants, various operators of water systems in California, the Environmental Protection Agency and environmental non-governmental organizations.

Environmental Justice, Small Business, Public Health, Leakage and CEQA

The activities resulting from this measure will include the development of software tools, reports and data and is not expected to cause either a direct physical change in the environment, or a reasonably foreseeable indirect physical change in the environment. As such, these activities are unlikely to be defined as a “project” under CEQA (Public Resources Code section 21065).

Related Objectives

Use of these tools will assist in program implementation and evaluation of program effectiveness. These tools can assist water agencies and regional boards determine the most effective measures to implement as part of their water management strategies under existing requirements. These tools will be beneficial to ensuring the cost-effectiveness of projects and governmental accountability.

Measure Metrics

The magnitude or amount of energy demand for the state's water systems is usually defined in gigawatt-hours per year. Energy intensity of any segment of the system to collect, extract, convey, treat or distribute water is usually measured in kilowatt-hours per million gallons.

Measure Goals and Potential Implementation Approaches

Measure Goals:

The goal of this measure is to develop several tools that can be used to determine energy effects of certain water conservation or efficiency measures both upstream and downstream of the measure at a more localized level. From this information, the potential GHG emission reduction can be determined. These tools include:

Protocols to inventory, characterize and measure California's types of water and energy interdependencies

Methodologies and guidelines for determining the GHG emission reductions from water-related conservation and efficiency measures using the data on interdependencies.

Use tools to determine the best methods to sustainably manage available resources as part of Basin Plans and the California Water Plan.

Implementation Approaches:

As mentioned above, the CPUC has initiated pilot programs and associated studies to explore the relationship between water-related conservation and efficiency measures and the associated embedded energy savings. From these efforts, protocols and methodologies will be developed in collaboration with the SWRCB, DWR and Energy Commission and other stakeholders.

Pilot program efforts: The period for the pilot programs and studies began January 1, 2008, and will run for 18 months. There are three phases. First, the utilities will design their programs while the utilities and CPUC's Energy Division retain consultants to undertake evaluations and studies. Second, the consultants will begin baseline studies, and work with the utilities to ensure that the pilot programs are likely to produce useful information. Third, the utilities will implement the approved pilot programs for one year, beginning July 1, 2008. Cumulatively, the utilities are authorized to spend approximately $6.4 million on this effort.

In addition, the SWRCB and DWR, as part of implementing the requirements of Proposition 84, will use this information to develop evaluation criteria for projects seeking public funding.

4. Technology

The pilots will be evaluating several activities that is involve different technologies including plumbing fixtures, appliances, irrigation devices, industrial processes, and treatment processes. The pilots will involve technologies available today.

5. Statutory Status

No additional statutory authority will be required.

6. Implementation Steps and Timeline

Final Evaluation Plan for the CPUC's pilot programs.

June 2008

SWRCB/DWR establishes energy efficiency evaluation criteria for projects seeking funding under Proposition 50 and Proposition 84 programs.

December 2008

Final Evaluation Report of the estimates of net energy and demand impacts achieved as a result of the CPUC pilot programs.

January 2010

7. Greenhouse Gas Emission Reductions

This measure does not directly result in any GHG emission reductions.

8. Costs and Cost Savings

The total budget for the CPUC's EM&V on the pilot programs and studies is $2.6 million. Other Benefits

The CPUC's *Water Action Plan* supports the importance of reducing the amount of energy needed by water utilities and the need to investigate cost effective energy savings and the appropriate way to allocate such savings among energy utilities. The information that will be gathered by the proposed pilots and studies reflects the Commission's commitment to supporting the *Water Action Plan* and coordinating with other statewide water management agencies.

9. References

"California's Water-Energy Relationship", Prepared in support of the 2005 IEPR, November 2005, http://energy.ca.gov/2005publications/CEC-700-2005-011/CEC-700-2005-011-SF.PDF

"Refining Estimates of Water-related Energy Use in California, Prepared for the Energy Commission by Navigant Consulting, Inc., PIER Final Project Report, December 2006, CEC-500-2006-118.

Decision 07-12-050, "Order Approving Pilot Water Conservation Programs Within the Energy Utilities' Energy Efficiency Programs".

Request for proposals, No. 07 PS 5734, California Public Utilities Commission, January 31, 2008.

http://www.cpuc.ca.gov/PUC/hottopics/3Water/051109_wateractionplan.htm

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1. Measure: Conduct research and demonstration projects that explore ways to reduce the energy intensity of the water use cycle and better manage the energy demand of the water system.

2. Agency:

California Energy Commission – PIER

3. Measure Description

Evaluate and conduct research to: deploy advanced emerging technologies in the water system to lower energy intensity; examine opportunities to shift loads off peak; integrate into the grid intermittent renewable generation from water systems; and better understand the interaction of water and energy within the state and identify new and innovative technologies and measures for mutually achieving energy and water efficiency savings.

Overview

Current estimates of the energy intensity associated with various components of the state's water systems are listed in the table below. The relative energy intensities and variability of ranges within and among segments and sub-segments of the water use cycle are shown in the table below. The research proposed as part of this measure will further examine these regional differences and provide even more refined estimates of the energy intensity of the state's systems that can assist in targeting efforts to increase conservation and improve efficiency that results in energy savings while meeting the state's water quality and reliability goals.

In and of itself, this measure will not result in any greenhouse gas emission reductions but is necessary to ensure that the best available technology and practices are investigated and known so that the energy intensity of the water sector can be reduced. Results of this measure can be used by agencies and stakeholders in implementation of energy savings measures related to the water sector.

The Energy Commission's Public Interest Energy Research (PIER) program's water energy related research objectives include:

- Use Energy More Efficiently
    - Reduce Energy Imbedded in Water
    - Water Source Extraction, Conveyance, Storage, Treatment, Distribution, End Use, Collection, Reclamation and Drainage Systems
- Use Water More Efficiently
    - Efficient Use of Water Improves Efficient Use of Energy Imbedded in Water
- Shift Water Related Energy Use Off-Peak
    - Daily, Weekly, and Seasonal Peaks
    - Improve Demand Response and Load Shaping Capabilities for Water-Related Energy Use

Currently the Energy Commission has identified several research opportunities that it is considering as part of the research roadmap. These are listed below.

Water Use Cycle Segments	Range of Energy Intensities (kWh/MG)	R&D Opportunities
Supply & Conveyance	0 - 13,800	• Reduction of system losses to increase local supplies. • Reduction of outdoor use to increase local supplies. • Reduction of storm water diversions to increase local groundwater recharge. • Increased water recycling to displace more energy intense marginal water supplies. • Technological advancement in desalination processes to decrease energy requirements and cost. • Revise operations and/or systems to reduce total energy and/or peak energy use. • Analysis of coordinated operations and conjunctive use of supplies to decrease use of more energy intense marginal water supplies and/or decrease peak energy use.
Water Treatment	100	• Technological advancements in response to more stringent water quality regulations. • Reduction of losses to increase local supplies.
Water Distribution	1,200	• Reduction of system losses to increase local supplies. • Optimize pumping.
Wastewater Treatment	1,100 - 2,450	• Increase biogas production.

Information developed from this research can be used to assess the actual potential for energy reductions of the water sector and possible GHG reductions that can cost-effectively be achieved.

Affected Entities

Other affected entities will include those stakeholders that participate in the development of the PIER Water Energy Roadmap and participate in the research efforts to be conducted.

Environmental Justice, Small Business, Public Health, Leakage and CEQA

Recommendations contained in the DWR's *California Water Plan Update 2005* and the California Energy Commission's *2005 Integrated Energy Policy Report (IEPR)*, re-iterated in the *2007 IEPR*, form the foundation of the water energy strategies and measures. These recommendations and the analyses on which they are based were developed in an open and public process that included public outreach and extensive input from various stakeholder groups such as water agencies, consultants, academics and environmental organizations. As part of the process for developing these strategies and measures, the WET-CAT is consulting with several of these same stakeholders and organizations. In addition, these strategies and measures will be discussed as part of the 2009 State Water Plan process and at regularly scheduled meetings of the State Water Resources Control Board.

At this time, no issues of leakage have been identified.

Energy Commission reviews all projects approved as part of the PIER process to determine whether CEQA is applicable to the project, and, if so, conduct a CEQA review.

Related Objectives

Maintaining a well functioning and reliable water infrastructure system ensures that California has quality water where and when it needs. Researching new technologies and methods of reducing the energy demand of these systems will lower overall costs to the state.

Measure Metrics

The magnitude or amount of energy demand for the state's water systems is usually defined in gigawatt-hours per year. Energy intensity of any segment of the system to collect, extract, convey, treat or distribute water is usually measured in kilowatt-hours per million gallons.

Measure Goals and Potential Implementation Approaches

Measure Goals:

The goal of this measure is to develop and evaluate technologies and designs that will improve the efficiency and performance of the water system while achieving all of the applicable water quality and management requirements. This measure on its own will not result in any GHG emission reductions. However, the application of resulting technologies and designs within the water system will.

Implementation Approaches:

The Energy Commission's PIER program has already initiated work on its 5-Year Water-Energy R&D Strategic Plan and Roadmap. Key elements include:

- Identify Needed Data and Methods to Obtain It Working with Stakeholders
- Focus on Sectors with Highest Energy Intensity
- Identify Highest Potential Conservation and Efficiency Sectors
- Assess R&D Opportunities with Stakeholders
- Develop R&D Project and Funding Partnerships
- Research Water-Energy Conservation Measures
- Assess Barriers to Measure & Practice Adoption
- Identify Pathways to Increase Successful Adoption

4. Technology

As mentioned above, the water systems rely on various technologies to move and treat water. In some cases, simple replacement of equipment such as pumps and motors with newer and more efficient models will achieve the desired objective. In other cases, additional engineering re-design or re-operation of the systems may be needed to optimize the performance of the equipment. For water quality-related efficiency improvements, research may focus on the treatment processes and the associated technologies, such as filtration, disinfection and desalting that lower overall energy intensity of these processes.

This measure assumes seeks to facilitate advancement and improvement in technologies and designs that can be used to increase water conservation and improve efficiency while achieving the state's water quality and reliability goals.

5. Statutory Status

No additional statutory authority will be required.

6. Implementation Steps and Timeline

One project has been completed:

- Refining Estimates of Water-Related Energy Use In California , 2006

One project will be completed over the next month:

- PIER Water-Energy Strategic Plan

Two projects are underway and/or about to begin:

- Agricultural Water and Energy Efficiency ($1.6M PIER funds)
- California Time of Use Water Meter Case Study ($400K PIER + $80K match)

Two other projects are in the development phase and are expected to begin later in 2008:

- Industrial Water and Energy Use Efficiency ($400K PIER + $400K match)
- Analysis and Optimization of Water and Energy Balances for Storage and Conveyance Systems ($400K PIER + $100K match)

There are also two additional projects in the planning phase dealing with various aspects of energy use associated with recycled water in California, with other potential projects in the concept development phase at this time.

7. Greenhouse Gas Emission Reductions

No direct GHG reductions expected from this measure.

8. Costs and Cost Savings

To be completed.

9. Other Benefits

Implementation of this strategy may also result in the reduction of costs to operate various segments of the water conveyance and treatment systems. Other benefits experienced by water system and treatment operators that have implemented energy efficiency measures include improved treatment performance, thermal energy recovery, increased operational capacity, extended equipment life, and shifting demand off-peak (http://www.energy.ca.gov/process/water/watersupply.html).

10. References

"California's Water-Energy Relationship", Prepared in support of the 2005 IEPR, November 2005, http://energy.ca.gov/2005publications/CEC-700-2005-011/CEC-700-2005-011-SF.PDF

"Refining Estimates of Water-related Energy Use in California, Prepared for the Energy Commission by Navigant Consulting, Inc., PIER Final Project Report, December 2006, CEC-500-2006-118.

http://www.water-ed.org/watersources/

http://www.owue.water.ca.gov/urbanplan/index.cfm

http://www.energy.ca.gov/publications/searchReports.php?pier1=IAW%20End-Use%20Energy%20Efficienc

http://www.energy.ca.gov/pier/programs.html#iaw

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1. Measure: Reuse Urban Water

2. Agency: State Water Resources Control Board (SWRCB)

Other agencies include the Department of Water Resources.

3. Measure Description

Overview

The primary sources of GHG emissions in the water sector are fossil fuel-based electricity generation and natural gas combustion. Approximately 19% of electricity and 30% of natural gas (non-power plant) consumed in the State are used to convey, treat, distribute, use, and dispose of water. When water is conserved, the energy required to develop, deliver, treat, and otherwise use that water is also conserved, and the emissions that would have been produced are avoided.

The term "embedded energy" refers to the amount of energy required to provide water at any point in the use cycle. The amount of embedded energy in any given unit of water varies throughout the state depending on the source, quality, and intended use of the water. In the simplest example, an acre-foot of water originating in the Sierra snowpack of northern California that is delivered to Los Angeles for consumption, incurs a significant embedded energy cost for pumping and conveyance. The California Energy Commission (CEC) prepared the following regional estimates of embedded energy.

REGIONAL ESTIMATES OF WATER EMBEDDED ENERGY [1]

	Indoor Uses		Outdoor Uses	
	Northern California	Southern California	Northern California	Southern California
Water Supply and Conveyance	*39%*	*75%*	*60%*	*88%*
kWh/MG (MWh/AF)	2,117 (0.7)	9,727 (3.2)	2,117 (0.7)	9,727 (3.2)
Water Treatment	*2%*	*1%*	*3%*	*1%*
kWh/MG (MWh/AF)	111 (0.1)	111 (0.1)	111 (0.1)	111 (0.1)
Water Distribution	*24%*	*10%*	*36%*	*11%*
kWh/MG (MWh/AF)	1,272 (0.4)	1,272 (0.4)	1,272 (0.4)	1,272 (0.4)
Wastewater Treatment	*35%*	*15%*	*0%*	*0%*
kWh/MG (MWh/AF)	1,911 (0.6)	1,911 (0.6)	0	0
Regional Total				
kWh/MG (MWh/AF)	5,411 (1.8)	13,022 (4.2)	3,500 (1.1)	11,111 (3.6)

kWh/MG = kilowatt hours per Million Gallons of water.
Percentages (%) and MegaWatt hours per Acre-foot (MWh/AF) added to table for this analysis.

