# Eastern Municipal Water District: A Case Study of Best-In-Class Water-Energy Programs and Practices

**A Study Conducted by:**

California Sustainability Alliance

**A Navigant Consulting Program,**
Funded by California utility customers under the auspices of the California Public Utilities Commission

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California Sustainability Alliance

*The California Sustainability Alliance* (the Alliance) is an innovative market transformation program funded by California utility customers under the auspices of the California Public Utilities Commission. The Alliance leverages action on environmental initiatives such as climate, smart land use and growth, renewable energy, waste management, water use efficiency and transportation planning to help the State of California achieve its aggressive energy efficiency goals more effectively and economically. In partnership with public and private organizations throughout California, the Alliance precipitates widespread market transformation by tackling major barriers to sustainability.

Seasoned advisors from both the public and private sectors have joined the Alliance to develop, test and deploy creative strategies to transform sectors with high energy efficiency potential. Initial pilots are targeting the greening of local government, commercial office space, sustainable community development, and recycled water. The Alliance's extensive network of environmental sustainability leaders include leading public and private entities and State agencies responsible for implementing California's landmark environmental initiatives.

The Alliance program is guided by a Steering Committee comprised of leaders in sustainability policy, programs and initiatives:

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## GLOSSARY

**Beneficial use** – Use of water that either directly or indirectly benefits people, animals or the environment.

**Brackish water** - Water containing dissolved minerals in amounts that exceed normally acceptable standards for municipal, domestic, and irrigation uses (considerably less saline than sea water).

**Distribution** – Transportation of water within an agency or utility's service territory, through a system of pipelines and pumps.

**Effluent –** Waste water or other liquid, partially or completely treated or in its natural state, flowing from a treatment plant.

**Energy Intensity –** The average amount of energy needed to transport or treat water or wastewater on a per unit basis (kilowatt hours per acre-foot of water (kWh/AF)

**Embedded Energy –** The amount of energy used to collect, convey, treat, and distribute water to end users, and the amount of energy that is used to collect and transport wastewater for treatment prior to safe discharge of the effluent in accordance with regulation.

**Groundwater** – Water that occurs beneath the land surface, stored in the pore spaces of alluvium, soil, or rock formations. It excludes soil moisture.

**Groundwater recharge** – The natural or artificial process of surface water infiltration into a groundwater basin.

**Recycled water** – Municipal, industrial, or agricultural wastewater which, as a result of treatment, is suitable for a direct beneficial use or a controlled use that would not otherwise occur.

**Reuse** – Generally used synonymously with "recycled water". Water reuse can, however, include use of any water, treated to any level (primary, secondary, tertiary) or untreated.

**Secondary treatment** –biological treatment to remove dissolved organic matter. Disinfection is usually required before discharge.

**Service territory** – The geographic area served by a water agency or utility.

**Tertiary treatment** – Wastewater treatment that includes the processes defined by primary and secondary treatment, plus an additional treatment phase, which may involve removal of additional nutrients and suspended organic matter, and/or additional disinfection.

**Wholesale deliveries** – Water that is provided to an agency or utility for resale to end users of water.

## ABBREVIATIONS AND ACRONYMS

**AF** – Acre foot (equivalent to 325,851 gallons)
**AFY** – Acre feet per year
**AQMD** – Air Quality Management District
**CO2** – Carbon Dioxide
**CPUC** – California Public Utilities Commission
**DO –** Dissolved Oxygen
**DWR** – Department of Water Resources
**EMWD –** Eastern Municipal Water District
**IOU** – Investor Owned Utility
**IRWMP** – Integrated Regional Water Management Plan
**kW** – Kilowatt
**kWh** – Kilowatt hour
**MAF** – Million acre-feet
**MG** – Million gallons
**MGD** – Million gallons per day
**MW** – Megawatt
**MWh** – Megawatt hour
**SCE** – Southern California Edison
**SCG** – Southern California Gas Company
**SWRCB** – State Water Resources Control Board
**TP** – Treatment plant
**UWMP** – Urban Water Management Plan
**WWTP** – Waste Water Treatment Plant

# EXECUTIVE SUMMARY

## Background

The California Sustainability Alliance (www.sustainca.org) is an innovative cross-cutting market transformation program designed to significantly increase and accelerate adoption of energy efficiency by packaging it with complementary "sustainability" measures (i.e., energy and water use efficiency, renewable energy, 'smart' land use and growth, waste management, and transportation management). In this manner, energy efficiency can be achieved more effectively and cost-effectively.

The Alliance program is comprised of multiple projects and programs, all dedicated towards (1) advancing and promulgating the body of sustainability best practices, tools and techniques; (2) leveraging the collective resources of all partners -- both public and private; local, state and federal; and (3) widely disseminating knowledge about emerging and existing best sustainability practices. The ultimate goal of the program is widespread holistic adoption of comprehensive sustainability throughout California.

An important aspect of the Alliance's path to market transformation is the participation of market and policy leaders in the identification of high potential opportunities, and then in the development, pilot-testing and implementation of innovative initiatives designed to overcome primary barriers to sustainability. Water is one of four high priority sectors targeted by the Alliance program.[1]

The California Public Utilities Commission completed several comprehensive studies in 2010 and 2011 that required extensive collection and compilation of historical data about the state's water-energy relationships. Members of the Alliance's Water-Energy Committee recommended complementing that body of work with:

- Detailed case studies that provide insights as to the types of water-energy benefits that could be achieved through partnerships between the state's water and energy sectors.
- Information to assist water agencies and energy utilities on how to better co-ordinate with each other to maximize energy savings.

With this advice, the Alliance conducted a study of a major water and wastewater agency in southern California to understand:

- The range of potential water-energy opportunities that could be implemented.
- The types of programs and technologies available to help the agency achieve water-energy benefits.

[1] The other three sectors targeted during the Alliance's program are green buildings, multifamily housing, and green local government.

- The primary types of barriers that will need to be overcome to increase adoption of "best" water-energy programs, practices and technologies.

## Process

Our process commenced with developing a detailed inventory of "best" policies, programs, practices and technologies for achieving water-energy benefits by water and wastewater agencies. We additionally documented state and utility programs that provide some form of assistance to water agencies to implement these best practices.

We then selected Eastern Municipal Water District (EMWD) as a case study to illustrate the types of strategies and measures California water agencies can implement. As part of the case study we documented EMWD's energy management practices and then conducted a gap assessment to understand which of the identified best practices have already been adopted by EMWD and which have not. Subsequently, we interviewed EMWD management and senior staff for additional insight into the barriers to additional opportunities. The case study and results of our gaps assessment are provided in Section 2.

As an additional gap assessment, we compared EMWD's with the state of California's objectives to lower the energy intensity of the water sector and ensure sustainable water resources. We found EMWD's actions collectively work towards achieving each of the state's five goals for the water sector as detailed in Section 3. EMWD's can be used an example to illustrate how state goals and objectives can be met by implementing a suite of measures.

Based on the results of the gap assessment and our interview with EMWD, we considered the types of changes to existing energy utility programs and broader policies that might be beneficial to increasing and accelerating adoption by the water sector. , These are summarized in our findings and recommendations in Section 4.

One of our recommendations was that utility account managers would benefit from an energy analysis and efficiency opportunity screening tool. The Alliance subsequently developed the Water/Wastewater Agency Energy Analysis and Best Practices Tool to fill this need.

## Significant Findings

- **A close relationship between water agencies and energy utilities is instrumental to achieving significant energy savings in the water sector.** EMWD has a very close relationship to its energy utilities. Operations staff at EMWD are in contact with account representatives from SCE and SCG on a regular basis. The positive relationship has lead EMWD to participate in numerous energy studies in close coordination with its energy suppliers. Close interactions like this are viewed by the Alliance as a necessity to advancing water-energy savings at other water agencies across the state.

- **A significant amount of data is available to baseline the energy use of water agency; however, availability of data is not required to identify promising energy saving opportunities.** EMWD collects and monitors data through a SCADA system. As a result, the agency has significant information to inform its energy management decisions. Collecting and analyzing this data could prove costly and time consuming for other water agencies and may present a barrier to further action. As observed by the Alliance in discussions with EMWD staff, promising energy saving opportunities can still be identified with higher level information.

- **Technology risk and the need for investment prioritization may prevent water agencies from installing certain efficiency measures.** For example, the EMWD has not installed energy efficient lighting in its administrative offices. Operations staff and the board are fully aware of the possibility and the rebates available; however the previously stated two reasons are preventing further action.

- **Newly adopted South Coast Air Quality Management District (AQMD) emissions limits may prevent EMWD and other water agencies from continuing to beneficially use biogas without significant and costly alterations to their system**. EMWD and other similar situated entities to consider retiring internal combustion engines and instead flaring the biogas with no beneficial use.

- **Integrating all energy management activities into one central location can prove challenging for water agencies.** EMWD noted fully integrating the entire staff's energy management knowledge is a difficult task. For example, SCADA and pump control programs could improve operation decisions by using data obtained from pump testing (performed by SCE). However operations staff was unsure if pump test results were being regularly integrated into the control and monitoring systems.

## Recommendations

The Alliance's recommendations are summarized below. Additional detail can be found in Section 4.

