Industrial Sectors Market Characterization

Water and Wastewater Industry

Prepared for

Pacific Gas & Electric and Southern California Edison

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Acronyms and Abbreviations

AB32	Assembly Bill 32 the Global Warming Solutions Act
ACEEE	Americans for an Energy Efficient Economy
ACWA	Association of California Water Agencies
AMO	Advanced Manufacturing Office
ANSI	American National Standards Institute
ARB	California Air Resources Board
ARRA	American Recovery and Reinvestment Act
ASCE	American Society of Civil Engineers
AWWA	American Water Works Association
CCCSD	Contra Costa County Sanitation District
CHP	combined heat and power
CO_2	carbon dioxide
CO_2e	carbon dioxide equivalent
CPUC	California Public Utilities Commission
CWEA	California Water Environmental Association
DOE	U.S. Department of Energy
EBMUD	East Bay Municipal Utility District
EEPS	Energy Efficiency Portfolio Standards
EITE	Energy Intensive Trade Exposed
GHG	greenhouse gas
ITP	Industrial Technologies Program
kWh	kilowatt-hour
MID	Modesto Irrigation District
MMBtu	million British thermal unit
NAICS	North American Industry Classification System
NAWC	National Association of Water Companies
NPDES	National Pollutant Discharge Elimination System
O&M	operations and maintenance
PG&E	Pacific Gas and Electric Company
RCRA	Resource Conservation and Recovery Act
RPS	Renewable Portfolio Standards

SCADA	Supervisory Control Data Acquisition
SDWA	Safe Drinking Water Act
SEP	Superior Energy Performance
TID	Turlock Irrigation District
U.S.	United States
U.S. EPA	U.S. Environmental Protection Agency

Summary of Findings

The water and wastewater industry (North American Industry Classification System prefix 221) collects surface water or groundwater, treats water to agricultural or potable standards, transports water to local distribution networks, delivers water to end users, and finally, collects and treats wastewater for discharge into the environment. PG&E and SCE customers in this sector include large public agencies and private water supply utilities, wastewater treatment districts, and integrated water and wastewater utilities. Irrigation and power districts located in California's Central Valley are also large users of electricity and natural gas.

Industry Landscape and Operational Models

Forty thousand out of 53,000 water supply systems nationwide are owned and operated by local or regional governments. Investor-owned utilities operated the remaining water systems. Municipalities also own and operate about 98 percent of wastewater systems. There is no competition between firms or other market forces (such as international competition) within the water and wastewater sectors. Due to the infeasibility of competing infrastructure systems, water and wastewater service is divided into exclusive service territories. Publicly owned municipal utilities tend to operate under a board of director model where an elected board sets utility policies and make decisions on investments. For investor-owned utilities, service rates are set by a public utility commission through the rate-case process.

The water supply and wastewater treatment industries are highly capital intensive due to required investments in costly infrastructure such as dams, pumping stations, treatment plants, and extensive pipe networks. Depreciation absorbs a relatively large share of revenue. Operational expenses for water supply and treatment consist primarily of purchases such as chemicals, energy, and purchased water, as well as wages and professional services. Wastewater treatment plants spend as much as 30 percent of their operations cost on energy. Raising funds for capital expenditures is challenging for municipal water utilities. Capital expenditures are typically funded by water and wastewater rates, taxes and/or the issuance of bonds. For investor-owned utilities, the regulatory rate setting process is time-consuming. Lengthy budgeting cycles and regulatory lag can be barriers to implementing energy efficiency projects.

Energy Use in the Industry

Californians use approximately 43 million acre-feet (about 14 trillion gallons) per year. Seventy-nine percent of that water goes to agricultural uses and 21 percent goes to the urban sector.[1] The relationship between water and energy resources is linked since energy is needed to pump, treat, transport, heat, cool, and recycle water. Pumping and treatment of water are the major drivers of energy consumption. Water also generates electricity in hydroelectric dams found throughout the state.