GHG emission reductions can be achieved when any water source or treatment process is replaced with an alternative source or process that requires less energy. As indicated above, "water supply and conveyance" is the greatest contributor to embedded energy, ranging from 39%-60% in northern California and 75%-88% in Southern California. Approximately half of the water supplied to Southern California is imported from other regions, notably the Colorado River and northern California. The energy required to convey water to Southern California can be more than four times that of northern California. Reducing water conveyance provides the greatest opportunity to reduce the embedded energy in water supplies and therefore, reduce GHG emissions. Developing local sources of water to replace imported water will reduce conveyance costs.

This measure is to develop stormwater as a reliable local supply, replacing water from more energy intensive sources and thus reducing GHG emissions. This measures proposes that Low Impact Development (LID) be required to maximize the availability of stormwater to increase local water supplies. Where favorable soil and geologic conditions exist, stormwater would be infiltrated to increase groundwater supplies. In locations where potential infiltration is either limited or not recommended, capture and storage would be required to preserve stormwater for nonpotable applications.

The LID measures proposed by this measure will yield GHG benefits wherever stormwater can be developed as a local water supply requiring less energy than other sources of water. As such, LID and similar stormwater management strategies should be evaluated prior to development more energy intensive alternatives, such as importing water or desalination. Desalination is being considered as a source of water for the San Francisco Bay and Monterey Bay regions. Preliminary evaluation indicates that stormwater management has the potential to provide the needed water at less cost and with less energy consumption.

[1] Navigant Consulting, Inc. 2006. *Refining Estimates of Water-Related Energy Use in California.* California Energy Commission, PIER Industrial/Agricultural/Water End Use Energy Efficiency Program. CEC-500-2006-118.

Potential GHG emission reductions that may be realized as a result of this measure are attributed to the use of stormwater to replace water that is presently obtained from more energy intensive sources. This measure presents a preliminary methodology to estimate the potential benefits of stormwater management in urban areas. Because of the preliminary nature of the methodology and cost information, this measure is being submitted as a "Text Only" measure that will be further developed during the AB32 scoping period.

Traditional stormwater management practiced in most American cities is premised on the objective to capture and convey water away from developed areas as swiftly as possible. Contemporary storm drain systems are engineered to accomplish this objective with remarkable efficiency. LID is a dramatically different stormwater management technique that evolved to reduce the adverse hydrologic and water quality impacts of traditional storm drain discharges on streams and receiving water bodies. LID is a suite of measures that incorporate stormwater management as part of the land use planning and site development process. The objective is to reduce the discharge rate and volume of stormwater discharge by increasing infiltration, and ultimately resulting in a water balance for the site that approximates the natural state prior to development.

Examples of LID measures include maintaining natural landscapes, minimizing impervious surface in development and using vegetated channels and bioretention cells (aka rain gardens) to intercept and infiltrate runoff, installation of rain barrels to capture stormwater for onsite irrigation, adoption of green street designs to eliminate curbs and gutters, disconnecting downspouts from storm drains to promote infiltration, or where infiltration is not desired or practical, redirecting downspouts to cisterns, surface storage basins. Many of these measures are implemented under land use or site design strategies identified as the Ahwahnee Principles, Planned Unit Development, or Conservation Development.

The primary objective of LID is to mitigate the adverse hydrologic and water quality impacts of traditional storm drains by reducing stormwater discharge into those water bodies. However, subsequent use of intercepted stormwater has generally been overlooked or viewed as secondary to the protection of local waterways. As climate change is predicted to alter the availability of water, the concept of converting stormwater into local supply has emerged as a promising GHG reduction and climate adaptation measure. The suite of LID measures can be redefined to maximize water supply benefits where appropriate. For example, development of regional infiltration basins or establishment of small neighborhood facilities to capture and reuse dry weather flows might not be considered typical LID measures, but are actions that could be included as part of LID strategies to capture runoff to enhance local supplies.

Preliminary Methodology

A preliminary methodology is presented in this document to estimate the potential water supply that could be realized from LID. The methodology was applied to the urbanized area of southern California. Calculations and estimates of land use acreage, water savings, energy savings, etc., presented in this document are from the preliminary analysis and should not be used for other purposes.

The urbanized area of Southern California is particularly well-suited to the use of LID to increase local water supplies. The geologic material underlying most of the region is highly permeable, providing rapid infiltration. The Mediterranean climate of the region provides a rainy winter season when water is abundant and a dry summer season during which imported water and groundwater are necessary to sustain communities.

The study area used for this preliminary analysis includes Ventura County, Los Angeles County, Orange County, San Diego County, and the western portions of San Bernardino County and Riverside County. The existing acreage of commercial and residential development within the study area was estimated from land use mapping, aerial photography and 2001 National Land Cover Data.[2] Development projections for the year 2020 and 2030 were obtained from the Southern California Area Governments,[3] San Diego Association of Governments,[4] and national scale land use data.[5] Redevelopment rates were calculated based on an annual national "loss rate" of 1.37% for commercial buildings and 0.63% for residential structures.[6] These numbers are likely conservative for Southern California, as the rate of development in the region exceeds national rates. Projected development rates were applied to the existing level of development in the study area to estimate the amount of area where LID techniques could be potentially implemented as a component of growth. These acreages are summarized in the following table.

PROJECTED ACRES OF DEVELOPED LAND USE BY LID OBJECTIVE IN THE SOUTHERN CALIFORNIA STUDY AREA

	Commercial	Residential	Green Streets
2020			
Infiltration	32,000	201,000	28,000
Capture	36,000	51,000	NA
Total	68,000	252,000	28,000
2030			
Infiltration	60,000	368,000	51,000
Capture	66,000	94,000	NA
Total	126,000	461,000	51,000

The average percentage of impervious surface for each land use type was estimated based on review of existing development. Average runoff from the impervious surface was calculated using rainfall data from the National Resource Conservation Service's (NRCS) 1961-1990 data set, averaged across each of the designated land uses. Runoff was calculated based on a runoff coefficient for impervious areas of $C = \% + 0.05$, where *%* is the percentage of impervious surface (with *%* = 100 percent for fully impervious areas).

The infiltrative capacity of soils underlying each land use type was determined using a combination of U.S. Department of Agriculture State Soil Geographic (STATSGO) soil data and Natural Resources Conservation Service (NRCS) Soil Survey Geographic (SSURGO) soil data. Where sufficient area with suitable pervious conditions is present, the methodology assumes that 100% of the runoff can be infiltrated. The length of time required for infiltrated water to filter through the soils and reach the aquifer varies significantly depending upon soils conditions and depth to the aquifer. Without site specific data it is impossible to determine this period of time.

[2] http://www.epa.gov/mrlc/nlcd-2001.html

[3] Integrated Growth Forecast, http://www.scag.ca.gov/forecast/index.htm

[4] http://www.sandag.cog.ca.us/index.asp

[5] See, e.g., Arthur C. Nelson, Toward a New Metropolis: The Opportunity to Rebuild America, Brookings Institution, Washington, DC. 2004. www.brookings.edu/dybdocroot/metro/pubs/20041213_RebuildAmerica.pdf

[6] Id.

Based on anecdotal information, it is estimated that infiltrated water would require approximately a year to percolate to the water supply aquifers. The significance of this period is that it represents the amount of time between the installation of LID measures on the surface and the point in time when water infiltrated by those measures could become available for extraction from the aquifer and used to replace more expensive water from other sources.

Where impervious surface runoff occurred over areas underlain by D class soils (impervious soils), capture was assumed to obtain the greatest amount of water. Capture was calculated based only from rooftop runoff, which averaged approximately 50% of total impervious surface area. Capture of rooftop runoff was also used as the basis for calculating the potential water savings in areas of high impervious surface content, defined as areas greater than 10 acres in size containing contiguous impervious cover of greater than 80%. These areas lack sufficient pervious area to infiltrate the total runoff from the impervious surface. In such conditions, 50% of the runoff was calculated as capture, 25% as infiltration, and 25% as runoff.

Finally, dry weather runoff was calculated within the study area based on a figure of 0.152 gallons per acre of pervious surface per minute for residential and commercial land use types likely to include landscaped cover. This figure was derived from the “Residential Runoff Reduction Study” performed by the Irvine Ranch Water District,[7] and extrapolated to include commercial development for this study.

Results

The potential water volume that could be captured as estimated by this analysis reflects the assumption that 100% of future residential and commercial development and redevelopment would be constructed to incorporate LID or other measures to increase infiltration. This study does not include implementation of infiltration measures at government, public use, or industrial sites, which account for a significant percentage of the total land use in the state.

The methodology assumes that 75% of local roads constructed within new development will be developed as “green streets” to allow natural infiltration, and that existing roadways will be resurfaced to allow for infiltration at a rate equal to the redevelopment rate for commercial structures of 1.37% annually. Finally, the methodology assumes a loss of infiltrated water of between 10% (high estimate) and 20% (low estimate) in order to account for loss of water in the root zone.

The analysis assumptions were adopted to estimate the potential water capture that could be realized. It is important to recognize that 100% of future development and redevelopment may not be able to achieve the desired level of infiltration. Some locales may have contaminated aquifers or water tables and increased infiltration might not be appropriate, or practices and/or regulatory requirements to require this level of infiltration could be adopted and implemented in the near future. However, the results of this analysis demonstrate that the volume of water that could be captured through urban infiltration is more than sufficient to warrant further consideration of development practices and regulatory requirements to forward this practice.

As shown in the following table, application of the preliminary methodology yielded estimates that 147,000 - 182,000 acre-feet (AF) per year of runoff could be captured and infiltrated or stored by 2020, and 270,000 - 333,000 AF/yr could be captured by 2030. This captured water could be used to replace imported water and/or water obtained from other energy-intensive

[7] Available at http://www.irwd.com/Conservation/water_conservation_research.php

sources and as such represents a water savings and a potential reduction of greenhouse gas emissions.

ESTIMATED WATER VOLUME CAPTURED IN THE SOUTHERN CALIFORNIA STUDY AREA Acre-Feet Per Year (AF/YR)

	2020	2030
LOW		
Infiltration (75%)	110,250	202,500
Capture (25%)	36,750	67,500
Total	147,000	270,000
HIGH		
Infiltration (75%)	136,500	249,750
Capture (25%)	45,500	83,250
Total	182,000	333,000

Although this measure is applicable throughout the State and can be implemented at a variety of scales and land use types, the estimates presented in this measure reflect only the costs and benefits estimated for the study area in Southern California.

Implementation of LID and associated infiltration measures at other locations would be expected to realize comparable water savings, but the energy savings and GHG reductions would likely be less. Nonetheless, the energy-cost to develop other technology based water treatment process, such as desalination or reverse osmosis are being considered in numerous locations. Nine desalination facilities are proposed in the San Francisco and Monterey regions. These plants would produce an estimated 82,000 acre-feet of water per year at an approximate energy consumption rate of 4.6 Megawatt hours per acre-foot of water (MWh/AF), requiring 242,000 MWh/yr to operate. This energy consumption greatly exceeds that required to implement infiltration, water recycling, or gray water use. Based on a cursory review of urban land use in the San Francisco Bay area, LID could provide sufficient water supply to offset the need for desalination with less the energy consumption.

<u>Affected Entities</u>

The breadth of this concept would alter land use development practices, municipal infrastructure design, and regulatory requirements. Effective implementation of this practice would require coordination at the local, regional, and State levels by numerous private and public entities. Requirements to incorporate LID or similar alternative stormwater management measures would impact property owners in urban areas that propose new development or redevelopment.

Adoption of more stringent discharge limits, enforced through such regulatory mechanisms as NPDES stormwater construction permits, could accelerate efforts to achieve the desired level of infiltration. Enforcement would be administered through local government, likely a combination of planning and public works departments.

The nature of local collection and reuse facilities would benefit local neighborhoods, parks, schools, and other recipients of the water provided by the facility. Local entities, such as community public works departments, would typically operate and maintain such systems. However, it is feasible for private entities such as business parks or residential subdivisions to construct and operate private systems.

Environmental Justice, Small Business, Public Health, Leakage and CEQA

This measure represents an evolving concept that is being studied as a means to reduce GHG emissions and increase local water supplies. To that extent, this measure has been presented in varying levels of development in public outreach and scoping meetings sponsored by the State Water Board and the Department of Water Resources. The development of a methodology and estimates of potential saving through urban infiltration are relatively recent additions to this measures that are the product of ongoing study of this concept.

Although infiltration and groundwater is a process that naturally occurs, the concept of deliberate infiltration of urban stormwater for eventual potable use is controversial. There are concerns that contaminants could be introduced into comparatively uncontaminated aquifers, and that groundwater is not subject to the same regulatory controls as surface water. These concerns need to be addressed.

The Department of Public Health is responsible for monitoring and enforcement of drinking water standards. Use of urban water is not anticipated to adversely impact public health or interfere with public health efforts. Urban water would be routinely tested, treated, distributed, and used as may be warranted in accordance with established public health and water quality standards.

Implementation of this proposed measure will require the construction of local infrastructure and reduce the volume of water that is discharged to waterways. As a result, this measure has the potential to reduce the volume of water available to downstream users or habitat.

Specific activities that may result from this measure may be considered a project under CEQA as defined by Public Resources Code section 21065 and further in California Code of Regulations, Section 15378 of Article 20. At this time, however, it is speculative to determine the application of specific CEQA requirements.

Related Objectives

The measure is motivated by multiple benefits. In this case, the measure is motivated by both greenhouse gas emission reduction and adaptation benefits.

The replacement of water from energy intensive sources with stormwater would reduce energy requirements and associated GHG emissions. This benefit would be tempered by the energy required for local pumping or treatment. As an adaptation action, this measure would increase a local supply of water.

Water Code Section 10610.4 states: “The Legislature finds and declares that it is the policy of the state as follows:

> (a) The management of urban water demands and efficient use of water shall be actively pursued to protect both the people of the state and their water resources.
>
> (b) The management of urban water demands and efficient use of urban water supplies shall be a guiding criterion in public decisions.