**<u>Recommendation #1: Utility account representatives should be equipped with tools to facilitate energy discussions with their water-agency customers.</u>**

Water agencies and energy utilities approach the water-energy nexus from uniquely different perspectives; facilitating discussion on common ground is necessary to advancing efficiency in the water sector.

To overcome these information barriers, the Alliance has developed the Water/Wastewater Agency Energy Analysis and Best Practices Tool as part of this project.[2] The tool is meant to provide users (both water operators and energy utility account managers) a high level view of how and where energy is being used in a selected water system and suggestions for reducing energy use. The tool overcomes information barriers by:

- Providing a customized estimate of energy use by subsystem based on user input specific to a water agency
- Providing a customized list of energy management best practice measures to consider, prioritized by relative potential to save energy and relative ease of implementation.

The tool is designed to be simple and require minimal input to generate results. Given user input the tool estimated annual energy use and energy costs associated with various sub-systems within a water agency's infrastructure. Based upon this analysis the tool provides a custom list of best practices and energy savings measures that should be explored by water agency and utility account representative to reduce energy use. Within each end use, potential measures are also ranked by savings potential and ease of implementation. The tool is illustrated and described in more detail in Section 4.

Additional engineering analysis will be required to quantify estimated energy savings and cost as well as determine any applicable rebate. Additional standardized tools should be developed for these analyses to enable ease of use and quality of calculations. Such future tools that should be developed (if not already developed) include the four listed below. These four tools would cover a large portion of possible energy efficiency savings. The requirements of these additional tools are described in more detail in Section 4.

- Pump efficiency
- Aeration system efficiency
- Leak loss detection and repair
- Stormwater infiltration reduction

**Recommendation #2: Both the energy and water industry should be encouraged to collaborate closer with each-other to advance energy efficiency in the water sector.**

[2] Available at: http://sustainca.org/tools

Energy utilities should provide their water agency customers with the skills and tools to manage their detailed energy data. Water agencies are primarily concerned with detailed water data (real time flows, storage levels, pressures); access to similarly detailed energy data (interval data, time of use data) could inundate them. Energy utilities should provide energy data in an accessible, summarized fashion (preferably though an online-platform) that provides intelligence to the agency regarding their energy use. This summarized data would allow water agencies to view trends in energy use on a system wide or individual facility basis and make more informed energy management decisions. A system like this would be especially beneficial to agencies that do not have SCADA systems. Prioritizing water agency infrastructure for smart meter retrofits would further enhance the quality and availability of energy data.

Beyond energy use data, utilities could assist water agencies in managing pump test data. Energy utilities offer pump testing for water agencies which provides valuable on single pumps. Often multiple pumps are tested while some pumps are tested multiple times over a period of years. Utilities should help their water agency customers manage this data in a system that helps water agencies prioritize the lowest efficiency, most energy intensity, or largest energy consuming pumps. Tracking data over time would help agencies identify trends and better manage their pump maintenance and repair initiatives.

Energy utility energy account managers should be trained to understand water and wastewater customers' needs and common energy saving opportunities. Most opportunities to save energy arise through regular maintenance or pre-planned construction projects. Therefore, utility account managers should encourage their water customers to review upcoming infrastructure changes and even operation and maintenance plans with utility account managers.

**Recommendation #3: Stakeholders should revisit the AQMD rules regarding biogas use in internal combustion engines.**

As a result of recent AQMD emissions rules, water agencies are considering retiring internal combustion engines powered by biogas and flaring the biogas with no beneficial use. One of the goals of AQMD policy is to "progress toward meeting clean air standards and protecting public health." However, it is possible that the current rules on biogas may actually have a negative impact on public health and the energy infrastructure. Until this issue is resolved, additional biogas investments will remain risky opportunities for water agencies.

Additional research and input from stakeholders on this topic is needed. The following are key aspects of a study that would provide value and better inform this discussion:

- Identify and characterize the number of water agencies, and number of currently operating facilities that would be adversely affected by this regulation.
- Conduct an engineering analysis to quantify the impacts of switching these facilities from biogas power to pipeline natural gas or electric power. The impact analysis should quantify the amount of on-site electricity or natural gas that would be needed to offset biogas use.
- Conduct an emissions analysis to determine the resulting GHG and pollutant emissions due to the change. The analysis should include both the emissions as a result of electric generation and the emissions that result from unutilized biogas.

Outlining these issues and providing supporting data will help stakeholders to better understand the scope of the problem and work towards a solution.

# SECTION 1: ENERGY MANAGEMENT BEST PRACTICES FOR THE WATER SECTOR

## The Water-Energy Nexus

The nation's water and energy resources are inextricably entwined. Significant energy is used by water infrastructure to pump, treat, transport, heat, cool, and recycle water. At the same time, a significant amount of water is also required to produce electricity and other energy resources. Over time, climate change has the potential to significantly affect both the availability and demand for water and energy resources. As resource managers face the challenges of meeting the demands of a growing population and economy, they also need to better understand and address this inter-relationship.

In 2003, the California Energy Commission examined the water related impacts and issues associated with the energy sector. Then in 2005, the Commission examined this relationship from the stand point of energy related impacts and issues associated with California's water sector. More recently, in 2010 the California Public Utilities Commission completed a series of studies[3] and pilot projects[4] to further explore the energy requirements of the state's water system and its use. These investigations showed that actions can be taken by program and resource managers throughout California to minimize the energy requirements of the water sector. These actions and measures include lowering the energy intensity of water resources and infrastructure, and the energy required for end-uses, predominately associated with pumping and heating.

Water infrastructure requires energy use in almost every segment and facility. The typical energy consuming segments of the water infrastructure are listed and described below.

> **Supply and Conveyance** – Reservoirs, canals, pump stations and groundwater pumps that produce and transport raw, untreated water. Examples include many of the facilities that the State Water Project and Colorado River Aqueduct operate.

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[3] Three studies by the CPUC further investigate the relationship of energy and water in the state of California. The three studies focused on energy use by the wholesale water system, energy use by retail water systems, and water use demand profiles for end use customers. Additional information and the final reports for these studies can be found at: http://www.cpuc.ca.gov/PUC/energy/Energy+Efficiency/EM+and+V/Embedded+Energy+in+Water+Studies1_and_2.htm

[4] California investor owned utilities implemented water-energy pilot projects from 2008 to 2009. The CPUC evaluated these projects in 2010 to determine energy savings. The results of the evaluation can be found in: EcoNorthwest. *Embedded Energy in Water Pilot Programs Impact Evaluation.* Prepared for the CPUC. December 2010.

**Water Treatment** – Treatment plants that purify raw water into potable water which can be used for drinking, washing, and other domestic urban uses.

**Water Distribution** – Pumps and pipelines that deliver water (raw or treated) to end-use customers of a water agency.

**Wastewater Collection** – Pumps, sewers, and pipelines that collect wastewater effluent from customers and transport it to a central wastewater treatment plant

**Wastewater Treatment** – Treatment plants that treat wastewater to required state standards prior to disposing the water into natural waterways. Wastewater treatment plant could include sludge/solids handling and biogas generation facilities.

**Recycled Water Treatment** – Treatment plants that incrementally treat wastewater to recycled water standards for re-use in non-potable end uses by customers.

**Recycled Water Distribution** – Pumps and pipelines that only distribute recycled water to end use customers.

Most retail water agencies operate only a subset of these facilities. Figure 1 outlines the above mentioned water infrastructure indicating the typical infrastructure operated by retail agencies. Figure 2 shows a breakdown of energy use in the treated water distribution process as a whole (water supply, treatment and distribution); pumping dominates, consuming 87% of the total energy use, with treatment as the second largest energy consuming process at 11%. Figure 3 shows a breakdown of energy use for wastewater treatment plants highlighting aeration and pumping as the two most energy intensive processes.