(c) Urban water suppliers shall be required to develop water management plans to actively pursue the efficient use of available supplies."

Measure Metrics

This document presents a preliminary methodology that quantifies the potential benefits of the stormwater management component of this measure. Although additional benefits could be realized by increasing regional infiltration and local dry weather flow recovery, sufficient information is unavailable to calculate those elements at this time.

To ensure that all power plant emissions are estimated using a consistent methodology, the calculation of emission savings realized at power plants will be performed by the CAT Electricity Sector subteam and ARB. The volume of water recycled and the associated energy savings are presented in this analysis for ARB application. Recycled water is expressed in million gallons (MG) and Acre-Feet (AF). Embedded energy is expressed in Kilowatt hours (kWh), Megawatt hours (MWh), and Gigawatt hours (GWh)

Measure Goals and Potential Implementation Approaches

The focus of this measure is the requirement to implement LID and comparable stormwater management strategies that increase infiltration and storage to augment local water supplies.

The breadth of this concept could alter land use development practices, municipal infrastructure design, and regulatory requirements. Effective implementation of this practice will require coordination at the local, regional, and State levels by numerous private and public entities. Requirements to incorporate LID and similar stormwater management strategies could impact property owners in urban areas that propose new development or redevelopment.

Adoption of more stringent discharge limits, enforced through such regulatory mechanisms as NPDES stormwater permits, could accelerate efforts to achieve the desired level of infiltration. Enforcement of the NPDES permits is the responsibility of the Water Boards, but many of these permits require local governments and agencies to also enforce ordinances and implement new planning and public works strategies.

4. Technology

Implementation of the proposed urban water activities included in this measure does not require the application of new technology. However, increased implementation could catalyze development of more cost-effective designs and energy efficient technologies. Further, there may be opportunities to use sustainable sources, such as solar, wind, or geothermal, to provide power for the small systems that would accomplish neighborhood capture.

5. Statutory Status

Water Boards have broad authority to establish permit requirements, terms and conditions for both stormwater discharges and water reuse (in lieu of wastewater discharges, for example). As such, the Water Boards have the authority to require water reuse as a means to prevent waste and unreasonable use. Additional statutory authority is not required to implement the regulatory elements of this measure.

Water Code Section 10610.4 states: "The Legislature finds and declares that it is the policy of the state as follows:

(a) The management of urban water demands and efficient use of water shall be actively pursued to protect both the people of the state and their water resources.

(b) The management of urban water demands and efficient use of urban water supplies shall be a guiding criterion in public decisions.

(c) Urban water suppliers shall be required to develop water management plans to actively pursue the efficient use of available supplies."

6. Implementation Steps and Timeline

The methodology and information used to estimate potential benefits are preliminary. The Water Boards will continue to develop this measure to better understand the benefits and the steps that may be necessary for broad implementation.

There are several urban water capture and infiltration projects that have been constructed in various communities throughout California, but widespread implementation has not occurred. In general, the breadth of this concept would alter land use development practices, municipal infrastructure design, and regulatory requirements. Effective implementation of this practice would require coordination at the local, regional, and State levels by numerous private and public entities.

In recent years, the Water Boards have undertaken a considerable regulatory focus to require LID measures as component of stormwater permitting. The draft Construction General Permit (CGP) includes requirements for projects subject to them (i.e., projects disturbing more than an acre and not in a currently urbanized area) to reduce runoff. This draft CGP includes incentives to incorporate LID type techniques in project design and will apply statewide to most new and redevelopment. Municipal Separate Storm Sewer System (MS4) permits all contain some requirements for new development and significant redevelopment projects. The baseline requirements are called Standard Urban Stormwater Mitigation Plans (SUSMPs) and these require that urban runoff generated by 85 percent of storm events from specific development categories be infiltrated or treated. The Regional Water Boards have extended the SUSMP baseline to add on LID-type and other requirements aimed at reducing impacts (e.g., water quality, hydromodification, etc.) associated with new and redevelopment projects within the MS4s' jurisdictional areas.

However, the Regional Water Boards have used different thresholds and approaches in their MS4 stormwater permitting and enforcement efforts – often to focus on those projects and activities that pose the greatest risk of discharge and adverse water quality. As a result there are many opportunities to improve the consistency and performance of these regulatory tools. Adoption of consistent stormwater regulatory requirements for impacts (e.g., water quality and hydromodification) associated with new and redevelopment projects could accelerate efforts to achieve the objectives of this measure.

7. Greenhouse Gas Emission Reductions

Green house gas emissions will be realized through the replacement of water from energy intensive sources with stormwater. The marginal water sources the study area were determined through review of MWD member agency Urban Water Management Plans, and identified as the West Branch of the State Water Project for Ventura and one-half of Los Angeles County, and the East Branch of the State Water Project for one-half of Los Angeles County, Orange County, San Bernardino County, Riverside County, and San Diego County.

Energy savings were calculated by multiplying the volume of stormwater that could be infiltrated or captured and stored by the existing cost of the water and subtracting the energy required for groundwater pumping. The results of this analysis are summarized in the following table.

ESTIMATED ENERGY SAVINGS
FOR THE SOUTHERN CALIFORNIA STUDY AREA

	2020		2030	
	AF/YR	**MWh/yr**	**AF/YR**	**MWh/yr**
LOW	147,000	333,000	270,000	610,000
HIGH	182,000	415,000	333,000	760,000

8. Costs and Cost Savings

The costs to install Low Impact Development are currently the focus of extensive study. The difficultly in quantifying a representative cost is a function of the multitude of measure configurations, the varying range of material and construction costs by location and site conditions, and the difficulty assigning a cost to measures that are often inseparable from project construction costs. Despite the wide range of costs among land use projects and locations, comparison of the cost to construct any given project as either a traditional development or a LID design consistently demonstrates that LID development is substantially less expensive. The U.S. EPA recently released the publication Reducing Stormwater Costs through Low Impact Development (LID) Strategies and Practices.[8] This publication presents 17 case studies of various LID projects throughout the US and Canada.

The costs and savings for the case projects varied widely, and because of the limited number of projects evaluated, the information does not provide any statistical validity. However, for the purposes of this analysis, cost savings used in the preliminary analysis were estimated based on the reported values and used as a reasonable representation of the potential cost savings that might be realized by this measure. The potential cost savings resulting from the implementation of LID instead of traditional infrastructure are presented in the following table. It is important to recognize that these numbers are of very limited source and only presented as general approximations for this draft analysis. Additional research is proposed to revise these values for future inclusion in later revisions of this measure.

[8] Reducing Stormwater Costs through Low Impact Development (LID) Strategies and Practices, December 2007, EPA 841-F-07-006.

POTENTIAL LID COST SAVINGS
COMPARED TO TRADITIONAL DEVELOPMENT COSTS
IN THE SOUTHERN CALIFORNIA STUDY AREA

	Commercial	Residential	Green Street
Savings/Acre (2007 $s)	$8,000	$7,000	$65,000
2020			
Acres	68,000	252,000	28,000
Savings (2007 $s)	$544,000,000	$1,764,000,000	$1,820,000,000
2030			
Acres	126,000	461,000	51,000
Savings (2007 $s)	$1,008,000,000	$3,227,000,000	$3,315,000,000

9. Other Benefits

All emission reductions realized by this measure are represented by the energy savings calculations presented in the appropriate sections of this analysis. Low Impact Development and similar stormwater management strategies evolved from the continued deterioration of streams and waterways. The original objective of LID and similar stormwater management strategies is to provide source control, i.e. capture and infiltration, of stormwater as a means to protect local waterways and aquatic habitats. Accordingly, implementation of this measure will provide water quality protection measures.

Urban water capture is primarily an adaptive measure that benefits local communities by providing an additional source of water to augment traditional supplies that may be reduced as a consequence of climate change. This approach could provide a relatively inexpensive way for low income communities to manage stormwater compared to the costs incurred by construction and maintenance of traditional municipal infrastructure.

10. References

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Climate Action Team
Water-Energy Sector Sub Group
Scoping Plan Measure Development and Cost Analysis

The purpose of this document is to provide the public with information about options considered and analyzed by the Climate Action Team (CAT) Sector Sub Groups for Air Board's consideration and potential inclusion in the Scoping Plan. This information should be drawn from the Measure Analyses previously developed by each Sub Group.

Information should only be updated to reflect significant changes in technology, staff assignments, and understanding of the issues.

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1. Measure: Require Water Recycling Plans

2. Agency: State Water Resources Control Board (SWRCB)

Other agencies include the Department of Water Resources.

3. Measure Description

Overview

The primary sources of GHG emissions in the water sector are fossil fuel-based electricity generation and natural gas combustion. Approximately 19% of electricity and 30% of natural gas (non-power plant) consumed in the State are used to convey, treat, distribute, use, and dispose of water. When water is conserved, the energy required to develop, deliver, treat, and otherwise use that water is also conserved, and the emissions that would have been produced are avoided.

The term "embedded energy" refers to the amount of energy required to provide water at any point in the use cycle. The amount of embedded energy in any given unit of water varies throughout the state depending on the source, quality, and intended use of the water. In the simplest example, an acre-foot of water originating in the Sierra snowpack of northern California that is delivered to Los Angeles for consumption, incurs a significant embedded energy cost for pumping and conveyance. The California Energy Commission (CEC) prepared the following regional estimates of embedded energy.

REGIONAL ESTIMATES OF WATER EMBEDDED ENERGY [1]

	Indoor Uses		Outdoor Uses	
	Northern California kWh/MG	Southern California kWh/MG	Northern California kWh/MG	Southern California kWh/MG
Water Supply and Conveyance	*39%*	*75%*	*60%*	*88%*
kWh/MG (MWh/AF)	2,117 (0.7)	9,727 (3.2)	2,117 (0.7)	9,727 (3.2)
Water Treatment	*2%*	*1%*	*3%*	*1%*
kWh/MG (MWh/AF)	111 (0.1)	111 (0.1)	111 (0.1)	111 (0.1)
Water Distribution	*24%*	*10%*	*36%*	*11%*
kWh/MG (MWh/AF)	1,272 (0.4)	1,272 (0.4)	1,272 (0.4)	1,272 (0.4)
Wastewater Treatment	*35%*	*15%*	*0%*	*0%*
kWh/MG (MWh/AF)	1,911 (0.6)	1,911 (0.6)	0	0
Regional Total				
kWh/MG (MWh/AF)	5,411 (1.8)	13,022 (4.2)	3,500 (1.1)	11,111 (3.6)

kWh/MG = kilowatt hours per Million Gallons of water.
Percentages (%) and MegaWatt hours per Acre-foot (MWh/AF) added to table for this analysis.

GHG emission reductions can be achieved when any water source or treatment process is replaced with an alternative source or process that requires less energy. As indicated above, "water supply and conveyance" are the greatest contributors to embedded energy, ranging from 39%-60% in northern California and 75%-88% in Southern California. Approximately half of the water supplied to Southern California is imported from other regions, notably the Colorado River and northern California. The energy required to convey water to Southern California can be more than four times that of northern California. Reducing water conveyance provides the greatest opportunity to reduce the embedded energy in water supplies and therefore, reduce GHG emissions. Developing local sources of water, such as water recycling, is a practical method to increase local supplies and reduce conveyance costs.

For the purposes of this measure, water recycling is generally defined as the diversion of municipal wastewater for subsequent use rather than discharge. Modern wastewater treatment facilities produce wastewater of sufficient quality for nonpotable applications, such as irrigation. This measure proposes a requirement for development and implementation of water recycling plans by wastewater management agencies working with water supply agencies, where the recycling of treated effluent is not maximized at wastewater

[1] Navigant Consulting, Inc. 2006. *Refining Estimates of Water-Related Energy Use in California.* California Energy Commission, PIER Industrial/Agricultural/Water End Use Energy Efficiency Program. CEC-500-2006-118.

treatment plants located in areas of imported water supply. Implementation of water recycling plans would be prioritized for those plants that discharge to water bodies from which the wastewater cannot otherwise be easily recovered, such as the ocean.

Water Recycling Challenges

One of the potential challenges to recycling wastewater is the availability of wastewater for recycling. When wastewater is discharged to a lake or stream system, the discharged wastewater mixes with the background (ambient) water and becomes part of the lake or stream. Ambient water supports beneficial uses in the natural environment (aquatic, wetland, and riparian habitats, and wildlife). Further, ambient water may be repeatedly withdrawn, reused, and discharged by downstream communities. The Department of Water Resources estimates that between 86 and 100 percent of wastewater in various regions of the Central Valley is reused in this manner. Use of water for a downstream beneficial use may establish a water right that includes the wastewater as part of the ambient flow, potentially preventing upstream communities from diverting water from their discharges for recycling. Recognizing this potential constraint, the greatest volume of wastewater potentially available for recycling may be wastewater that is discharged to the ocean, salt sinks, or other locations where the discharge becomes irrecoverable. Wastewater discharged via the municipal ocean outfalls in Southern California is suitable for industrial and agricultural uses, but most is discharged to the ocean.

Another challenge to the implementation of recycled water is public perception and demand. For public health and safety reasons, the use of recycled water is subject to restrictions administered by the Department of Public Health. For example, wastewater that is treated to secondary standards can be used for irrigation of agricultural lands such as pastures, industrial applications, and applications that do not allow contact with food products or people. Wastewater that is has undergone more advanced treatment can be used in urban settings to irrigate parks, schools, and landscaping. Recycled water cannot be conveyed in pipes with potable water. Instead, recycled water must be conveyed in a separate system known as "purple pipe". Purple pipe is used to distinguish recycled water from potable water and must include posted notice that recycled water is nonpotable. These regulatory requirements contribute to an understandable reluctance by some of the public to accept recycled water as a safe alternative water supply.

Water Recycling Volume

The report, *Water Recycling 2030: Recommendations of California's Recycled Water Task Force*[2] (RWTF), prepared by the California Recycled Water Task Force (RWTF) in 2003 provides a comprehensive assessment of water recycling potential in California. The RWTF produced a range of estimates of the amount of water that could be recycled in the state through the year 2030. Projections for the years 2010, 2020, and 2030 are presented in the following table.