**Figure 1 - Typical Water Infrastructure Segments**

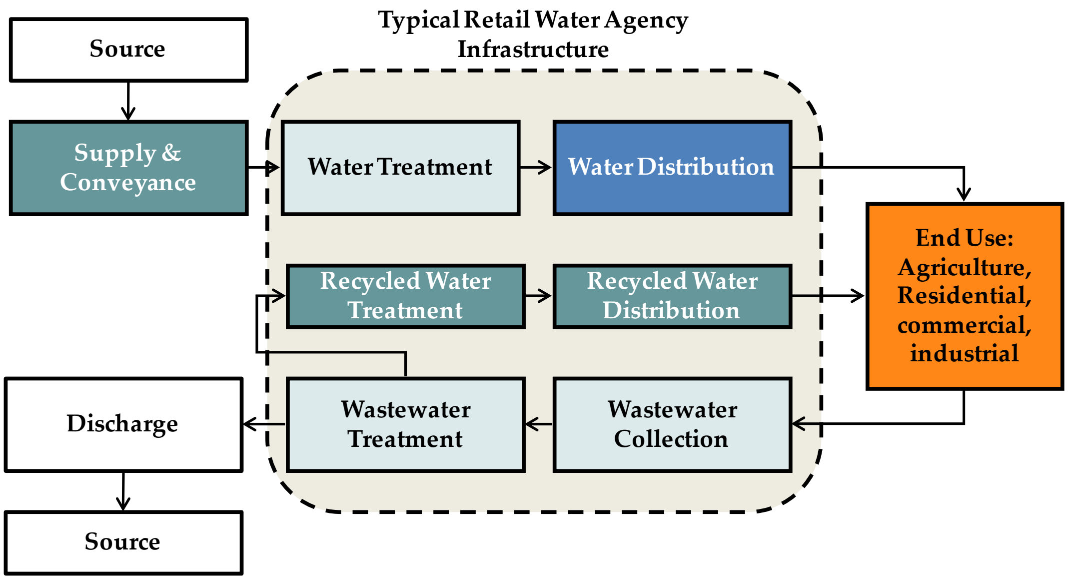
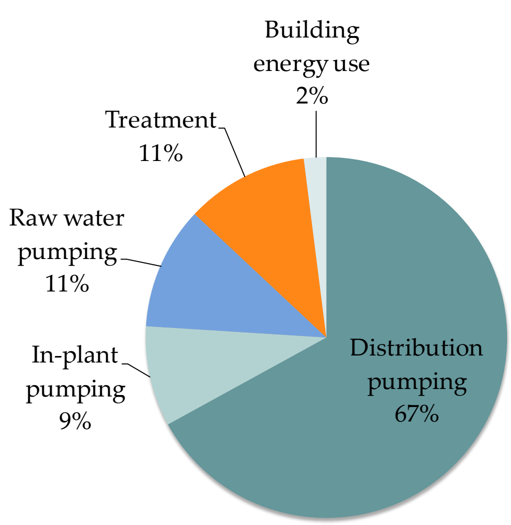
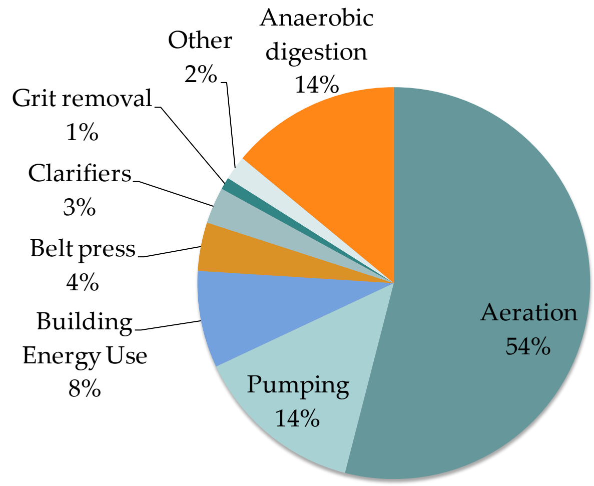



**Figure 2 - Illustrative Energy Use by Treated Water Systems**[5]




[5] Southern California Edison. 2011. http://www.sce.com/business/ems/waterandwastewater/default.htm

**Figure 3 - Illustrative Energy use for an Activated Sludge Wastewater Treatment Plant[6]**




## Energy Management Best Practices for Water Agencies

The Alliance has identified seven strategies to improving water agency energy management practices, listed in Figure 4. Multiple organizations and associations have examined and described the best practices for energy management by water agencies. The Alliance reviewed these best practice guide-books and then developed the seven strategies listed Figure 4.[7]

[6] Science Applications International Corporation (SAIC). *Water and Wastewater Energy Best Practice Guidebook.* Focus on Energy. 2006.

[7] The Alliance reviewed the following sources:

Water Environment Research Foundation. *Energy Efficiency in Wastewater Treatment in North America: A Compendium of Best Practices and Case Studies of Novel Approaches*. 2010

Water Environment Research Foundation. *Energy Efficiency in the Water Industry: A Compendium of Best Practices and Case Studies*. 2010

UK Water Industry Research Ltd. *Energy Efficiency in the Water Industry: A Compendium of Best Practices and Case Studies*. 2010

Water Environment Research Foundation. *Energy Efficiency in Value Engineering: Barriers and Pathways*. 2010

London Economics. *Competition in Upstream Sewage and Sludge Markets*. 2010

Stillwell, Hoppock, and, Webber. *State of Science Report: Energy and Resource Recovery from Sludge*. 2008

NYSERDA. *Statewide Assessment of Energy Use by the Municipal Water and Wastewater Sector*. 2008

AWWARF/ NYSERDA. *Energy Index Development for Benchmarking Water and Wastewater Utilities*. 2007

Focus on Energy, SAIC. *Water and Wastewater Energy Best Practice Guidebook*. 2006

**Figure 4 - Best Practice Strategies for Water-Energy Management**

**Internal Strategies**

- Reduce energy consumption within water and wastewater treatment and distribution systems
- Improve energy management systems
- Increase ability to participate in demand response
- Self-produce energy (electricity & gas) as a by-product of systems operations
- Reduce energy intensity of water supplies

**External Strategies**

- Reduce Embedded Energy through Potable Water Conservation
- Self-Produce Clean Energy

The best practice strategies are meant to guide internal water-agency policies and decision making towards more sustainable and energy efficient operation. Table 1 expands on these strategies by providing illustrative measures that can be implemented to achieve each best practice strategy. The illustrative measures listed are those that would most broadly apply to any water agency.

**Table 1 - Summary of Best Practices for Water Agencies**

| | Best Practice Strategy | Illustrative Measures |
|---|---|---|
| Internal | Reduce Energy Consumption within Water and Wastewater Treatment and Distribution Systems | • Optimize pump efficiency (high efficiency motors, pumps & VFDs; regular testing and O&M; reduction of friction in pipes & pumps)<br>• Optimize aeration system efficiency (high efficiency blowers, fine bubble aeration, DO Control)<br>• Install efficient lighting, HVAC, other building systems<br>• Reduce wet weather pumping & treatment energy by reducing storm water infiltration<br>• Reduce heat losses & recover/productively use waste heat<br>• Retrofit systems for new cost-effective efficiency technologies |
| | Improve Energy Management Systems | • Monitor/manage energy consumption at the sub-system and/or driver level (e.g. use of SCADA)<br>• Continually re-balance systems and processes to maximize efficiency |
| | Increase Ability to Participate in Demand Response | • Integrate flexibility into systems design and operations to enable load shifting<br>• Integrate storage (water, wastewater, electric &/or gas) where beneficial to minimize on-peak electricity consumption |
| | Self-Produce Energy (Electricity & Gas) as a By-Product of Systems Operations | • Produce electricity through transport of water & wastewater (e.g., in-conduit hydropower)<br>• Increase production & use of biogas/bio-methane from wastewater treatment (anaerobic digestion, co-digestion with other bio-wastes, upstream collection of FOG) |
| | Reduce Energy Intensity of Water Supplies | • Reduce energy use for water transport<br>• Minimize use of imported water supplies<br>• Groundwater Recharge to develop and maintain local supplies<br>• Increase development & use of low energy intensity local water supplies (recycled, storm water, grey water)<br>• Reduce water losses |
| External | Reduce Embedded Energy through Potable Water Conservation | • Implement water conservation programs<br>• Reduce leaks & losses<br>• Decrease use of potable water for non-potable uses<br>• Storm water capture |
| | Self-Produce Clean Energy | • Develop wind, solar, biomass, biogas, CHP and other clean energy resources not produced as a by-product of water and wastewater operations; may be for direct use and/or for sales of surplus energy |

As shown in Figure 2 and Figure 3, pumping accounts for a significant portion of energy use in water and wastewater treatment and distribution segments of the water use cycle; aeration is the largest consumer of energy in wastewater treatment plants. The Alliance prepared additional descriptions of several of the best practices for pumping and aeration end uses that can be found on the Alliance website.[8] This appendix contains additional detail on select measures, data on cost and expected savings, and case studies from around the U.S. Pumping best practices include mechanical refurbishment and polymer coating to reduce friction. Combined these pump best practices can reduce pump energy use by 3-25% (depending on pump condition). Aeration best practices include fine bubble aeration, high efficiency blowers, and dissolved oxygen control. When implemented together, these aeration technologies could decrease wastewater treatment plant energy use by 17-49%

In addition to the best practices listed in Table 1, the Alliance examined several emerging technology and management practices for the water and wastewater sector. These include: fuel cells, leak loss detection and repair, co-digestion of bio-waste, distributed wastewater recycling, and advanced biogas microorganisms. These emerging technologies could assist water agencies achieve several of the best practice strategies, as indicated in Table 2. A summary description of these technologies and practices can also be found on the Alliance website.[9]

[8] http://sustainca.org/programs/water_energy/measures/select_best_practices_pumps
[9] http://sustainca.org/programs/water_energy/measures

**Table 2 - Emerging Technology Applicability to Best Practice Strategies**

| | | | Emerging Technologies | | | | |
|---|---|---|---|---|---|---|---|
| | | | Fuel cells | Leak loss detection and repair | Co-digestion of bio-waste | Distributed wastewater recycling | Advanced biogas microorganisms |
| Best Practice Strategy | Internal | Reduce Energy Consumption within Water and Wastewater Treatment and Distribution Systems | | | | X | |
| | | Improve Energy Management Systems | | | | | |
| | | Increase Ability to Participate in Demand Response | | | | | |
| | | Self-Produce Energy (Electricity & Gas) as a By-Product of Systems Operations | X | | X | | X |
| | | Reduce Energy Intensity of Water Supplies | | X | | X | |
| | External | Reduce Embedded Energy through Potable Water Conservation | | X | | X | |
| | | Self-Produce Clean Energy | X | | | | |

## Implementing Energy Management Best Practices

Numerous utility and state programs are available to assist water-agencies in implementing several of the previously mentioned best practice strategies. These programs include:

- **Southern California Gas Energy Efficiency Calculated Incentive Program**: Offers rebates on qualifying gas equipment including: biogas generation, high efficiency burners, energy management systems, high efficiency boilers, and other equipment. [10]
- **Southern California Edison Express and Customized Solutions Programs:** Offers rebates on qualifying electric equipment including: premium efficiency motors, lighting, motors and pumps controls, VSDs, SCADA systems, fine

[10] Additional information available at: http://www.socalgas.com/for-your-business/rebates/equipment-incentives.shtml?webSyncID=d778bc2c-b46c-e795-d892-3bb1adcc9105&sessionGUID=c514de30-9209-146e-5a60-61559dcc3eed

bubble aeration for wastewater treatment, right-sizing pumps, and other process controls. [11,12]

- **Agriculture Pumping Services**: Both SCE and SCG provide free tests of water pumps to determine efficiency and recommend potential improvements. [13]
- **Demand Side Management Program:** SCE offers financial incentives for electrical load reducing equipment. [14]
- **California Solar Initiative:** Managed by the California Public Utilities Commission, and administered by California's Investor Owned Utilities, this program provides funding for qualifying solar installations. [15]
- **Self-Generation Incentive Program:** Provides financial incentives for the installation of new, qualifying self-generation equipment (including fuel cells) installed to meet all or a portion of the electric energy needs of a facility.[16]
- **Water Recycling Funding Program:** Provides technical and financial assistance from the State Water Resources Control Board to increase reuse of treated municipal wastewater for beneficial uses.[17]

However, these traditional routes of assistance may not be enough to influence change in the water sector.

California's investor-owned utilities offer several types of energy efficiency programs. Most incentives are provided through prescriptive utility programs that offer incentives for "typical" measures – e.g., standard energy efficiency retrofits such as high efficiency motors and efficient lighting - that lend them well to estimated or "deemed" energy savings based on average operating experiences. However, these types of "deemed" measures omit innovative approaches to modifying water and wastewater systems and operations that may have high potential for energy savings. Consequently, a limited number of water agencies participate in utility prescriptive rebate programs.

The California Public Utilities Commission (CPUC) and investor-owned energy utilities have long recognized that there are other types of important energy savings

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[11] Additional information available at: http://asset.sce.com/Documents/Business%20-%20Energy%20Management%20Solutions/100721_Water.pdf

[12] Additional information available at: http://asset.sce.com/Documents/Business%20-%20Energy%20Management%20Solutions/100721_Water.pdf

[13] Additional information available at: http://www.sce.com/b-rs/agriculture/pumping-services/pumping-services.htm

[14] Additional information available at: http://asset.sce.com/Documents/Business%20-%20Energy%20Management%20Solutions/100721_Water.pdf

[15] Additional information available at: http://www.sce.com/solarleadership/gosolar/california-solar-initiative/about.htm

[16] Additional information available at: http://www.socalgas.com/innovation/self-generation/index.shtml?webSyncID=d778bc2c-b46c-e795-d892-3bb1adcc9105&sessionGUID=c514de30-9209-146e-5a60-61559dcc3eed

[17] Additional information available at: http://www.swrcb.ca.gov/water_issues/programs/grants_loans/water_recycling/

opportunities that are unique to a system, facility or process and cannot be readily catalogued and accorded value on a "deemed" basis. Therefore, the CPUC authorized establishment of a special category of energy incentives that could be customized for unique systems and facilities, typically for large industrial customers, using engineering studies and assessments. The mechanisms for paying such customized incentives reside within so-called "Standard Performance Contracts" (SPCs) in which the incentive levels are standardized, but the measures themselves are customizable.

Water agencies are prime candidates for Standard Performance Contracts due to their use of customized equipment and systems. Utility rebates for customized upgrades would increase the financial attractiveness of energy efficiency for water utilities. Such illustrative best practice measures (Table 1) that would benefit from SPCs include (but are not limited to):

- Reduce friction in pipes and pumps
- Reduce heat losses and recover/productively use waste heat
- Reduce wet weather pumping and treatment energy by reducing storm water infiltration
- Reduce water losses
- Use of pump monitors and controls

While SPCs would be customized to each water-agency, the practices and technologies that would be the best candidates for SPCs are applicable across the majority of water agencies in California.

California energy utilities may benefit from examining water-sector utility programs from around the country. The Alliance searched for such programs. While many utilities claim to cater specific programs to the water sector, only one program stood out by developing specific assistance tools for water agencies: New York State Energy Research and Development Authority's (NYSERDA) Municipal Water and Wastewater Efficiency Initiative.[18] NYSERDA tools and resources include:

- **Self-Help Tools.** The Water Checklist and Wastewater Checklist have been designed to assist smaller facilities with identifying opportunities for energy efficient improvements.
- **Benchmarking Tools.** Helps facilities track and monitor the energy trends and plant performance.
- **Payback Analysis Tool.** Assists facilities with the life cycle cost comparison of different equipment replacement alternatives.

[18] Additional information available at: http://www.nyserda.com/programs/Environment/muniwaterwwt.asp

- **Case Studies.** NYSERDA developed numerous case studies to help water and wastewater facilities understand how NYSERDA programs can assist with implementing energy efficiency improvements.

# SECTION 2: EASTERN MUNICIPAL WATER DISTRICT CASE STUDY

The Eastern Municipal Water District (EMWD) was chosen as a case study to illustrate the types of strategies and measures California water agencies can implement. EMWD has a history of progressive energy management practices and a drive to continually improve its system.

## Service Territory and Infrastructure

EMWD is a public agency that was formed in 1950; it provides or supplements supplies to over 100,000 customers (a population of more than 750,000 people over 542 square miles). EMWD provides imported water from Metropolitan Water District of Southern California (MWD) and pumps groundwater to meet demands of customers. In addition, EMWD performs desalination of some marginal quality groundwater, filtration of surface water supplies, and collection and treatment of wastewater

EMWD is located in a semi-arid area that is characterized by hot, dry summers (average maximum temperatures in the high 90s °F) and cooler winters (average lows into the 30s °F). The average rainfall is between 10 and 11 inches with rainfall typically occurring between December and March. The area experiences a wide range in rainfall including multiple year droughts.

Population grew significantly in EMWD's service territory in the last 30 years. During the mid-1980s through 1990, population growth exceeded 10% per year. In the early 1990s growth declined because of the economic recession. In the late 1990s, growth again was high leading to challenges for EMWD to develop new sources of supply and provide new facilities and infrastructure to provide water supplies to the new customers. Growth slowed between 2005 and 2010. Since 1990 the population has increased by 350,000. Population is projected to increase by another 400,000 over the next 25 years.[19]

Table 3 summarizes the infrastructure operated by EMWD. The water facilities include infrastructure for treatment, storage, distribution, wastewater collection, and wastewater treatment.

[19] EMWD. 2010 *Urban Water Management Plan.* 2011 http://www.emwd.org/index.aspx?page=281

**Table 3 - EMWD Infrastructure Summary**

| | |
|---|---|
| Miles of Distribution Piping | 2,421 |
| Miles of Wastewater Collection Pipes | 1,727 |
| Number of Water Pumping Plants | 84 |
| Number of Sewer Lift Stations | 46 |
| Number of Plants: | |
| *Treatment* | 2 |
| *Desalination (Brackish)* | 2 |
| *Water Reclamation* | 4 |
| Groundwater Wells | 18 |
| System-wide Treated Water Storage Capacity: | 193 MG |
| Recycled Water Production Capacity | 60 MGD |

Sources:

Building the Future, the Story of the Eastern Municipal Water District
EMWD Urban Water Management Plan.[20]
EMWD Insights [21]
Discussions with EMWD Staff

## Comparison of EMWD Energy Management Strategies to Best Practices

For years, EMWD has pursued cost-effective projects to provide safe and reliable water and wastewater management services to its community. Their primary strategies have included energy efficiency measures as well as generation of biogas and energy. Table 4 below indicates the best practice strategies and measures that have been implemented by EMWD. Following the table are details regarding specific actions the EMWD has taken.