[2] California Department of Water Resources. Water Recycling 2030: Recommendations of California's Recycled Water Task Force. 2003. http://www.owue.water.ca.gov/recycle/taskforce/taskforce.cfm

2002 TASK FORCE PREDICTIONS
STATEWIDE RECLAIMED WATER
(Acre-Feet per year, AF/yr)

	2010	**2020**	**2030**
Low	890,000	1,370,000	1,850,000
Mid	1,030,000	1,540,000	2,050,000
High	1,170,000	1,710,000	2,250,000

This measure proposes a requirement for development and implementation of water recycling plans by wastewater management agencies working with water supply agencies, where the recycling of treated effluent is not maximized at wastewater treatment plants located in areas of imported water supply. Implementation of water recycling plans would be prioritized for those plants that discharge to water bodies from which the wastewater cannot otherwise be easily recovered, such as the ocean.

To estimate the volume of wastewater potentially available for recycling, a list of NPDES permitted wastewater treatment plants in California was extracted from the USEPA Clean Watersheds Needs Survey (CWNS)[3]. Query of the CWNS identified 676 wastewater facilities in the state. Data obtained from the CWNS and used in this analysis included the wastewater treatment facility name, the population served, and the location of the facility.

The primary objective of measures prepared for the AB32 Scoping Plan is to achieve GHG reductions. Water recycling in regions where water supply is locally available has less potential to achieve GHG reductions than recycling in regions where imported water or water obtained from energy-intensive processes such as desalination are more prevalent. Communities in Southern California typically rely on a greater proportion of energy-intensive water than their counterparts in northern California. For the purposes of this analysis, a subset of 182 wastewater treatment facilities in the counties of Inyo, Ventura, Los Angeles, San Bernardino, Orange, Riverside, Imperial, San Diego and southeastern Kern was extract from the CWNS list and used to estimate potential GHG emission reductions that could be realized through water recycling in Southern California. The volume of wastewater was calculated for each WWTP based on the "population served" data from the CWNS. The most current CWNS data is 2004. The population data reported by CWNS was updated to 2011 and 2030 values using population growth projections from the US Census Bureau.[4] This analysis uses a wastewater generation value of 120 gallons per capita per day for the estimation of future flows. However, as water conservation measures become more common, per capita wastewater generation will decrease. As a result, the estimates in this analysis may be higher than future conditions. The estimated wastewater flows are presented in the following table.

[3] USEPA Clean Watersheds Needs Survey (CWNS), http://www.epa.gov/cwns/2004data.htm

[4] U.S. Census Bureau Projections 2004-2030.
http://www.wsdot.wa.gov/planning/wtp/datalibrary/population/WSPopulationGrowth.htm

ESTIMATES OF POPULATION SERVED AND WASTEWATER VOLUME

	Statewide*		Southern California*	
	2011	**2030**	**2011**	**2030**
NPDES-permitted WWTPs	676	676	182	182
Population Served	37.9 million	53.7 million	21.4 million	28.6 million
Est. Wastewater Volume (Million Gallons per day, MGD)	4,543 MGD	6,452 MGD	2,570 MGD	3,433 MGD

* For the purposes of this estimate, Statewide and Southern California are defined as the 676/182 WWTPs described above. Wastewater volumes calculated as CWNS Population Served x 120 gallons/capita/day.

Number of WWTPs and Population Served obtained from USEPA Clean Watershed Needs Survey (CWNS). "Population Served" is not the same as State population as it does not include persons on septic or non-NPDES wastewater treatment systems.

In 2002, the RWTF reported that approximately 10% of municipal wastewater was being recycled. Assuming that this level of recycling will continue without additional incentives or requirements, recycling of 10% of the wastewater flow from municipal treatment plants is defined as the baseline for this analysis. The baseline 2030 volume of recycled wastewater from the treatment plants included this analysis is estimated to be 645 MGD statewide, of which 343 MGD would occur at the 182 facilities in Southern California.

The RWTF estimated that the potential level of water recycling that could be achieved is 23% of the municipal wastewater flow. The goal of this measure is to further efforts to achieve the 23% potential recycling level identified by the RWTF. As shown in the following table, recycling 23% of the wastewater from the facilities included in this analysis represents 1.7 million acre-feet per year (AF/yr) statewide, of which 885,000 AF/yr would be recycled in Southern California. It is likely that other recycling measures will be identified and implemented before 2030 that will contribute to increased water recycling. This measure will help achieve 23% recycling by 2030.

2030 ESTIMATE OF RECYCLING POTENTIAL

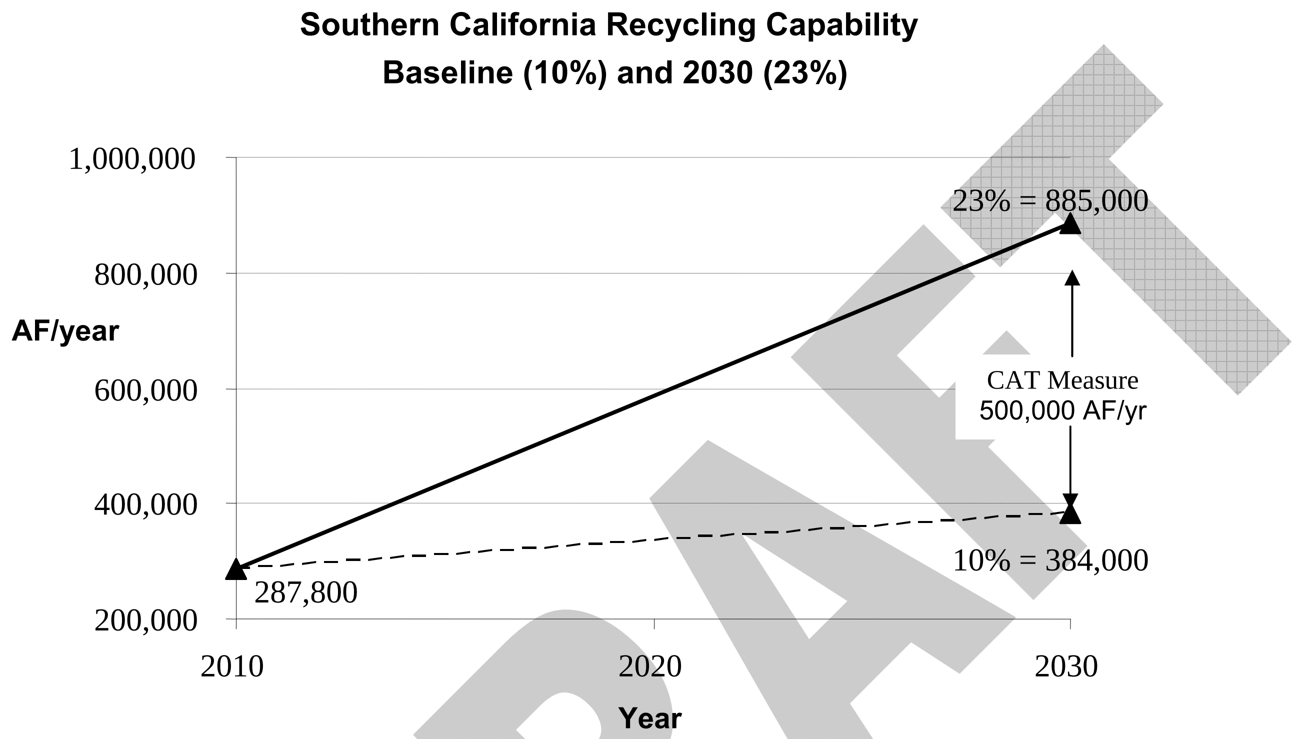
	Statewide*	Southern California*
Est. Wastewater Volume	6,452 MGD	3,433 MGD
10% Baseline	645 MGD 723,000 AF/yr	343 MGD 384,000 AF/yr
23% RWTF Recycling Potential	1,484 MGD	790 MGD

	1,663,000 AF/yr	885,000 AF/yr
Difference (measure)	839 MGD 940,000 AF/yr	447 MGD 500,000 AF/yr

* For the purposes of this estimate, Statewide and Southern California are defined as the 676/182 treatment facilities identified from the CWNS query described in the text above. Wastewater volumes are calculated as Population Served x 120 gallons/capita/day.

Recognizing that substantial emission reductions are only possible where water with a high embedded energy level can be reduced or replaced. The potential GHG reductions estimated in this analysis are based on the implementation of water recycling at facilities in Southern California where embedded energy is relatively high. The methodology does not address the feasibility of recycling at specific facilities, and is presented only as an estimate of water potential recycling and benefits that could be achieved in the region. It is likely that levels of recycling will be greater at some facilities and less at others, and that water recycling will also be implemented at locations not identified in the representative facilities used in this analysis.

As calculated in the above table, and shown in the following figure, the difference between the baseline and the 23% goal is estimated as 447 MGD (500,000 AF/yr). The predicted baseline level of water recycling in 2030 is 343 MGD (384,000 AF/yr). The addition of 447 MGD (500,000 AF/yr) will increase the total level of water recycling in Southern California to 790 MGD (885,000 AF/yr). Construction of water recycling facilities that produce 30,000 AF/yr of new capacity each year from 2010 through 2030 would provide the recycling capacity goal of 885,000 AF/yr in Southern California by 2030. Of the 30,000 AF/yr annual increase, 5,000 AF/yr would be baseline and 25,000 AF/yr would be attributed to new facilities.



<u>Energy Use</u>

Reducing the amount of embedded energy in water is proposed as the primary method to achieve emission reductions in the water sector. Water recycling creates a local water supply, thus reducing the amount of water that must be imported from non-local sources. The amount of energy required for water recycling varies depending upon the quality of the source water and the level of treatment required. An average of 660 kWh per AF (0.7 MWh/AF) is used for this analysis. The net energy savings realized by the water recycling at WWTPs is estimated as the difference between the energy required to provide new water and the energy required for recycling. Applying this methodology, the potential energy savings are estimated as follows:

ESTIMATE OF POTENTIAL ENERGY SAVINGS BY REPLACING IMPORTED WATER WITH RECYCLED WATER

	Supply and Conveyance	−	Recycling	=	Net Savings
Northern California	0.7 MWh/AF	−	0.7 MWh/AF	=	0.0 MWh/AF
Southern California	3.2 MWh/AF	−	0.7 MWh/AF	=	2.5 MWh/AF

Refer to Estimates For Water Embedded Energy table earlier in this section for the basis of the values presented above.

The above calculations are regional estimates and are not appropriate for application in a more local context. For example, it may be generally concluded that the potential energy saving achievable in northern California through recycling is marginal, but there are locations in northern California where recycling will save energy and others where it could require more energy than the existing water supply. A similar broad interpretation should be applied to Southern California. Because most communities in Southern California import a portion of their water from outside of the region, it can generally be ascertained that an energy savings may be achieved through water recycling. The actual savings will vary depending upon a variety of factors including such considerations as the source and quality of the imported water, the proposed use of the recycled water (level of treatment required), and the recycling technology.

The estimated annual energy savings that would be realized by recycling wastewater at the 182 WWTPs in Southern California in 2030 is estimated as 500,000 AF/yr multiplied times 2.5 MWh/AF, saving an estimated 1,254 GW/yr in 2030 and beyond.

<u>Affected Entities</u>

This measure proposes a requirement for development and implementation of Water recycling plans by wastewater management agencies working with water supply agencies, where the recycling of treated effluent is not maximized at wastewater treatment plants located in areas of imported water supply. Implementation of water recycling plans would be prioritized for those plants that discharge to water bodies from which the wastewater cannot otherwise be easily recovered, such as the ocean. A large proportion of the communities in Southern California rely on imported water, and substantial discharges of wastewater to the ocean occur from several large ocean outfalls in the region. As a consequence, projects in Southern California would likely be prioritized to expand water recycling to reduce energy consumption and GHG emissions. Public and private water suppliers, distributors, and end-users, will be affected by the expanded use of recycled water.

<u>Environmental Justice, Small Business, Public Health, Leakage and CEQA</u>

Public outreach and stakeholder meetings have been held by the various Climate Action subteams, including the water-Energy Team (WETCAT). Meeting venues have included the Department of Water Resources in conjunction with outreach for the State Water Plan, and the State Water Board as part of ongoing development of the Water Board Strategic Plan Update as well as at Water Board workshops and meetings as Climate Change Items. Continued public outreach will occur throughout the spring and summer of 2008 as the proposed measures are further refined and quantified. Verbal and written comments are accepted at all public meetings.

Increased production of recycled water is not anticipated to adversely impact public health, nor will it interfere with public health efforts. Recycled water will be treated, distributed, and used in accordance with established public health and water quality standards.

On a local scale, increased recycling has the potential to reduce the volume of water available to downstream users or habitat. The availability of water and feasibility of recycling will be evaluated at individual wastewater treatment facilities as appropriate prior to implementation.
Implementation of the proposed measure will require the construction of local infrastructure and will reduce the volume of discharge water directly returned to the environment. These activities have the potential to affect environmental resources. Specific activities that may result from this measure may be considered a project under CEQA as defined by Public Resources Code section 21065 and further in California Code of Regulations, Section 15378 of Article 20. At this time, however, it is speculative to determine the application of specific CEQA requirements.

Related Objectives

The measure is motivated by multiple benefits. In this case, the measure is motivated by both greenhouse gas emission reduction objectives and other objectives.

Water Code Section 10610.4 states: “The Legislature finds and declares that it is the policy of the state as follows:

(a) The management of urban water demands and efficient use of water shall be actively pursued to protect both the people of the state and their water resources.

(b) The management of urban water demands and efficient use of urban water supplies shall be a guiding criterion in public decisions.

(c) Urban water suppliers shall be required to develop water management plans to actively pursue the efficient use of available supplies.”

Measure Metrics

To ensure that all power plant emissions are estimated using a consistent methodology, the calculation of emission savings realized at power plants will be performed by the CAT Electricity Sector subteam and ARB. The volume of water recycled and the associated energy savings are presented in this analysis for ARB application. Recycled water is expressed in million gallons (MG) and Acre-Feet (AF). Embedded energy is expressed in Kilowatt hours (kWh), Megawatt hours (MWh), and Gigawatt hours (GWh).