[20] EMWD. 2010 *Urban Water Management Plan.* 2011 http://www.emwd.org/news/pubs_uwmp.html
[21] EMWD. *EMWD Insights*, 2011. http://www.emwd.org/news/Insights/Insights9-11.pdf

**Table 4 - Summary or Best Practices Strategies Implemented by EMWD**

| Best Practice Strategy | | Illustrative Measures |
|---|---|---|
| Internal | Reduce Energy Consumption within Water and Wastewater Treatment and Distribution Systems | • **Optimize pump efficiency (high efficiency motors, pumps & VFDs; regular testing and O&M; reduction of friction in pipes & pumps)**<br>• **Optimize aeration system efficiency (high efficiency blowers, fine bubble aeration, DO Control)**<br>• Install efficient lighting, HVAC, other building systems<br>• **Reduce wet weather pumping & treatment energy by reducing storm water infiltration**<br>• **Reduce heat losses & recover/productively use waste heat**<br>• Retrofit systems for new cost-effective efficiency technologies |
| | Improve Energy Management Systems | • **Monitor/manage energy consumption at the sub-system and/or driver level (e.g. use of SCADA)**<br>• **Continually re-balance systems and processes to maximize efficiency** |
| | Increase Ability to Participate in Demand Response | • **Integrate flexibility into systems design and operations to enable load shifting**<br>• Integrate storage (water, wastewater, electric &/or gas) where beneficial to minimize on-peak electricity consumption |
| | Self-Produce Energy (Electricity & Gas) as a By-Product of Systems Operations | • Produce electricity through transport of water & wastewater (e.g., in-conduit hydropower)<br>• **Increase production & use of biogas/bio-methane from wastewater treatment (anaerobic digestion, co-digestion with other bio-wastes, upstream collection of FOG)** |
| | Reduce Energy Intensity of Water Supplies | • **Reduce energy use for water transport**<br>• **Minimize use of imported water supplies**<br>• **Groundwater Recharge to develop and maintain local supplies**<br>• **Increase development & use of low energy intensity local water supplies (recycled, storm water, grey water)**<br>• **Reduce water losses** |
| External | Reduce Embedded Energy through Potable Water Conservation | • **Implement water conservation programs**<br>• **Reduce leaks & losses**<br>• **Decrease use of potable water for non-potable uses**<br>• Storm water capture |
| | Self-Produce Clean Energy | • **Develop wind, solar, biomass, biogas, CHP and other clean energy resources not produced as a by-product of water and wastewater operations; may be for direct use and/or for sales of surplus energy** |

**Bold Text - Measures implemented by EMWD**

**Reduce Energy Consumption within Water and Wastewater Treatment and Distribution Systems**

- **Pump Testing** – EMWD continually works with SCE to regularly test the performance of its pumps. Testing ensures they are operating efficiently and can identify maintenance issues promptly. EMWD uses high efficiency motors and pumps as well as VFDs where possible. EMWD has been participating in SCE's pump test program for more than 15 years.

- **High Efficiency Aeration Systems** – All treatment plants use fine bubble aerators, dissolved oxygen (DO) controllers, and either digester gas-powered blowers or high-efficiency high-speed electric blowers. Combined these technologies can reduce aeration system energy use 30-45%; more information can be found on the Alliance website.[22] Local air quality management rules restrict the turndown ratio of EMWD's gas blowers reducing their range of speed. Additional energy savings could be achieved by switching to electric blowers that use variable speed drives.

- **Reducing Storm Water Infiltration** – EMWD's programs to reduce stormwater infiltration have reduced sewer pumping and wastewater treatment energy use. EMWD detects infiltration via sewer sampling and water flow analysis. When know infiltrations are detected, EMWD repairs seals or replaces whole sections of pipe accordingly.

- **Recover/Productively Use Waste Heat** – EMWD implements heat recovery in multiple locations to reduce overall energy use. Waste heat is recovered from fuel cells and is used to heat anaerobic digesters. The digesters would otherwise be heated using pipeline natural gas or methane gas from the digesters. Waste heat is also recovered from microturbines at the EMWD's headquarters. The microturbines provide electricity to the building while waste heat is used to drive an absorption chiller to provide cooling to the building.

**Improve Energy Management Systems**

- **Energy Optimization Program** – EMWD uses a Supervisory Control and Data Acquisition (SCADA) system to monitor its energy use. Additionally the Derceto Energy Optimization Program provides intelligent economic dispatch of pumps throughout the water distribution system. The program is designed to reduce energy savings by shifting usage from peak demand times to off-peak and mid-peak times and prioritize high efficiency pumps without any decreases in water

[22] Available at: http://sustainca.org/programs/water_energy/measures/aeration_system_improvement

delivery.[23] The system optimizes operations based on energy rates, water demand, storage levels, and pump efficiency parameters.

**Increase Ability to Participate in Demand Response**

- **Demand Response** - EMWD spends more than $10 million a year on energy costs. In 2007, the district enrolled in EnerNOC's Clean Green California demand response (DR) program. Currently EMWD has enrolled multiple facilities in the program pledging a total of 3.7 MW of its demand in exchange incentive payments. Shutting down major electricity-using equipment (e.g., pumps) at multiple facilities reduces demand when needed. Participating in the program saves approximately $200,000 in energy costs a year. EMWD is perusing an opportunity to further expand its DR programs by potentially partnering with Honeywell to install control devices to reduce energy usage during times of peak demand.[24] In addition to these third party partnerships, EMWD enrolled multiple facilities in SCE's interruptible rate class. These facilities total 8.5 MW of demand; controlling their use during critical peak periods saves EMWD $350,000 in energy costs a year.

- **Dual Fuel Pump Stations** – EMWD is one of the largest operators of stationary engines in California. More than 20 of EMWD's pump stations are "dual fuel" – featuring gas engine driven pumps operating alongside electric pumps. The gas pumps are used during on-peak times to reduce electric use while continuing to meet water demand.

- **System Consolidation** - Taking advantages of economies of scale the Washington booster station allows EMWD to reduce energy and treatment costs by consolidating water supplies from several wells into one facility that can be operated when rates are lower.[25] The pump station is a duel-fuel station.

**Self-Produce Energy (Electricity & Gas) as a By-Product of Systems Operations**

- **Cogeneration** – Approximately 600,000 cubic feet of digester gas is produced daily at EMWD's four treatment/reclamation facilities using anaerobic digesters. Gas at two facilities is captured and used to generate as much as 1,400 kW of electricity from five fuel cells, cutting greenhouse gases by more than 10,600 tons annually and saving EMWD an estimated $1.6 million in energy costs per year. Waste heat from the fuel cells are used to heat anaerobic digesters further saving

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[23] Additional information available at: http://www.derceto.com/Case-studies/Fact-sheets/EMWD

[24] Additional information available at: http://www.emwd.org/modules/showdocument.aspx?documentid=1417

[25] Additional information available at: http://www.emwd.org/modules/showdocument.aspx?documentid=1427

energy. At EMWD's remaining two treatment facilities, digester gas is used to drive gas engines to power aeration system offsetting energy purchases.[26]

- **<u>Distributed Generation: Microturbines</u>** – Eight 60 kW microturbines provide power to EMWD's headquarters. The microturbines use pipeline natural gas to generate electricity and supply approximately 50% of the building's peak electric demand. Additionally EMWD recovers waste heat from the microturbines to drive a 150 ton absorption chiller that provides space cooling for the building.

- **<u>FOG Waste to Energy</u>** – EMWD is investigating the possibilities of capturing fats, oil, and grease (FOG) waste generated by restaurants and food processing upstream of its wastewater treatment plants for the production of B100-quality biodiesel. In addition to lowering the costs of treatment at their facilities, EMWD expects this waste to provide a valuable renewable fuel. EMWD is considering collecting the FOG to produce a feedstock that can be exchanged for diesel fuel or producing biodiesel themselves.

- **<u>Co-Digestion of Bio-waste</u>** – EMWD is in discussions with a local food processor to use the food processor's bio-waste as additional feedstock for EMWD's biogas digesters. This could increase biogas and on-site electricity production or provide an opportunity to sell surplus biogas to SCG or other parties. Co-digestion is estimated to increase biogas production 10-40%; more information can be found on the Alliance website.[27]

**Reduce Energy Intensity of Water Supplies**

- **<u>Wastewater Recycling</u>** - All wastewater in EMWD's service area undergoes tertiary treatment and meets recycled water standards (approximately 45 MGD). By recycling its wastewater, EMWD significantly expands its local supplies and reduces demand on more energy intensive imported resources. Currently 75% of recycled water is put to beneficial use for agriculture uses and landscape irrigation for golf courses, parks, cemeteries, freeway landscapes, playgrounds and schoolyards.[28] Additionally, EMWD uses recycled water to maintain a constructed wetland for environmental enhancement creating beneficial wildlife habitat and recreation opportunities.[29]

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[26] Additional information available at: http://www.emwd.org/modules/showdocument.aspx?documentid=1420

[27] Available at: http://sustainca.org/programs/water_energy/measures/co_digestion_bio_waste

[28] Additional information available at: http://www.emwd.org/index.aspx?page=149

[29] Additional information available at: http://www.emwd.org/modules/showdocument.aspx?documentid=1428

- **Desalination Program** - To reduce demand on imported water and become more self-sufficient, EMWD desalinates approximately 6,500 acre-feet of otherwise unusable brackish groundwater (with a maximum capacity of up to 12,000 acre-feet). EMWD's Desalination Program assists with salinity management in the area to allow for the expansion of water recycling and the protection of high-quality ground water.[30] Brackish water desalination is less energy intensive than importing water.

**Reduce Embedded Energy through Potable Water Conservation**

- **Customer Conservation and Efficiency Programs** - EMWD was one of the original signatories of the California Urban Water Conservation Council Memorandum of Understanding and implements 14 conservation Best Management Practices for commercial and residential indoor and landscape water use. EMWD overall demand peaked in 2007 at more than 100,000 AF before declining though 2010 to below 80,000 AF. This demand reduction is attributed to tiered billing rates, water shortage and conservation programs, and California's economic down-turn. To meet the requirements of the California Water Conservation Act of 2009, EMWD will continue to implement aggressive water conservation and efficiency measures to ensure it achieves the 20 percent per capita reduction in water use by 2020. This will require a reduction in per capita consumption from 212 gallons per day to 184 gallons per day. [31]

- **Leak Detection Program** – EMWD has a long-standing leak detection program. In its 2010 Urban Water Management Plan, EMWD estimated its water loss in its potable water system to be approximately 7%. More recently, the district completed a study in collaboration with Southern California Edison, in which the district confirmed that its system is sound and the districts system-related water losses are less than 7% as originally estimated.

**Self-Produce Clean Energy**

- **Solar Power at Headquarters** – EMWD is developing solar generation at its headquarters building in Perris. A 500 kW AC system is planned to begin operation in mid-2013 alongside existing microturbines supplying a portion of the building's energy use.

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[30] Additional information available at: http://www.emwd.org/modules/showdocument.aspx?documentid=1432

[31] Additional information available at: http://www.emwd.org/index.aspx?page=281

## Opportunities to Improve EMWD Energy Management Strategies

While EMWD is a progressive agency there are still several best practice strategies that have not yet been implemented. When Alliance staff discussed these opportunities with EMWD, it found that often barriers prevented the agency from moving forward with these actions.

**Polymer Coating Internal Pump Surfaces** - In discussions with EMWD, Alliance staff pointed EMWD to the possible pump efficiency improvements from internal surface coating. EMWD will now consider this opportunity in its pump maintenance programs. This measure would be a prime candidate for a standard performance contract due to its custom nature.

Over time, pumps experience a decrease in efficiency due to erosion, corrosion, cavitation, and deposits that increase friction on the internal surfaces of the pump.[32] The increased resistance to flow decreases pump efficiency. This natural degradation of pump performance can be reversed and halted with the use of pump coating.

Pump coating consists of a two-step process. Internal surfaces of the pump are first sandblasted to remove build-up and to smooth surfaces. Then, polymer or epoxy-based coating is painted, or sometimes sprayed, onto the wet contact areas of a pump which increases energy efficiency as well as extends the life of the pump without significantly changing the internal dimensions. The coating is 10 to 20 times smoother than polished stainless steel which reduces friction losses effectively improving energy efficiency[33]. The coating also protects the inside surfaces of the pump from erosion and corrosion.

Pump coating is a cost effective way to improve efficiency. Depending on the pump size, total installation, including sandblasting, coating, filler, and labor, results in an installed cost between $1,200 and $13,000 per pump. Coating improves efficiency in used and old pumps by 5% to 30% (depending heavily on the condition of the pump. Even coating a brand new pump can increase efficiency 2-3% although one study demonstrated a 7% increase.[34] Smaller pumps receive the most efficiency benefit due to the higher surface area to volume ratio.

Additional information on pump coating can be found on the Alliance website.[35]

**In-Stream And In-Pipeline Hydropower Generation** - In an effort to maximize all renewable power options in their system, EMWD is exploring the feasibility of producing electricity through in-conduit hydropower systems. EWMD conducted a

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[32] Maillard, Jeremie. *Coating Technology Increases Pump Performance*. Improving Pump Performance. Runcorn, UK. June 2008.
[33] Xia, William. *Polymer Coating of Pumps Boosts Efficiency Performance*. WaterWorld. January 2002.
[34] Millard, Jeremie. *Coating Technology Increases Pump Performance.* Belzona. June 2008.
[35] Available at: http://sustainca.org/programs/water_energy/measures/select_best_practices_pumps

feasibility study at the Perris potable water plant to generate power from raw water delivered by the Metropolitan Water District of Southern California (MWD). The location features low flow and low head; however, EMWD believes a 60 kW generator could be installed.

**<u>Building HVAC and Lighting Measures</u>** - Best practices to reduce building energy use include high efficiency lighting upgrades, motion/occupancy sensor installation and scheduling, and high efficiency HVAC equipment. EWMD recently completed a lighting audit of its headquarters and is preparing to retrofit its indoor lighting systems. However, priority for energy management and capital improvement is generally placed on water infrastructure.

**<u>Biogas Clean-Up to Pipeline Quality</u> -** New air quality rules may prohibit EMWD from burning biogas in several of its engines. Compliance with the new rules would require cost prohibitive emissions controls. As a result, EMWD is exploring technologies that can purify (clean) the biogas to pipeline quality so it can be sold directly to potential customers (initial discussions have already begun with a natural gas developer) or to the Southern California Gas Company. However, uncertainty surrounding upcoming air quality rules may affect this project.

**<u>Storage Management to Maximize Off-Peak Treatment and Pumping</u>** - EMWD is aware of the opportunities to manage storage in order to reduce system energy use. EMWD's system is already taking advantage of this practice to the capacity that it can. Every water agency is unique and in the case of EMWD, building additional storage for the sole purpose of energy management is not cost effective.

**<u>Automatic Dissolved Oxygen (DO) Control</u>** - EMWD currently uses automatic DO controllers in its wastewater treatment plants. However, the gas blowers used in aeration processes do not allow the full savings from DO control to be realized. DO control saves the most energy when coupled with variable speed electric blowers. EMWD's gas blowers have less capacity to adjust their speed and output due to AQMD restrictions. Switching to electric blowers could save additional energy. However, the change could be expensive and may not be eligible for utility rebates as it may be viewed as a fuel switching measure.

# SECTION 3: MEETING STATE WATER-ENERGY GOALS

Many of EMWD's actions are consistent with state of California's objectives to lower the energy intensity of the water sector and ensure sustainable water resources. EMWD's actions can be used an example to illustrate how these goals and objectives can be met by implementing a suite of measures. EMWD's actions collectively work towards achieving each of the state's five goals for the water sector as later illustrated in Table 5. The state goals for the water sector have been formed as a result of Assembly Bill (AB) 32.

To address the potential effects of greenhouse gases (GHGs), the State legislature passed and the governor signed, Assembly Bill (AB) 32, the landmark California Global Warming Solutions Act of 2006. This law established a comprehensive program of regulatory and market mechanisms to achieve real, quantifiable, cost-effective reductions in GHGs[36]. To implement the requirements of AB 32, the California Environmental Protection Agency coordinated with other state agencies forming the Climate Action Team (CAT). AB 32 required the California Air Resources Board (ARB) to develop the Climate Change Scoping Plan (2008) that defined actions required to reduce GHGs. ARB developed this plan with input from the CAT and its subgroups. Because California's water system and use have such a significant demand on energy resources and thus contribute to the production of GHGs, key measures and strategies were developed to target reductions in associated energy demand and thus reduce GHGs.

The Water-Energy (WET-CAT) Subgroup[37] of the CAT was tasked with coordinating the study of greenhouse gas effects on California's water supply system and recommend measures that reduced GHGs associated with California's water system and water-related uses. Under leadership of the Department of Water Resources and State Water Resources Control Board, state agencies assessed the energy associated with California's water infrastructure and associated GHGs as well as reductions that could arising out of water supply alternatives, such as water recycling and conservation.

The Climate Change Scoping Plan (2008) contained five key recommended measures to reduce GHGs associated with water in California.[38] The measures include:

- (W-1) Water Use Efficiency - Expand water conservation and efficiency programs to maximize savings

[36] The updated forecast of 507 MMTCO2e is referred to as the AB 32 2020 baseline. Reduction of an estimated 80 MMTCO2e are necessary to reduce statewide emissions to the AB 32 Target of 427 MMTCO2e by 2020.
[37] http://climatechange.ca.gov/wetcat/index.html
[38] Appendix C, Section 6, Water; please note the 6th strategy related to funding.

- (W-2) Water Recycling - Require water recycling plans at wastewater treatment plants and encourage substitution of potable water with recycled and brackish water when appropriate
- (W-3) Water System Energy Efficiency – Implement cost effective energy efficiency measures in water system infrastructure projects
- (W-4) Reuse Urban Runoff - Capture urban runoff, discharged water, and leaking water from urban sources for reuse in local applications such as irrigation
- (W-5) Increase Renewable Energy Production - Develop renewable projects that can be co-located with existing water system infrastructure such as biogas and solar facilities.

Since the release of the Scoping Plan, measures related to climate adaptation have also been explored. The California Department of Water Resources (DWR) now requires that energy and GHGs be addressed in local water agencies' urban water management plans (UWMP) and integrated regional water management plants (IRWMP). Generally overseeing the implementation of the recommended measures, the WET-CAT agencies[39] have been working with local agencies and other stakeholders on several programs and proceedings to ensure desired reductions in GHGs are achieved.

As early adopters of innovative and economical practices, EMWD's actions are consistent with the WET-CAT measures that as shown in Table 5.