Measure Goals and Potential Implementation Approaches

This measure proposes a requirement for development and implementation of Water recycling plans by wastewater management agencies working with water supply agencies, where the recycling of treated effluent is not maximized at wastewater treatment plants located in areas of imported water supply. Implementation of water recycling plans would be prioritized for those plants that discharge to water bodies from which the wastewater cannot otherwise be easily recovered, such as the ocean.

The estimated annual energy savings that would be realized by recycling wastewater at the 182 WWTPs in Southern California in 2030 is estimated as 500,000 AF/yr multiplied times 2.5 MWh/AF, saving an estimated 1,254 GW/yr in 2030 and beyond. The construction of water recycling facilities that produce 30,000 AF/yr of new capacity each year from 2011 through 2030 (20 years) would achieve the total recycling capability of 885,000 AF/yr in 2030. Of the 30,000 AF/yr increase, 5,000 AF/yr would be the result of continued implementation at the current level (baseline) and 25,000 AF/yr would be attributed to this water recycling measure.

Related actions that will support the efforts of this measure include:

a. Revision of Water Board funding criteria to consider water recycling (Land Use CAT subteam measure)
b. Coordination with the DWR, CEC, and CPUC on the water-energy connection in the areas of research, planning, and project implementation activities.
c. Future compliance with AB1481 (Simitian) to adopt a general permit for use of recycled water for irrigation of public spaces
d. Recognition of Water Recycling as a goal in the Water Boards Strategic Plan Update 2008-2012

4. Technology

Implementation of water recycling systems does not require the application of new technology. However, increased demand and implementation are expected to catalyze development of more cost-effective and energy efficient technologies. Further, there may be opportunities to use sustainable energy sources, such as solar, wind, or geothermal, to provide power for water recycling.

5. Statutory Status

The Water Boards have the authority to require water recycling. The Water Boards permit authority includes the ability to establish permit terms and conditions, including requirements for water recycling. Additional statutory authority is not required to implement the regulatory elements of this measure.

Water Code Section 10610.4 states: “The Legislature finds and declares that it is the policy of the state as follows:

(a) The management of urban water demands and efficient use of water shall be actively pursued to protect both the people of the state and their water resources.

(b) The management of urban water demands and efficient use of urban water supplies shall be a guiding criterion in public decisions.

(c) Urban water suppliers shall be required to develop water management plans to actively pursue the efficient use of available supplies.”

6. Implementation Steps and Timeline

The future availability of staff and financial resources to support development of water recycling plans and implementation of additional water recycling systems by local agencies is unknown, dependent upon allocation of state funds and proposition/bond funding. Staff resources may be unavailable to accomplish expanded assignments, research, outreach, and public participation.

It is anticipated that new requirements could be implemented in sufficient time to require construction of additional water recycling facilities as soon as 2011. For the purposes of this analysis, implementation is assumed to occur at a uniform rate for 20 years. Legal challenge and environmental constraints are unknown factors that could adversely impact implementation.

7. Greenhouse Gas Emission Reductions

GHG reductions realized by water recycling will be the product of reducing the amount of energy that would otherwise be required to deliver new water. As a result, emission reductions resulting from this measure will be realized at regional power plants. The calculation of emissions savings at power plants is being performed by the CAT Electricity Sector subteam and ARB. To ensure that all power plant emissions are calculated using a consistent methodology, ARB staff have indicated that water-energy measures provide estimates of annual energy savings and cost information. Those values will be used by ARB to calculate GHG emission reductions at power plants.

For the purposes of this measure, energy savings and costs are estimated for every year from 2011 through 2030. Energy savings are estimated as the difference in electrical energy used to deliver “new” water and the saving realized by recycling water at the local wastewater treatment plant. Annual costs are estimated as (1) the capital cost to install additional water recycling infrastructure each year, i.e. a fixed capital cost, and (2) a recurring annual O&M cost to operate the new installed facility from the year of construction through 2030. Please refer to Table 3 which provides detailed costs and energy values that can be used to calculate GHG reduction.

8. Costs and Cost Savings

The cost to recycle water is highly variable depending upon a variety of factors including such considerations as the quality of the water at origin, the proposed uses of the recycled water, the treatment technology and facility/equipment used. The Water Boards will incur nominal costs, largely staff time, preparing and adopting requirements that water recycling plans be prepared for WWTPs. It is conceivable that opposition to such requirements could trigger unforeseen challenges potentially triggering CEQA or economic analyses that would require dedication of staff resources to address, but such costs cannot be anticipated at this time. The cost of water recycling at WWTPs will be borne by the operating entities that construct and operate the recycling facilities. All costs identified this analysis are expressed in 2007 constant dollars.

The 2003 Recycled Water Task Force estimated the approximate costs to implement water recycling as $6,600 to construct/install infrastructure with the capacity to process one AF per year and $300 per AF for operating and maintenance (O&M) of those facilities thereafter. The RWTF values are in year 2000 dollars. The RWTF values have been converted to 2007 dollars values using 6% annual growth yielding $10,000 (rounded to $1,000) and $450, respectively. The $10,000 estimated cost to develop infrastructure divided by the 40-year life expectancy of that infrastructure yields an estimated capital cost of $250 per AF of recycled water processed. Each facility would incur an annual O&M cost of $450 per AF for the 40-year life of the facility.

As described in the preceding section, this measure will contribute to the development of new facilities that add 25,000 AF/yr of recycling capacity each year for the period 2011-2030. An estimated capital investment of $250 million per year ($10,000 infrastructure cost per AF x 25,000 AF/yr of capacity) will be required to achieve the water recycling goal by 2030.

9. Other Benefits

All emission reductions realized by this measure are represented by the energy savings calculations presented in the appropriate sections of this analysis. Water recycling is primarily an adaptive measure that benefits local communities by providing an additional source of water to augment traditional supplies that may be reduced as a consequence of climate change.

10. References

California Department of Water Resources. Water Recycling 2030: Recommendations of California's Recycled Water Task Force. 2003. http://www.owue.water.ca.gov/recycle/taskforce/taskforce.cfm

California Energy Commission. Refining Estimates of Water Related Energy Use In California, December 2006. Presentation: Water-Related Energy Use In California, Assembly Committee on Water, Parks and Wildlife. February 20, 2007. Martha Krebs, Ph.D., Deputy Director for Research & Development, Public Interest Energy Research Program, California Energy Commission.

California State Water Resources Control Board. Office of Research Planning & Performance. Draft Water Boards Strategic Plan Update. 2008.

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U.S. Environmental Protection Agency. Clean Watersheds Needs Survey (CWNS), http://www.epa.gov/cwns/2004data.htm

Climate Action Team
Water-Energy Sector Sub Group
Scoping Plan Measure Development and Cost Analysis

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1. Measure: Develop renewable projects that can be co-located with existing water system infrastructure

2. Agencies:

California Energy Commission (Energy Commission) and Public Utilities Commission (CPUC)

3. Measure Description

Consistent with the Energy Commission's *2007 Integrated Energy Policy Report* (IEPR) recommendation to "establish a more cohesive statewide approach for renewables development that identifies preferred renewable generation and transmission projects in a 'road map' for renewables", the purpose of this measure is to identify and implement specific projects that take advantage of the state's water system-related opportunities to generate renewable electricity. Renewables are sources of energy that are naturally replenished, thus diminishing the supply problems potentially encountered with finite resources (i.e., fossil fuels). Examples of energy existing within water systems (water and wastewater projects) include water moving through conduits, sunlight, wind, and gases emitted from decomposing organic wastes. Producing energy from these resources at water and wastewater facilities will reduce greenhouse gas (GHG) emissions by offsetting the need for the facilities to consume electricity derived from natural gas and coal, which constitutes nearly 60 percent, on average, of electricity supplied by California's electric grid.

<u>Overview</u>

Renewable energy development within existing water system infrastructure would include projects for economical in-conduit hydroelectric (estimated at 278 MW) generation, small pumped storage facilities, solar, wind, and biofuel (projected at 138 MW in 2020). The preferred method for implementing such projects is for water system operators to develop their own self-funded, cost-effective projects. However, we recognize that many operators require financial assistance to make promising projects a reality. Knowing that incentive programs do exist, we recommend that a portion of available funding support be reserved to provide needed financial assistance where agencies face implementation barriers to project development. In addition, ongoing research should regularly assess the economical potential in order to better target incentives and technological improvements to lower renewables generation costs.

All renewable energy production opportunities under this measure have the potential to contribute to California's Renewables Portfolio Standard (RPS), which was established by Senate Bill 1078 (Sher, Chapter 516, 2002).[1] The *2003 Energy Action Plan* adopted by the Energy Commission and CPUC recommended that the 2017 target date in SB 1078 be accelerated to 2010. The accelerated target was set in statute by Senate Bill 107 (Smitian, Chapter 464, Statutes of 2006),[2] effective January 1, 2007. The RPS sets the goal that 20% of the state's electricity be generated from renewable energy by 2010. The *2004 IEPR Update* recommended the additional target of 33% renewables by 2020. The Energy Commission's *Renewables Portfolio Standard Eligibility Guidebook*[3] defines criteria for inclusion of a resource in the RPS. Excess RPS-eligible electricity generated by water system facilities and sold to utilities would be eligible to count toward the utility's contribution to the RPS. Generally, the electricity exported from the water system site would benefit the utility's RPS procurement.

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[1] http://www.leginfo.ca.gov/pub/01-02/bill/sen/sb_1051-1100/sb_1078_bill_20020912_chaptered.pdf
[2] http://www.leginfo.ca.gov/pub/05-06/bill/sen/sb_0101-0150/sb_107_bill_20060926_chaptered.pdf
[3] Renewables Portfolio Standard Eligibility Guidebook (Third Edition), publication # CEC-300-2007-006-ED3-CMF, adopted December 19, 2007, www.energy.ca.gov/renewables/documents/index.html

Renewable electricity used to meet on-site loads, although it will lower the GHG footprint of the site, would not count toward the RPS.

In addition, AB 1969 (Yee, Chapter 731, 2006)[4] requires a tariff structure for the purchase of renewable electricity generated at water and wastewater facilities, providing a streamlined means for electricity to be sold to utilities and sent to the electricity grid. In cases where a facility has robust enough resources to generate more electricity than it uses, these tariffs may be used as an incentive to encourage the water or wastewater agency to fully develop their renewable resources for electricity production.[5]

Affected Entities

Development of a regulatory system for feed-in tariffs, to streamline the contracting and interconnection process for water and wastewater agencies to produce on-site renewable energy generation for export onto the grid, is the responsibility of the CPUC, as directed by AB 1969. This measure will affect the Department of Water Resources (DWR), which operates the State Water Project (SWP) and the U.S. Bureau of Reclamation, the federal agency responsible for the Central Valley Project (CVP) and other irrigation projects throughout California. The measure will also affect local water supply and wastewater agencies, including those operated by city governments, and publicly-owned and investor-owned electric utilities (POUs and IOUs, respectively).

Environmental Justice, Small Business, Public Health, Leakage and CEQA

The foundation for this measure is recommendations from the Energy Action Plan (I and II) and Integrated Energy Policy Report (2003, 2005, 2006 update, and 2007). Public hearings and workshops were held in development these policy documents. In addition, hearings on legislation provided opportunity for public comment regarding specific topics: SB 1078 (2002) and SB 107 (2006) on the RPS, AB 1969 (2006) on feed-in tariffs, and AB 809 (2007) on counting incremental increases in efficiency at large hydroelectric plants toward the RPS.

At this time, we expect the measure to benefit all electricity users in California, by reducing demand on the electric grid. Specific affected populations have not yet been identified. Thus, any possibility of disproportionate impacts will have to be evaluated at a later date. Financial burdens are not expected, as the measure as defined must be cost-effective, thereby avoiding any measure-related increases in rates or indirect costs. A public health co-benefit is present for wastewater treatment biofuel projects: wastes are stabilized in an airtight chamber before being flared, reducing odors and emission of non-GHG co-pollutants.

Increasing generation at water system facilities is intended to reduce demand for grid-generated electricity. Installed generation would be permanent, resulting in dependable, long-term generation. The resulting reduction in demand for grid electricity will follow the same pattern, so out-of-state generation from GHG-emitting sources is expected to adjust to reduced demand and leakage is not expected to occur.

Specific activities that may result from this measure may be considered a project under CEQA and will require evaluation for possible exemption or the need to produce environmental assessment. At this time, it is too speculative to determine the application of specific CEQA requirements.

[4] http://www.leginfo.ca.gov/pub/05-06/bill/asm/ab_1951-2000/ab_1969_bill_20060929_chaptered.pdf

[5] For more information on the CPUC implementation of the AB 1969 Feed-in tariff program see: http://www.cpuc.ca.gov/PUC/energy/electric/RenewableEnergy/feedintariffs.

Related Objectives

This measure is motivated by multiple objectives. In addition to GHG reduction, projects will help achieve the following benefits:

- Better management of on-site electricity load at water system sites
- Mitigation of electricity price volatility
- Contribution to meeting the RPS
- Disposal of organic wastes contained in wastewater in an environmentally-preferred manner.

Measure Metrics

The primary metric for this measure is the total yearly generation in Megawatt hours (MWh) at water system sites. Additional metrics include temporal variation in generation in Megawatts (MW), the percent reduction of the water system's demand on the electricity grid, and the number of water system facilities employing some means of renewable, on-site generation.

Measure Goals and Potential Implementation Approaches

The goal of this measure is to develop all potential renewable resource opportunities in the state's water system, through establishment of streamlined interconnection and tariff rules. Resolution E-4137 adopted by the CPUC to implement AB 1969 establishes tariff rules. In Decision (D.) 07-07-027, the CPUC established pricing terms for tariffs, providing non-negotiable 10, 15, and 20-year fixed-price contracts, based on the Market Price Referent (MPR), to small generators of renewable electricity. Small generators under the bill are those with an effective capacity less than 1.5 MW, which includes some water and wastewater sites. The bill allows water and wastewater facilities generating electricity from eligible renewable sources to sell the entire output of these eligible renewable generating facilities to IOUs or to sell net generation in excess of any on-site use and further, for the IOU to count any eligible generation exported onto the grid per facility toward their RPS procurement targets. AB 1969 requires all electrical corporations under CPUC jurisdiction to create feed-in tariffs for purchase of RPS-eligible electricity from water and wastewater agencies and caps development at 250 MW statewide.

The smaller utilities, (BVES, Pacificorp, Sierra Pacific and Mountain Utilities) have a 1 MW size cap per facility and relatively small allocations under the statewide cap[6]. The cap does not apply to and is not affected by electricity used on-site from sources other than the eligible renewable generating facility. While the feed-in tariff required by AB 1969 and implemented by CPUC may benefit many water system projects, the Energy Commission recommends in its 2007 IEPR that the site-specific feed-in tariff cap be raised to 20 MW—which may lead to demand for the program exceeding the 250 MW statewide cap.

4. Technology

Three of the technologies to be used for this measure—solar photovoltaic, wind, and hydroelectric—generate electricity without directly emitting GHGs. Water system facilities using these technologies to generate electricity will offset the need for electricity from GHG-emitting fossil-fuel sources, such as natural gas or coal (imported electricity). Generation from biofuel emits carbon dioxide but prevents methane—a stronger GHG than carbon dioxide—from entering the atmosphere, thus reducing the overall atmospheric warming effect of emitted gases.

In-Conduit Hydroelectric

[6] http://docs.cpuc.ca.gov/PUBLISHED/NEWS_RELEASE/78824.htm

Wherever there is flowing water, its kinetic energy may be captured and converted to electricity. Water flows from high water surface elevation (head) to areas with lower head. The potential to generate electricity is directly proportional to the head difference between two points on the water surface. The site-specific head difference partially determines whether a project is cost-effective. Similar to wind technology, blades capture the energy of flowing water, spinning a central shaft containing a turbine generator . For example, the SWP consumes electricity to pump water to high elevation, where water then flows downhill through man-made conduits. In cases where this energy may be recaptured by directing flowing water toward turbine generators, energy expended in pumping is recaptured—thus reducing the demand for energy in the system (California's Water-Energy Relationship). In other cases, where man-made conduits decrease in elevation in the direction of water transport, hydroelectricity produced in-conduit may be sold to utilities. Electric transmission or distribution lines are needed to connect the generation facility to the electricity grid.

<u>Pumped Storage</u>

Water may be used to store energy until the need for electricity is greatest. Pumped storage requires a pump installed in a pipeline equipped with a turbine connecting two reservoirs of different elevation. Water is pumped uphill during off-peak hours when demand for electricity is low, stored in the upper reservoir until demand increases, and then runs downhill through turbines during peak hours, to produce electricity when it is needed most. Small projects use tanks as reservoirs and may generate small amounts of electricity as needed; large projects connect dammed reservoirs and may provide 500 MW or more of peak generation (California's Water-Energy Relationship).

In order for electricity generated during peak hours to be RPS-eligible, electricity used for off-peak pumping must have been RPS-eligible also.

<u>Solar</u>

Sunlight energy may be captured using solar photovoltaic cells and solar thermal technology. Solar photovoltaic cells use sunlight energy to directly activate electrons, producing electricity. Several cells arranged side-by-side in a small rectangular grid comprise a module; several modules installed together comprise an array. Solar photovoltaic cells may be installed at offices of water system agencies and at system facilities, on rooftops and covering parking spaces. Photovoltaic array design provides flexible options with respect to size and location. Modules typically produce 5 to 300 W of direct current electricity. Peak sunlight hours and peak electricity demand hours often coincide, so solar technology generally has the advantage of producing its highest output when the electricity is needed most. Batteries may be co-installed to store small amounts of electricity for nighttime or periods of cloudy weather .

The same advantage is provided by solar thermal technology, but installations require large amounts of single-purpose dedicated land. Because of this technological requirement, solar thermal projects are not currently suggested for pursuit within water systems.

<u>Wind</u>

Windmills have blades designed to capture the force of air currents, spinning a central cylinder containing a turbine generator. Utility-scale turbines typically produce energy in the range of 100 kilowatts to several megawatts. Multiple electric-generating windmills may be grouped together, comprising a wind farm. Winds are generally highest in mountains, making this renewable resource a promising means to use at water system sites where pumps bring water to high elevation.

<u>Wastewater Treatment Biofuel</u>

When organic solids (e.g., sewage, dairy manure, and food wastes) decompose in an oxygen-free environment, they emit methane—a usable gas for energy production. Sewage wastewater is one waste substance which emits gases as it sits in digesters. Anaerobic digesters are temperature-controlled, airtight chambers in which organic solids are sealed, to be allowed to decompose. Digesters use suction pipes to extract gas emitted from the waste. Typically, this gas is about 65% methane, which when captured can be combusted to run a generator. Increasing on-site renewable energy production may be directly used on-site to provide energy for water recycling, an energy-intensive process. The costs of recycling water could be reduced by developing and utilizing on-site, renewable energy to reduce or replace dependence on energy from the electricity grid.

Geothermal

The Earth's internal heat provides geothermal generation in some locations proximate to water system sites. In some projects, recycled water may be injected to augment natural steam production. However, geothermal resources are limited geographically and are typically developed outside of water systems. Because of these limitations, they are not at this time suggested as a target for further development of renewables within water systems.

5. Statutory Status

Adequate statutory authority exists to implement this measure; no additional modifications or additions are needed. On-site electricity generation and usage does not require state approval, but rather will be approved by local entities. Statutory authority for water system operators to sell the full output of on-site renewable electric generation or the net output in excess of on-site consumption is granted by AB 1969.

6. Implementation Steps and Timeline

Implementation will involve four strategies: 1) providing a regulatory framework allowing water system operators to develop renewable projects by their own choosing, 2) using financial incentives to encourage additional project development, 3) assessing economic potential to better target future incentives, and 4) researching technologies to lower costs and improve performance. Implementation steps and timeline are to be coordinated with renewables measures from the electricity subgroup.

1) Regulatory Framework

Resolution E-4137 implementing PU Code Section 399.20 as added by AB 1969 was approved by the Commission on February 14, 2008. The tariffs as modified by E-4137 became effective as of that date and should be available to all publicly owned water and wastewater customers receiving retail electric service from CPUC regulated IOUs. The tariffs are available on a first come first served basis until the utilities' allocation of the 250MW statewide is reached. The CPUC expanded the program by extending an additional 228 MW to any small renewable generator subject to the same RPS eligibility, size and interconnection requirements. This extension was only applied to PG&E and SCE territories, and later phases of the program may want to consider a uniform and consistent expansion, as well as modifications to the size requirements. The MPR is a generation price, and as such it does not include a subsidy for renewable generation.

2) General Financial Incentives

Water system facilities located in investor-owned utility service territories *may* be eligible for the following Energy Commission and CPUC-administered programs:

- The Existing Renewables Program provides rebates for grid-connected wind turbines producing up to 30 kW.
- Water and wastewater facilities installing wind distributed generation projects 30 kW to 5 MW would also be eligible to receive incentives from the Self Generation Incentive Program (SGIP), but incentive itself is capped at 3 MW. For more information on SGIP go to http://www.cpuc.ca.gov/PUC/energy/051005_sgip.htm
- Solar PV distributed generation at commercial or municipal water facilities would be eligible for California Solar Initiative incentive but could not also participate in the Feed in tariff program. [7]
- Small wind (<30kW) and renewable fueled fuel cells could receive benefits from the ERP program, but would also not be eligible for the Feed-in tariff.
- RPS-eligible facilities greater than 1.5 MW can bid into IOU solicitations for energy under the Renewables Portfolio Standard. SCE has also established a standard biomass contract, offering the MPR for energy from biomass facilities up to 20 MW.

3) Targeted Financial Incentives

AB 1969 does not allow participation in other incentive programs sponsored by the state's IOU ratepayers, but it does not prohibit the use of other incentive programs. For example, the Cities of Berkeley and San Francisco have each approved financing schemes for solar which could be used in conjunction with the AB 1969 feed-in tariffs.

As noted above there are targeted financial incentives for certain renewable technologies under SGIP and CSI.

4) Technology Research

Ongoing research is critical to implementation. Research will help to identify new technologies and development opportunities, and to assess overall renewable generation-potential. Current research is underway in the Energy Commission's PIER program to assess the economical potential of biofuel production at wastewater treatment plants. Additional research is needed to assess the economical potential of other technologies co-located with water and wastewater facilities. Cost of developing renewables projects may decrease when new technologies become available.

7. Greenhouse Gas Emission Reductions

Increasing renewable electricity generation will reduce GHG emissions by offsetting the need for electricity produced from fossil fuel sources. Potential GHG emission reductions will be calculated at a later date. Potential to displace the need for fossil-fuel electricity generation is illustrated by numerous examples of projects undertaken at water and wastewater facilities.

Hydroelectric

This generation opportunity is being utilized by several local agencies:

- Alameda County Water District produces electricity using hydropower[8] at its Mission San Jose Treatment Plant. Despite using an energy-intensive treatment process, the plant usually generates more electricity than it uses.

[7] http://www.cpuc.ca.gov/PUC/energy/Solar/
[8] http://www.acwd.org/history.php5

• San Diego County Water Authority operates an in-line hydroelectric generation facility, producing 20,000,000 kWh per year, which it sells to San Diego Gas & Electric and delivers to the electricity grid. (California Urban Water Agencies, *Climate Change and Urban Water Resources)*

• Santa Clara Valley Water District operates a hydroelectric facility at Anderson Dam, generating 713,000 kWh of electricity in FY 2005-2006. Generated electricity is sold to PG&E and delivered to the electricity grid. (*From Watts to Water)*

A recent Energy Commission Public Interest Energy Research (PIER) study estimated statewide undeveloped technical potential for hydroelectric generation in manmade conduits at 1,100 GWh/yr, with nameplate[9] generation capacity of 255 MW. Developable potential is about evenly split between municipal and irrigation district systems. Additional projects identified by the Department of Water Resources raised the nameplate generation total to 278 MW (Energy Commission, *California Small Hydropower and Ocean Wave Energy Resources*).

<u>Pumped Storage</u>

Pumped storage projects may reduce GHG emissions, if operated during 24-hour periods with a large difference between minimum and maximum electricity demand. Pumped storage projects allow fossil-fuel electricity plants to operate at lower generation levels during high demand hours. The uphill pumping of water during low demand hours may, in some cases, result in lower GHG emissions, because of the high carbon-intensity of producing additional electricity when demand is high.

<u>Solar Photovoltaic</u>

In its December 2007 report *Climate Change and Urban Water Resources: Investing for Reliability*, California Urban Water Agencies (CUWA) describes renewable energy projects CUWA agencies have taken to reduce their carbon footprints. Several agencies have reduced their reliance on other energy sources, using solar photovoltaic (PV) energy systems:

• East Bay Municipal Utility District (EBMUD) produces 600,000 kWh per year at its Sobrante Water Treatment Plant, accounting for 10% of the facility's energy needs.

• Santa Clara Valley Water District produces 350,000 kWh per year at its headquarters, using rooftop and carport installations of solar PV.

• The City of San Diego installed a solar PV system atop its Alvarado Water Treatment Plant. Installed in March 2007, the system produced 778,274 kWh during its first nine months of operation, meeting 20% of the plant's power needs. The system's current capacity is 1.135 MW; the city plans to boost capacity to 5 MW.

• Contra Costa Water District is installing solar PV at its Ygnacio Pump Station, capable of generating 34% of energy needs during peak energy use.

<u>Wind</u>

The state's three largest areas of wind generation developments are Altamont Pass, Tehachapi Pass, and San Gorgonio Pass (Figure 1, *Impact of Wind Turbine Technologies*, Energy Commission, 2006). Of these, the Tehachapi Pass wind development is near the SWP's California Aqueduct and the San Gorgonio wind development is near Metropolitan Water District's (MWD) Colorado River Aqueduct. The Tehachapi site is characterized in *Impact of Wind Turbine Technologies* as having "some of the best thermal winds in the state", but located

[9] Claimed based on facility design

in an area with a "relatively weak…transmission system" for delivery to uses in Southern California Edison's service territory. [10]

Both the SWP and the MWD project use hydroelectric pumps to bring water over mountain passes. The Tehachapi pass is the location where the SWP's Edmonston pumping plant is used to lift water 1,926 feet up and over the Tehachapi Mountains, into the Los Angeles Basin. Because the Tehachapis have robust wind generation opportunity, this location in particular should be explored for potential to co-locate wind electricity generation with water system sites.

Wastewater Treatment Biofuel

Several California agencies produce energy from this resource:

- EBMUD captures methane released from solids digestion process, at its main wastewater treatment plant. Recovered gas is used to generate 90% of plant's electricity. EBMUD plans to expand generation by 2009, to produce more electricity than it uses and deliver electricity to the grid. CUWA, *Climate Change and Urban Water Resources*
- San Francisco Public Utilities Commission captures methane at both of its wastewater treatment plants, using recovered gas to produce electricity and hot water for plant operations. CUWA, *Climate Change and Urban Water Resources*
- Additional biosolids may be collected and added to digesters, concentrating biofuel emissions where they can be captured and increasing methane production from waste. Inland Empire Utilities Agency collects manure from off-site dairy digesters and adds it to two wastewater digesters it operates (*California's Water-Energy Relationship*, Energy Commission, 2005).

Preliminary estimates by the Energy Commission's PIER program (personal communication: Valentino Tiangco) quantify developed production from biofuel at wastewater treatment plants at 20 facilities statewide, for a total of 64 MW. A preliminary estimate of total potential generation is 116 MW (863 GWh/yr) statewide for 2005. This potential is projected to increase to the following statewide totals in future years: 124 MW (924 GWh/yr) in 2010, 135 MW (1,004 GWh/yr) in 2017, and 138 MW (1,027 GWh/yr) in 2020. These estimates are for technologically-feasible projects and do not reflect a determination of cost-effectiveness or economic potential.