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[39] Several efforts are underway by the WETCAT agencies to implement these measures. These include:

- Landscape irrigation equipment: www.energy.ca.gov/appliances/irrigation/
- Twenty percent reduction in per capita consumption of water by 2020. http://www.waterboards.ca.gov/water_issues/hot_topics/20x2020/index.shtml
- Recycled water development: http://www.waterboards.ca.gov/water_issues/programs/water_recycling_policy/index.shtml
- Water infrastructure in-system improvements: http://www.energy.ca.gov/recovery/blockgrant.html and http://www.energy.ca.gov/process/water/index.html
- Increasing renewable energy production and combined heat and power (CHP) development as part of the 2009 Integrated Energy Policy Report proceeding: http://www.energy.ca.gov/2009_energypolicy/
- Reuse of urban runoff: http://www.waterboards.ca.gov/water_issues/programs/low_impact_development/index.shtml

**Table 5 - EMWD Actions Align with WET-CAT Goals**

| WET-CAT Goals | EMWD Actions |
|---|---|
| **(W-1) Water End Use Efficiency** | • Customer Conservation and Efficiency Programs<br>• Leak Detection Program |
| **(W-2) Water Recycling** | • Wastewater Recycling |
| **(W-3) Water System Energy Efficiency** | • Pump Testing<br>• High Efficiency Aeration Systems<br>• Energy Optimization Program<br>• Demand Response<br>• System Consolidation<br>• Leak Detection Program |
| **(W-4) Reuse Urban Runoff** | • Use of recycled water for wetlands and environmental enhancement |
| **(W-5) Increase Renewable Energy Production** | • Cogeneration Projects<br>• Renewable Fuel Development<br>• FOG Waste to Energy<br>• Co-Digestion of Bio-waste<br>• Solar Generation at Headquarters |

# SECTION 4: FINDINGS AND RECOMMENDATIONS

The Eastern Municipal Water District is one of the more progressive water agencies in California with regards to energy management. EMWD has engaged in multiple activities that align with the best practices researched by the Alliance and the State of California's goals for reducing the energy and environmental impact of the state's water infrastructure. Studying EMWD's experiences and interviewing its management has led the Alliance to several key findings and recommendations.

## Findings

**A close relationship between water agencies and energy utilities is instrumental to achieving significant energy savings in the water sector.** EMWD has a very close relationship to its energy utilities (Southern California Gas and Southern California Edison). Operations staff at EMWD are in contact with account representatives from SCE and SCG on a regular basis. The Alliance sees this as a strong driving force behind EMWD's progressive energy management strategies. The positive relationship has lead EMWD to participate in numerous energy studies in close coordination with its energy suppliers. Close interactions like this are viewed by the Alliance as a necessity to advancing water-energy savings at other water agencies across the state. Several anecdotal examples provided by other water-energy experts reveal the opposite is true as well: when there is little interaction between water agency staff and energy utility staff, little done to reduce energy use at the water agency.

**A significant amount of data is available to baseline the energy use of water agency; however, availability of data is not required to identify promising energy saving opportunities.** EMWD collects and monitors data through a SCADA system. As a result, the agency has significant information to inform its energy management decisions. Collecting and analyzing this data could prove costly and time consuming for other water agencies and may present a barrier to further action. As observed by the Alliance in discussions with EMWD staff, promising energy saving opportunities can still be identified with higher level information.

**Each water agency faces unique circumstances and operates unique systems.** Most water agencies can reduce their energy consumption by adhering where possible to the seven previously listed best practice strategies. However applicability of illustrative measures will vary from agency to agency. This was noticed in the case of EMWD:

- Leak detection showed EMWD's relatively new system has few leaks. The measure is expected to be beneficial for older systems where it could result in significant energy savings.

- Hydropower generation is possible only in locations where excess head, suitable access to energy demands, and accessible infrastructure is available. While EMWD locations meet these criteria, staff has yet to identify a cost effective technology for their system specifics.

**Technology risk and the need for investment prioritization may prevent water agencies from installing certain efficiency measures.** For example, the EMWD has not installed energy efficient lighting in its administrative offices. Operations staff and the board are fully aware of the possibility and the rebates available; however the previously stated two reasons are preventing further action.

- In 2011 the EMWD board considered installing LED lighting in efforts to use "best available technologies". However, the board observed that LEDs are not currently cost effective but might be in the near future. As such, EMWD further delayed lighting equipment upgrades because of the technology risk associated with LEDs. EMWD is concerned that investments in efficient lighting equipment today (which would be used for the next 7-10 years) will preclude investments in LEDs in the next several years (when they may become cost effective). In early 2012 EMWD started to consider conventional high efficiency lighting.
- EMWD is prioritizing upgrades to its water infrastructure (pumps, pipes, and plants) over building improvements as water infrastructure is considered mission-critical. This prioritization highlights the difficult decisions water agencies face with limited budgets. Even though some energy efficiency replacements may seem like "clear winners" to the energy industry, water operators must prioritize mission-critical investments.

**Newly adopted South Coast Air Quality Management District (AQMD) emissions limits may prevent EMWD and other water agencies from continuing to beneficially use biogas without significant and costly alterations to their system**. EMWD and other similar situated entities to consider retiring internal combustion engines and instead flaring the biogas. Another alternative is to condition biogas to pipeline quality and sell the gas; however, current technologies are also not cost-effective. Either way there is no easy solution to this problem. Upon request of the California Energy Commission (CEC), the AQMD has adopted an Energy Policy in which they state their commitment to work with the CEC and other parties to resolve these barriers. [40] Until these barriers are resolved, however, EMWD has stated that it is too risky for them to continue to invest substantial funds in increased production and use of biogas.

**Integrating all energy management activities into one central location can prove challenging for water agencies.** EMWD noted fully integrating the entire staff's energy

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[40] AQMD Air Quality-Related Energy Policy, A Resolution of the Governing Board of the South Coast Air Quality Management District (AQMD) approving the AQMD Air Quality-Related Energy Policy, adopted September 9, 2011. http://www.aqmd.gov/prdas/climate-change/EnergyPolicy.html

management knowledge is a difficult task. For example, SCADA and pump control programs could improve operation decisions by using data obtained from pump testing (performed by SCE). However operations staff was unsure if pump test results were being regularly integrated into the control and monitoring systems.

## Recommendations

EMWD also faces several common barriers in the water industry that prevent the agency from implementing several high-potential practices. Addressing these barriers could open the doors to deeper energy savings in the water industry.

**Recommendation #1: Utility account representatives should be equipped with tools to facilitate energy discussions with their water-agency customers.**

Water agencies and energy utilities approach the water-energy nexus from uniquely different perspectives; facilitating discussion on common ground is necessary to advancing efficiency in the water sector.

- Water agencies are often aware of their total energy use; however, without advanced monitoring systems (such as SCADA) they may not be aware of energy use at the subsystem level. Lack of knowledge of the true drivers of energy use in a water system can lead to sub-optimal energy management decision.
- Energy utilities typically bring to the table an extensive list of opportunities for their customers to reduce energy use; however there is no formal prioritization of these opportunities. Measures that should be considered "low hanging fruit" may be passed over while more complex solutions are pursued.

To overcome these information barriers, the Alliance has developed the Water/Wastewater Agency Energy Analysis and Best Practices Tool.[41] The tool is meant to provide users (both water operators and energy utility account managers) a high level view of how and where energy is being used in a selected water system and suggestions for reducing energy use. The tool overcomes information barriers by:

- Providing a customized estimate of energy use by subsystem based on user input specific to a water agency; and
- Providing a customized list of energy management best practice measures to consider, prioritized by relative potential to save energy and relative ease of implementation.

The tool is designed to be simple and require minimal input to generate results. Given user input the tool estimates annual energy use and energy costs associated with various

[41] Available at: http://sustainca.org/tools

sub-systems within a water agency's infrastructure. Sample energy and cost analysis output is illustrated below in Figure 5.

**Figure 5 - Best Practices Tool Energy and Cost Analysis Sample Output**

**Potable Water System**

| Current Energy Use | Approximate Energy Use Based on an "Average" Potable Water System | | | | | | |
|---|---|---|---|---|---|---|---|
| | Natural Gas | | | Electric | | | Total |
| | Total Gas Use (Therms) | Total Gas Cost ($) | Average Energy Cost per pump | Total Electric Use (KWh) | Total Electric Cost ($) | Average Energy Cost per pump | Total Energy Cost |
| Raw Water Pumping | 11,000 | $8,800 | $8,800 | 1,076,321 | $102,000 | $10,200 | $110,800 |
| In-plant Pumping | - | $0 | | 968,689 | $92,000 | | $92,000 |
| Treatment Processes | - | $0 | | 1,183,953 | $112,000 | | $112,000 |
| Distribution Pumping | 67,000 | $53,600 | $10,720 | 6,555,773 | $623,000 | $12,460 | $676,600 |
| Building Energy Use | 22,000 | $17,600 | | 215,264 | $20,500 | | $38,100 |
| *- Lighting* | | | | *75,834* | *$7,222* | | |
| *- HVAC* | | | | *63,324* | *$6,030* | | |
| *- Other Building Energy Use* | | | | *76,106* | *$7,248* | | |

**Wastewater System**

| Current Energy Use | Approximate Energy Use Based on an "Average" Wastewater System | | | | | | |
|---|---|---|---|---|---|---|---|
| | Natural Gas | | | Electric | | | Total |
| | Total Gas Use (Therms) | Total Gas Cost ($) | Average Unit Energy | Total Electric Use (KWh) | Total Electric Cost ($) | Average Unit Energy Cost | Total Energy Cost |
| Wastwater Lift Pumps | 2,842 | $2,270 | $2,270 | 857,816 | $68,600 | $6,860 | $70,870 |
| In-plant pumps | - | $0 | | 900,475 | $72,000 | | $72,000 |
| Grit removal | - | $0 | | 64,320 | $5,150 | | $5,150 |
| Belt press | - | $0 | | 257,279 | $20,600 | | $20,600 |
| Clarifiers | - | $0 | | 192,959 | $15,400 | | $15,400 |
| Aeration (blowers) | 46,022 | $36,800 | $18,400 | 2,083,956 | $167,000 | $55,667 | $203,800 |
| Anaerobic digestion | 29,829 | $23,900 | $7,967 | - | $0 | $0 | $23,900 |
| Building HVAC & lighting | 17,045 | $13,600 | | 514,557 | $41,200 | | $54,800 |
| Other | 4,261 | $3,410 | | 128,639 | $10,300 | | $13,710 |

Based upon this analysis the tool provides a custom list of best practices and energy savings measures that should be explored by water agency and utility account representative to reduce energy use. Illustrated in Figure 6, the measures are grouped by major energy end uses prioritizing the largest energy consumers first. Within each end use, potential measures are also ranked by savings potential and ease of implementation.