8. Costs and Cost Savings

According to Energy Commission estimates, the technologies discussed herein have the following levelized fixed costs of generation (merchant costs, from Table 2 in *Comparative Costs of Electricity Generation Technologies*):

[10] However, the CPUC has approved transmission upgrades to access approximately 1100 MW of capacity – likely wind – and is now considering an application that would access approximately 3400 additional MW.

Technology	Project Size (MW)	Levelized Merchant Cost of Generation ($/MWh)
Conventional Combined Cycle (natural gas)	500	102.19
Wastewater Treatment Biofuel	0.5	97.34
In-Conduit Hydroelectric	1	52.84
Solar – Concentrating PV	15	424.84
Wind	50	84.24

A natural-gas technology is shown for cost comparison. Of the renewable options, the cost of generation for in-conduit hydroelectric is just over half the cost for natural gas. Wind and biofuel from wastewater treatment are also cheaper to generate. These technologies thus present opportunity for cost savings, if renewable projects are developed to displace the need for electricity produced by natural gas. Solar is more expensive; however, the cost estimate includes construction. Solar generation is expensive because of the high cost of PV cells, but once the initial investment is made, only occasional maintenance and power inverter replacements are necessary. Solar generation avoids more expensive electricity generation than other renewables, as shown in Exhibit 9 of *Updated Macroeconomic Analysis of Climate Strategies*.

In addition to the fixed costs above, some generation technologies have variable costs. Figure 4 in Comparative Costs of Electricity Generation Technologies shows that in-conduit hydroelectric and biofuel from wastewater treatment have small variable costs, relative to natural gas technologies. Wind and solar have no variable costs. Because of the lower variable costs inherent in generation from renewables, price stability is an inherent advantage, compared to natural gas generation.

Cost estimates may change when a carbon adder is incorporated into the analyses producing these estimates. This measure attempts to capture less easily estimated costs arising from the emission of GHGs. By offsetting the need for fossil-fuel electricity generation, this measure saves costs of GHG emissions not yet quantified. However, for every MWh of renewable electricity generated, it is estimated that an average of 390 kg of CO_2e emissions are avoided (*Updated Macroeconomic Analysis of Climate Strategies*).

9. Other Benefits

Renewable projects co-located with existing water system infrastructure can reduce the reliance of those water system facilities on the electricity grid. In addition to offsetting the need for fossil-fuel electricity, water system operators will receive the benefits of reduced susceptibility to electricity price volatility. The state's electricity system benefits from localized load management.

In the case of producing energy from biofuel at wastewater treatment plants, there are several additional benefits in capturing methane emitted from waste:

- Anaerobic digestion of biosolids nearly eliminates fecal coliform bacteria, which is a pollutant if it enters the water supply

- Methane is captured rather than allowed to enter the atmosphere, where it is a potent GHG, trapping significantly more global warming potential per molecule than carbon dioxide.
- The energy produced can be used on-site for water recycling or treatment.

Solar photovoltaics provide the additional benefit of producing their peak output at times when electricity is generally needed most. Pumped storage contains a similar benefit of providing electricity when it is needed most, except these projects only store energy, rather than produce.

10. References

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Climate Action Team

Water-Energy Sector Sub Group

Scoping Plan Measure Development and Cost Analysis

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Climate Action Team

Water-Energy Sector Sub Group

Scoping Plan Measure Development and Cost Analysis

1. ***Strategy: Reduction of Greenhouse Gas Emissions Through Water Use Efficiency Measures***

2. ***Agency: Department of Water Resources***

3. ***Strategy Description:***

Introduction

The Governor has identified conservation as one of the key ways to provide water for Californians and protect and improve the Delta ecosystem. He has directed state agencies to develop and implement a more aggressive plan to help achieve a 20 percent reduction in per capita water use statewide by 2020. This directive builds upon the *California Water Plan Update 2005*, which identified water use efficiency as a "foundational action" for California water management.

To implement this goal, DWR is collaborating with the California Energy Commission, the California Public Utilities Commission and the State Water Resources Control Board to develop and implement various measures and strategies to increase water use efficiency and thereby reduce greenhouse gas emissions related to water use. To support this implementation, this conservation initiative will need to utilize the many Integrated Regional Water Management (IRWM) planning efforts throughout California. During 2008, the four-agency group will collaboratively prepare a statewide water use efficiency measure for consideration in the Public Review Draft of the California Water Plan Update 2009.

Overview

The primary benefit of improving water use efficiency is to increase supply reliability by lowering of demand and cost-effectively stretching existing water supplies. Another important benefit of improving water use efficiency is based on the relationship between greenhouse gas emissions and the use of fossil fuels. This relationship is key to the reduction of greenhouse gas emissions through water end use efficiency because of the potential to reduce energy demand. Of the approximately 19% of all electricity and 30% of natural gas (non-power plant) consumption associated with water, 73% of this electricity and nearly all of the natural gas is associated with the agricultural and urban end use of water. The energy is used to convey, treat, and distribute water, before and after its use. Many of the state's inter-basin transfer systems also have significant hydroelectric generation. The Central Valley Project, East Bay Municipal Utility District's (EBMUD) Mokelumne Aqueduct, and San Francisco's Hetch Hetchy Regional Water System are all net energy producers. Despite its significant hydroelectric capacity, the State Water Project (SWP) is a net energy consumer. However, the SWP uses its storage capacity to pump water during off-peak hours and to generate hydroelectricity during on-peak hours.

Based on data from the draft *Statewide Assessment of Energy Used to Manage Water*, it is estimated that at least 44 million metric tons of CO_2 emissions are expelled on average annually to provide the 44 million acre-feet (MAF) of urban and agricultural water used statewide.[1] This estimate does not consider that while water management uses energy that can generate greenhouse gas (GHG) emissions, water also generates energy (hydroelectricity) that does not. The primary emission sources for GHGs are: (1) fossil fuel-based electricity generation, and (2) natural gas combustion. According to this draft analysis, an annual water savings of 3.1 MAF by 2030 (from the *California Water Plan Update 2005*), the high-end estimate for urban water use efficiency, would yield equivalent energy savings of approximately 10,075 gigawatt hours (GWH) of electricity.

The *2005 Integrated Energy Policy Report* provided an initial estimate of energy demand associated with water conveyance, treatment, distribution and use. These estimate were refined in the Energy Commission's 2006 PIER report, *Refining Estimates of Water-Related Energy Use in California* "…with particular attention focused on refining the estimates for energy embedded (needed to convey, treat and distribute) in a unit of water delivered to the consumer. The energy required to produce, convey, treat, and distribute water varies significantly among communities depending on their individual circumstances. There is also diversity among customers. For example, hot water consumption in tall buildings (which requires both heating and pressurization) is more energy intense than single- and two-story buildings. Because of this diversity, water efficiency programs can emphasize locations and customer uses that have relatively higher energy intensity. Alternatively, some water use efficiency measures (e.g., agricultural drip irrigation using surface water) may actually increase energy demand.

The key to the reduction of GHG through water use efficiency is strategic investment in measures tied to water-energy intensity. In general, when a unit of water is saved, so too is the energy required to convey, treat, deliver, and use, as well as treat and dispose of, that unit of water. Region, elevation, water source, water use sector, and energy source, among other factors, all influence water-energy intensity. The statewide average for GHG emissions per acre foot is skewed by the wide local variation in the water-energy intensity. For example, everything else being equal, improved water use efficiency in an industrial plant in Northern California will save 2,920 kWh compared to 9,270 kWh saved in a comparable plant south of the Tehachapi Mountains, annually.

[1] Of note, environmental water use generally does not result in GHG emissions. However, some forms of environmental water use can do so, either directly (e.g., via pumping of water in managed wetlands, which requires the use of energy generated by power plants that emit GHGs) or indirectly (e.g., foregoing hydroelectricity production in order to use the water to meet environmental objectives and using other energy sources to provide a substitute for the hydroelectricity results in GHG emissions).

California will achieve 1.76 MAF of urban water savings by 2020 to meet the Governor's call for a 20 percent per capita reduction in statewide water use. Many measures can be used to meet this goal, such as local investment, state grant funding and technical assistance, public education, and ordinances and regulations. For this analysis, we used two approaches to illustrate how this amount of water conservation can be achieved and the funding involved. First, implementation of locally cost-effective conservation measures is estimated to save 773,000 acre-feet per year by 2020. Second, an additional 224,000 acre-feet per year will be saved by 2020 through the accelerated investment of State grant funding, and 769,000 AF will be saved by 2020 from enforcement of codes adopted before December 2004. This investment is consistent with the Governor's call and uses bond money to create incentives for local water agencies that pursue new conservation practices, particularly in reducing landscape water use. For this estimate, $17.5 million is estimated to be available in 2008; $51 million per year of State grant funding is assumed to be available from 2009 to 2014, followed by $20 million per year from 2015 to 2017 and $10 million per year from 2018 to 2020. Using these assumptions, the water savings and the measures to achieve them are summarized below.

Water Reduction Goals (Thousand Acre-Feet Per Year)

Measure	2020	2020-2030[2]	2030
Locally cost effective funded	773	108	881
Grant funded	224	--	224
Subtotal	997	108	1,105
Code Enforcement	769	201	970
Total	1,766	309	2,075

The Water Plan Update projects that by 2030 there is a potential for 970,000 AF of water savings from code enforcement, 881,000 AF from locally cost effective conservation measures and 224,000 AF from grant funded projects. These estimates are based on:

- The cost of accelerated unit water savings for 2020 is the same as the cost of unit water savings for 2030.
- Grant funded water savings of 2030 can be achieved by accelerating grant funding by 2020.
- Locally cost effective water savings can be accelerated.

The 2030 targets for urban water savings and resulting GHG emissions reductions can only be met if all locally cost-effective projects are implemented by all urban water agencies. If these locally cost-effective measures are not implemented voluntarily by local agencies, additional State grant funding to provide incentive or new regulations to enforce implementation of these conservation measures would be needed to achieve

[2] Additional water savings that can be achieved between 2020 and 2030. Grant funds will be expended by 2020.

the targets. Accelerating the grant funding investment to attain more water savings would result in additional emission reductions.

Additional incremental, passive savings of 812,000 acre-feet annually by 2030 are estimated to result from State codes and regulations adopted since December 1, 2004 and 970,000 acre-feet is expected to be saved from State codes and regulations adopted before December 2004; GHG emission reduction credit for the water savings, resulting from State codes and regulations is not included for the purposes of this analysis.

Additional work is needed to refine the potential for GHG emission reductions through water use efficiency and the most efficient and effective strategy for achieving the full potential. The Water-Energy Subgroup will:

- Identify the energy intensity of various water end uses by region in order to prioritize the implementation of water conservation measures. This task involves determining how much embedded energy is required to deliver water to urban end-users and to treat wastewater for multiple utilities in specific regions of the state in order to identify demand-side water-energy efficiency opportunities for the regions.
- Carry out research into the embedded energy required to deliver water to agricultural end users and into the sources of embedded energy in water for each region.
- Identify efficient urban and agricultural water management opportunities that use less energy.
- Determine the marginal cost per acre foot of urban and agricultural water by region.
- Develop a strategy for potential implementation that includes recycling and brackish-water desalination in areas with high water-energy intensity. Additional research will be required to determine the potential for GHG reductions and the cost effectiveness of specific recycling and brackish water desalination projects.
- Develop a standardized approach to evaluating how water management actions described in the *California Water Plan Update* impact GHG emissions.
- Coordinate with the California Energy Commission and California Public Utilities Commission (CPUC) on the water-energy connection in the areas of research, planning, and project implementation activities.
- Refine the initial targets of GHG reduction.

Affected Entities

Public and private water suppliers, distributors, end-users, and wastewater treatment facilities will be directly affected by the strategy. There are approximately 460 urban water suppliers—those serving more than 3,000 customers or more than 3,000 acre-feet per year—that provide water directly and indirectly to Californians. In addition, there are numerous public and private water companies serving fewer customers and lower volumes of water. Estimated annual urban water use is 8.7 MAF per year. There are also 180 irrigation districts serving 35.0 MAF per year to agricultural customers. There are approximately 115 municipal wastewater treatment agencies with over 200 treatment facilities that process a total of 4.5 MAF of water per year.

Environmental Justice, Small Business, Public Health, Leakage and CEQA

The development, adoption and implementation of energy efficiency standards for appliances and buildings are a discretionary decision undertaken by a public agency and have the potential to result in direct or indirect physical changes in the environment. As such, it constitutes a “project” under the California Environmental Quality Act (CEQA) (Pub. Resources Code § 21065). The California Energy Commission, as lead agency, is required to consider the environmental consequences of its projects in compliance with CEQA (Public Resources Code § 21000 et seq.) and the CEQA Guidelines (California Code of Regulations Section 15000 et seq.) and when feasible to mitigate any related adverse environmental consequences. It is likely that adoption of energy efficiency standards for irrigation equipment and other water using appliances may result in increased installation of water-efficient fixtures, equipment and controller devices. Environmental impacts will be dependent on the type and scope of standards adopted and will be examined as part of any standard setting proceeding.

In the event adoption of energy efficient standards for water using appliances creates a significant environmental impact, an environmental impact report (EIR) is required to be drafted. The EIR is used to disclose the potential environmental effects of the proposed action that may result and the proposed mitigation.

Related Objectives

Water Code Section 10610.4 states: “The Legislature finds and declares that it is the policy of the state as follows:

(a) The management of urban water demands and efficient use of water shall be actively pursued to protect both the people of the state and their water resources.
(b) The management of urban water demands and efficient use of urban water supplies shall be a guiding criterion in public decisions.
(c) Urban water suppliers shall be required to develop water management plans to actively pursue the efficient use of available supplies.”

Strategy Metrics

The primary metrics for measuring the strategy are measurement of gallons of water use per megawatt hour (MWh), GHG emissions per MWh per utility and water use efficiency program cost per gallon of water. Implementation of urban Best Management Practices (BMPs) and agricultural Efficient Water Management Practices (EWMPs) will be accelerated and target resources and incentives to BMPs that require less energy.

- Increase investment in water use efficiency. Accelerate implementation BMPs for urban water conservation and EWMPs for agricultural water conservation through financial incentives or regulations.
- Target resources to water use efficiency measures that require less energy such as water using appliances, plumbing fixtures, and irrigation pumps that are water and energy efficient.