**Figure 6 - Best Practices Tool Energy and Measure Prioritization Sample Output**

| Best Practices Measures By Category | Measure Score (5 = High, 1 = Low) | | Total Measure Score |
|---|---|---|---|
| | Energy Savings Potential | Ease of Implementation | |
| **Aeration** | | | |
| Install and optimize automatic dissolved oxygen control | 4 | 5 | 9 |
| Install fine bubble aeration | 5 | 3 | 8 |
| Install high efficiency blowers (multistage, variable speed) | 4 | 3 | 7 |
| **Pumping** | | | |
| Pump testing and maintenance | 3 | 5 | 8 |
| Install Variable Frequency Drives (VFDs) | 4 | 3 | 7 |
| Reduction of friction in pumps (polymer pump coating) | 2 | 5 | 7 |
| Prioritize most efficient pumps for processin[illegible]ad | [illegible] | [illegible] | [illegible] |

Note: Table truncated

Equipped with a tool like this, energy utilities and water agencies will have a framework and checklist around which to discuss and prioritize energy saving opportunities. The tool would allow customers and account managers to quickly screen opportunities specific to the agency. The Alliance was unable to identify any other similar, publically available tool. However, some tools do exist to assist agencies in benchmarking their energy use.[42]

Additional engineering analysis will be required to quantify estimated energy savings and cost as well as determine any applicable rebate. Additional standardized tools should be developed for these analyses to enable ease of use and quality of calculations. Such future tools that should be developed (if not already developed) include the four listed below. These four tools would cover a large portion of possible energy efficiency savings.

- **Pump efficiency** – The majority of energy used by water systems is for pumping. Therefore a calculator to estimate the annual energy savings, cost savings and payback period of pump efficiency improvements would be broadly used. The tool should be able to estimate savings for a variety of measures including: high efficiency motors, high efficiency pumps VFDs, pump maintenance, and internal

[42] An example includes tools developed by NYSERDA. http://www.nyserda.ny.gov/en/Page-Sections/Commercial-and-Industrial/Sectors/Municipal-Water-and-Wastewater-Facilities/Tools-and-Materials.aspx

friction reduction. While VFDs and high efficiency motors and pumps tend to be rebated through prescriptive utility programs, a pump efficiency tool would be able to provide value in calculating the benefits of more customized measures such as friction reduction and pump maintenance/repair.

- **Aeration system efficiency** – The majority of energy used by wastewater treatment plants is for aeration systems. Several measures present the opportunity to save significant energy. The tool should be able to estimate savings for a variety of measures including: fine bubble aerators, dissolved oxygen control, and high efficiency blowers (variable speed, multi-stage, etc.) The tool should incorporate parameters such as biochemical oxygen demand (BOD) which drives aeration energy use.

- **Leak loss detection and repair** – Recent studies by the CPUC found that leak loss detection and repair has the potential to save significant amounts of energy in the water sector. [43] Many stakeholders in the water sector are already aware of the water savings achievable but there is little standardized guidance on estimating energy savings. A standardized tool should:
    - Help estimate energy intensity of leaked water accounting for supply, treatment and distribution infrastructure. Energy intensity can be estimated using energy bill data and/or system pressure.
    - Apply energy intensity to amount of recoverable water to estimate actual energy savings.

- **Stormwater infiltration reduction** – While leaks and losses in potable water systems increase energy use, stormwater infiltration into wastewater collection systems similarly increases energy use. Stormwater infiltration increases influent flow to treatment plants requiring more pumping and treatment energy use. Similar to leak loss prevention, there is little standardized guidance on estimating energy savings from reducing infiltration. A standardized tool should:
    - Help candidate agencies quantify their wastewater system energy intensity using energy bill and flow data.
    - Apply the energy intensity to actual infiltrations reduced to estimate energy savings.

These water-energy tools would allow utilities to more easily calculate savings and rebate measures through standard performance contracts. Without standardized tools, engineering analysis and calculations would be required for each custom

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[43] California investor owned utilities implemented water-energy pilot projects from 2008 to 2009. The CPUC evaluated these projects in 2010 to determine energy savings. The results of the evaluation can be found in: EcoNorthwest. *Embedded Energy in Water Pilot Programs Impact Evaluation.* Prepared for the CPUC. December 2010.

implementation of water-sector efficiency measures. Tools increase the certainty of savings and increase the ability for utilities to offer incentives to their customers.

**Recommendation #2: Both the energy and water industry should be encouraged to collaborate closer with each-other to advance energy efficiency in the water sector.**

***Collaborate Data Management***: Water agencies are among the largest customers of an energy utility often managing more than 100 separate energy metered facilities. Water agencies manage a large amount of their own data related to water operations. Meanwhile energy utilities maintain a large and detailed dataset of energy use by their water-agency customers. These two data sets both provide significant amounts of insight into water agency energy use, though managing this combined data can prove challenging.

Energy utilities should provide their water agency customers with the skills and tools to manage their detailed energy data. Water agencies are primarily concerned with detailed water data (real time flows, storage levels, pressures); access to similarly detailed energy data (interval data, time of use data) could inundate them. Energy utilities should provide energy data in an accessible, summarized fashion (preferably though an online-platform) that provides intelligence to the agency regarding their energy use. This summarized data would allow water agencies to view trends in energy use on a system wide or individual facility basis and make more informed energy management decisions. A system like this would be especially beneficial to agencies that do not have SCADA systems. Prioritizing water agency infrastructure for smart meter retrofits would further enhance the quality and availability of energy data.

Beyond energy use data, utilities could assist water agencies in managing pump test data. Energy utilities offer pump testing for water agencies which provides valuable information on single pumps. Often multiple pumps are tested while some pumps are tested multiple times over a period of years. Utilities should help their water agency customers manage this data in a system that helps water agencies prioritize the lowest efficiency, most energy intensity, or largest energy consuming pumps. Tracking data over time would help agencies identify trends and better manage their pump maintenance and repair initiatives.

***Cross-sector Training***:
Energy utility energy account managers should be trained to understand water and wastewater customers' needs and common energy saving opportunities. Most opportunities to save energy arise through regular maintenance or pre-planned construction projects. Therefore, utility account managers should encourage their water customers to review upcoming infrastructure changes and even operation and maintenance plans with utility account managers.

Education can be directed at water-agencies as well. For example, water agency associations should encourage their member agencies to develop a close relationship with their energy providers. Utilities can go as far as offering water-system operator efficiency training. Topics could cover SCADA, pump testing and repair programs. Energy utilities could also establish partnerships with local chapters of water associations to reach out to more water agencies. These partnerships can serve as a source for disseminating information such as energy efficiency case studies and best practice manuals.

**Recommendation #3: Stakeholders should revisit the AQMD rules regarding biogas use in internal combustion engines.**

As a result of recent AQMD emissions rules, water agencies are considering retiring internal combustion engines powered by biogas and flaring the biogas with no beneficial use. One of the goals of AQMD policy is to "progress toward meeting clean air standards and protecting public health." However, it is possible that the current rules on biogas may actually have a negative impact on public health and the energy infrastructure. Until this issue is resolved, additional biogas investments will remain risky opportunities for water agencies.

Additional research and input from stakeholders on this topic is needed. The following are key aspects of a study that would provide value and better inform this discussion:

- Identify the number of water agencies, and number of currently operating facilities that would be adversely affected by this regulation. A survey of water agencies within the SCAQMD could achieve this. Characterizing these faculties (size, type, current technology, possible replacement technologies) is needed.
- Conduct an engineering analysis to quantify the impacts of switching these facilities from biogas power to pipeline natural gas or electric power. The impact analysis should quantify the amount of on-site electricity or natural gas that would be needed to offset biogas use. The study should also identify the most likely generation source of increased electric demand. It is expected that many of the stationary engines under scrutiny are operated during peak hours. Switching these loads to electric may increase the demand from natural gas powered peak power plants.
- Conduct an emissions analysis to determine the resulting GHG and pollutant emissions due to the change. The analysis should include both the emissions as a result of electric generation and the emissions that result from unutilized biogas.

Outlining these issues and providing supporting data will help stakeholders to better understand the scope of the problem and work towards a solution.