- Shift water use off the peak energy demand period to reduce peaks, fill energy production valleys, and reduce GHG emissions.[3] A large enough reduction in peak water use will make it possible to turn some peak power plants off or reduce the operating hours of the remaining plants. The net result is less energy used and reduced GHG emissions.

Strategy Goals and Implementation Approaches

- Identify and prioritize agricultural and urban water use efficiency measures with negligible or low energy demand, target resources accordingly, and accelerate implementation when funding becomes available.
- Develop energy efficiency criteria for the water use efficiency and integrated regional water management grant programs.
- Identify energy source, water-energy intensity, and marginal cost per acre foot of agricultural and urban use by region, water use sector, end use, and other factors using current data compiled by water agencies.
- Promote water conservation through water recycling, when the embedded energy is less than other sources of water supply, and estimate the GHG reductions through water recycling technical assistance.
- Refine the initial targets after gathering data over the next year and establish statewide GHG Reduced Emission Targets (RETs) from water use efficiency measures.
- Estimate funding needs and develop financing strategies for achieving the GHG RETs.
- Develop a standardized approach to evaluating the impact that the water management actions described in the *California Water Plan Update* has upon GHG emissions.

Coordinate with the CEC, SWRCB, and CPUC on the water-energy connection in the areas of research, planning, and project implementation activities.

4. Water Use Efficiency Measures

DWR, working with the CEC, SWRCB, CPUC and other entities, will carry out a range of water use efficiency measures including core measures focused on reducing water use as well as measures specifically aimed at developing information about the water-energy relationship. The objective is to use the information to implement water conservation programs that optimize energy conservation and reduce GHG's over the next twenty years. For instance, Priority 3 in the SWRCB 2008 Draft Strategic Plan

[3] Reduction of water and energy use at demand peaks reduces GHG emissions from the generally less efficient, electrical generation power plants used during peak periods. In general, these "peak" power plants are less efficient than those used during base load periods. In addition, in order for these power plants to be available to provide electricity for the few hours of a peak, they also need to be running—effectively idling—for many other hours of the day. If energy use is shifted to the valleys, the efficiency of those plants is increased. In addition, the use of power during peak periods makes it necessary to generate additional power beyond the amount actually used because of congestion in the power transmission and distribution lines.

Update is the promotion of sustainable water supplies which includes support for updating the BMPs by urban and agricultural consumers. One of the actions in the draft plan includes working with DWR to ensure effective implementation of the BMPs by urban suppliers and taking action, where appropriate to limit waste and unreasonable use of water. The Energy Commission is committed to using its Building and Appliance Standards to cost effectively save both water and energy and will be evaluating options to do so in the next proceeding. The California Public Utilities Commission 2005 Water Action Plan adopted the principle of efficient use of water and the objective of strengthening water conservation programs to a level comparable to those of energy utilities. It states that “The Commission will use existing tools to strengthen utility conservation programs, and will provide the necessary direction to do so by initiating formal proceedings where appropriate.” DWR is participating in the water-energy partnership with the CEC and PUC.

- **Best Management Practices** Promote greater urban water conservation:
    - a. Implement Chapter 628, Statutes of 2007, AB 1420, that requires DWR, in consultation with the SWRCB and California Bay-Delta Authority, to develop eligibility requirements urban water suppliers to implement demand management measures (DMMs) described in the urban water management plan (UWMP) in order to be eligible for specified water management grants and loans. This statute requires DWR to convene an independent panel to provide recommendations to the Legislature on new DMMs (conservation) measures, technologies and approaches. This statute also requires DWR to prepare a report to the Legislature that identifies water conservation measures that achieve water savings significantly above DWR conservation levels.
    - b. Use incentives (such as access to funding) to promote greater implementation of BMPs
    - c. Use regulatory tools to ensure greater implementation of BMPs
- **Water-related Energy Efficiency Standards** The California Energy Commission will establish: and update energy appliance efficiency standards to conserve water and energy:
    - d. Establish efficiency standards for irrigation controllers and spray devices
    - e. Conduct research and demonstration projects that reduce the energy intensity of the water recycling process and improves overall quality
    - f. Establish water conservation and efficiency standards for both buildings and appliances that save both water and energy
    - g. Conduct research and demonstration projects that explore ways to reduce the energy intensity of the water use cycle and better manage the energy demand of the water system.
- **Landscape Water Conservation** Promote greater landscape water conservation:
    - h. Encourage a systematic approach to low impact development in order to conserve water and energy, improve water quality, reduce the production of green waste, and protect other resources
    - i. Establish efficiency standards for irrigation controllers and spray devices
- **Irrigation Efficiency** Promote greater irrigation efficiency:

j. Promote more widespread agricultural water management planning
k. Establish efficiency standards for irrigation controllers and spray devices
l. Update California's model water efficient landscape ordinance
m. Upgrade the California Irrigation Management Information System of automated weather stations

- **Analytical Tools** Develop information and analytical tools to better quantify the energy associated with each aspect of water use in each region of California in order to prioritize water use efficiency efforts

n. Identify the energy intensity of various water end uses by region in order to prioritize the implementation of water conservation measures. This task involves determining how much embedded energy is required to deliver water to urban end-users and to treat wastewater for multiple utilities in specific regions of the state in order to identify demand-side water-energy efficiency opportunities for the regions.
o. Carry out research into the embedded energy required to deliver water to agricultural end users and into the sources of embedded energy in water for each region.
p. Identify efficient urban and agricultural water management opportunities that use less energy.
q. Determine the marginal cost per acre foot of urban and agricultural water by region.
r. Develop a strategy for potential implementation that includes recycling and brackish-water desalination in areas with high water-energy intensity. Additional research will be required to determine the potential for GHG reductions and the cost effectiveness of specific recycling and brackish water desalination projects.
s. Develop a standardized approach to evaluating how water management actions described in the *California Water Plan Update 2005* impact GHG emissions.
t. Coordinate with the CEC and CPUC on the water-energy connection in the areas of research, planning, and project implementation activities.
u. Refine the initial targets of GHG reduction.

5. Statutory Status:

Additional statutory authority may be required to implement any regulatory elements of the strategy.

6. Implementation Steps and Timeline:

Currently, the State does not have the resources needed to achieve the initial targets outlined above. However, energy conservation is one of the funding criteria in the Water Use Efficiency grant program ($28 million in Fiscal Year 2006-07, $35 million in the Fiscal Year 2007-08 funding cycle) to implement the water conservation measures that will also help reduce GHG emissions. Pending availability of funding and necessary human resources, DWR, in coordination with other agencies, including CEC, SWRCB, and CPUC, will initiate the following:

FY 08-09

- Evaluate energy impacts of water use efficiency in grant-funded projects.
- Identify water conservation measures with low energy demand.
- Update California's model water efficient landscape ordinance
- Upgrade the California Irrigation Management Information System of automated weather stations
- Promote water conservation through recycling.
- Refine funding estimates to achieve the GHG RETs and develop funding strategy.
- Initiate a proceeding to evaluate appropriate water-related energy efficient appliance standards, including irrigation equipment and controls.

Future years

- Identify and prioritize agricultural and urban water use efficiency measures with negligible or low energy demand by region and target resources accordingly.
- Initiate development of standardized approach in evaluating the impact of water management actions on GHG emissions.
- Refine the initial targets and estimate of the GHG reductions, including contributions from water recycling technical assistance.
- Accelerate implementation when funding becomes available.
- Identify the water-energy intensity required to deliver, treat, and dispose of water to end users; energy use by source;
- Identify the marginal cost of water per acre-foot by region;
- Identify water-energy intensity of water by end users.
- Identify water-energy intensity of agricultural water use by region.
- Refine funding needs estimates for achieving the GHG RETs.
- Regularly update water-related energy efficient appliance standards, including irrigation equipment and controls.

7. GHG Emission Reductions:

The GHG emission reductions are realized as a result of energy savings. The GHG emission reductions are estimated based on the energy saved (i.e., MWh) and the emissions avoided per MWh. The emissions factor for electricity consumption avoided was adopted for the overall analysis of all the climate strategies and is presented separately.

8. Costs and Cost Savings:

Total Annual water savings (including savings from code enforcement) of 1.76 MAF can be achieved through 2020. It is assumed that local agencies are implementing locally cost-effective water conservation measures at an estimated cost of $233 per acre-foot, and that State grant funding of $17.5 million in 2008, $51 million per year from 2009 to 2014, $20 million from 2015 to 2017 and $10 million from 2018 to 2020 is available to implement additional water conservation measures. If locally cost effective and grant funded water savings are 1.0 MAF through 2020, and 1.1 MAF per year through 2030, then total gross implementation costs by 2030 will be $3.6 billion and water cost savings would be $10.1 billion in current dollars at the estimated average cost of approximately $530 to $635 per acre-foot (approximate average costs from California Bay-Delta Authority and *Water Use Efficiency Comprehensive Evaluation,* August 2006).

Of note, the cost savings presented in this document are an estimated value based on limited data and the following assumptions: The average cost savings includes avoided cost of capital, energy, and treatment and assumes no reuse of water. The average cost and average cost savings include the costs and savings associated with changes in fuel consumption. The weighted averages are based on baseline water use projections, before projected conservation (California Bay-Delta Authority, *Water Use Efficiency Comprehensive Evaluation,* August 2006). In cases where water is reused, the cost savings are overestimated. Urban reuse ranges from about 4% in the San Francisco Bay Region to about 65% in the Tulare Lake Region. The statewide reuse average is about 18%.

Affected by reuse are the cost savings, energy use, and GHG emissions benefits of urban conservation that arise from reducing the need for the development and conveyance of water supply. For example, because of reuse of about 10% in the South Coast Region, 1,000 acre-feet of conserved applied water will only have about a 900 acre-foot impact on the need for conveying water from the Colorado River, assuming that it is the marginal source of supply.

The estimated water savings in acre-feet are based on an estimate of increases in savings to reach the locally cost effective and grant funded 1.11 MAF per year level in 2030 for total savings (including savings from code enforcement) of 2.1 MAF per year. Studies are needed to refine the estimates of water conservation, the net energy impacts, and GHG emission reduction.

9. Other Benefits:

By improving water use efficiency, energy consumption is avoided. The co-benefits of reduced energy consumption include reduced emissions of criteria pollutants, reduced strain on the electric grid, and other factors. The reduced emissions of criteria pollutants are computed using a standard set of emissions factors across all the strategies, and are presented separately.

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Detailed Strategy Goals Table

Strategy: Reduction of Greenhouse Gas Emissions Through Water Use Efficiency Measures

Agency: Resources

Affected Entities: Public and private water suppliers, distributors, end-users, and wastewater treatment facilities will be directly affected by the strategy. There are approximately 460 urban water suppliers (i.e., those serving more than 3,000 customers or more than 3,000 acre-feet per year) providing water directly and indirectly to Californians. In addition, there are numerous public and private water companies serving fewer customers and lower volumes of water. There are also 180 irrigation districts and approximately 115 municipal wastewater treatment agencies with more than 200 treatment facilities.

The total water savings in this table include locally cost effective water savings and grant fund induced water savings. It does not include savings from enforcement of codes and regulations adopted before December 2004 (included in the 2005 California Water Plan Update) or codes and regulations adopted since December 1, 2004.

	Strategy Goals as Defined by the Strategy Metrics	
Year	Water - Acre-feet (Million)	Electricity (GigaWatt Hours - GWh)
2005		
2006		
2007		
2008	0.08	239
2009	0.15	479
2010	**0.23**	**718**
2011	0.31	957
2012	0.38	1,196
2013	0.46	1,436
2014	0.54	1,675
2015	0.61	1,914
2016	0.69	2,153
2017	0.77	2,393
2018	0.84	2,632
2019	0.92	2,871
2020	**1.00**	**3,111**
Full Implementation Year (2030)	1.11	3,448

Detailed Greenhouse Gas Emissions Impacts Table

Strategy: Reduction of Greenhouse Gas Emissions Through Water Use Efficiency Measures

Agency: Resources

Affected Entities: Public and private water suppliers, distributors, end-users, and wastewater treatment facilities will be directly affected by the strategy. There are approximately 460 urban water suppliers (i.e., those serving more than 3,000 customers or more than 3,000 acre-feet per year) providing water directly and indirectly to Californians. In addition, there are numerous public and private water companies serving fewer customers and lower volumes of water. There are also 180 irrigation districts and approximately 115 municipal wastewater treatment agencies with more than 200 treatment facilities.

Year	**Non-Energy GHG Impacts**	**Energy Impacts**
	CO_2e	**GWh**
2005		
2006		
2007		
2008		239
2009		479
2010		**718**
2011		957
2012		1,196
2013		1,436
2014		1,675
2015		1,914
2016		2,153
2017		2,393
2018		2,632
2019		2,871
2020		**3,111**
Full Implementation Year		3,448

Detailed Cost Table

Strategy: Reduction of Greenhouse Gas Emissions Through Water Use Efficiency Measures

Agency: Resources

Affected Entities: Public and private water suppliers, distributors, end-users, and wastewater treatment facilities will be directly affected by the strategy. There are approximately 460 urban water suppliers (i.e., those serving more than 3,000 customers or more than 3,000 acre-feet per year) providing water directly and indirectly to Californians. In addition, there are numerous public and private water companies serving fewer customers and lower volumes of water. There are also 180 irrigation districts and approximately 115 municipal wastewater treatment agencies with more than 200 treatment facilities.

Year	Cost and Savings Estimates (million dollars)		
	Annual Capital Costs	Operating Costs[1]	Annual Cost Savings
2005			
2006			
2007			
2008	$31		$41
2009	$79		$82
2010	$93		**$125**
2011	$106		$168
2012	$120		$210
2013	$134		$248
2014	$148		$291
2015	$132		$332
2016	$145		$376
2017	$159		$421
2018	$162		$467
2019	$176		$514
2020	$190		**$572**
Full Implementation Year (2030)	**$205**		**$705**
Uncertainty	+-10		+-10

1. Operating costs are included in the annual capital costs.