Electric loads at water and wastewater treatment plants consist primarily of air blowers for aeration; but also include pump motors; drying of solids; and in some cases ultraviolet light disinfection and ozonation. The energy intensity of water treatment and wastewater plants has risen in recent decades in response to increasingly stringent water quality regulatory requirements. However, there are ample opportunities for water and wastewater plants to achieve significant energy savings. Some of the best options for energy efficiency in the wastewater sector include reducing aeration energy for secondary treatment, process optimization, and improving controls such as Supervisory Control and Data Acquisition (SCADA). Wastewater treatment plants often use anaerobic digesters to generate biogas for electricity generation and process heating. As such, digesters reduce energy consumption from pipeline natural gas and electricity from the grid. Water agencies and utilities can also promote water conservation in their service territories and communities to reduce the amount of volume consumed and treated.

Drivers, Barriers, and Decision Making

Water agencies and wastewater utilities are highly regulated by the state of California for potable water quality and environmental protection for wastewater treatment. Because failures to achieve water quality or environmental standards can result in serious penalties, water and wastewater utilities tend to be highly risk averse to changes in their processes. Managers are generally resistant to changing equipment or processes that may risk the functionality of the system for the sake of saving energy. Risk aversion can be eased through education and outreach. Management and operators would benefit from exposure to case studies showing how other utilities have saved energy through operational changes and through technology upgrades.

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[1] Department of Water Resources, *California Water Plan Update 2005.* Volume 1, Table 3-1. http://www.waterplan.water.ca.gov/previous/cwpu2005/index.cfm

Water agencies and wastewater utilities face funding challenges both in the approval process and in tolerance for finding measures with a short enough payback periods. Board of directors' approval may be required for projects over $100,000. State and federal grants and utility incentives also provide needed funding. When purchasing new equipment, low cost loans are often more attractive than incentives because internal approvals are easier. Typically, investments in efficiency are paid for through rate payer receipts; however, with the approval of Proposition 218 in 1996 California government agencies are restricted to increasing tax rates without the consent of tax payers.[2]

Environmental stewardship is a significant driver for water and wastewater utilities to invest in energy efficiency. In certain locations, customers are willing to pay more in water rates for environmental benefits. However, other utilities are driven more by rate protection, meaning they will only tolerate short payback period requirements for capital investments. Electrical utilities should understand which customers are driven by environmental concerns over cost concerns, and tailor their programs accordingly. Utilities should focus on low cost/no cost and short payback measures for water customers with less of an environmental driver and lower tolerance of long payback periods.

Due to risk aversion to modifications of existing systems, renewable energy projects are a much easier sell than modifications to water treatment infrastructure. Power Purchase Agreement (PPA) leasing agreements have worked well for renewable energy, as there is no need for going through the difficult funding process or assuming the ownership risk.

Due to their unique nature, custom energy efficiency programs work best with water and wastewater utilities. Utilities should work with the customers to understand their maintenance and upgrade needs over the next ten years and work with them during the planning process. These are the best times to upgrade to efficient equipment.

Overall Findings

The following findings regarding improving the adoption of energy efficiency measures in the water and wastewater industry are based on the research presented in this report.

- Given that water utilities' primary responsibility is to provide adequate supplies of clean water to ratepayers that meet local and federal regulatory standards, efforts to

[2] California Tax Data. 2011. *Property Tax Information, Factsheet: What is Proposition 218?* http://www.californiataxdata.com/pdf/Proposition218.PDF

implement energy efficiency measures are often met with ambivalence by plant managers who either rank it low on the priority list or are worried that major modifications may have negative consequences for water quality compliance.

- Energy efficiency programs should be designed to address the culture of risk aversion in the water sector. One approach to mitigate concern about energy-saving technologies is to support and promote demonstration and pilot projects and case studies.
- Water and wastewater utilities appreciate positive public recognition, as they operate in a very public and sometimes political arena. Utility offerings that provide recognition of goals achieved or energy saved are valued.
- Larger water utilities that are more sophisticated in their approach to energy efficiency may be open to comprehensive energy systems management approaches. A short-term goal-based program that includes developing an action plan, a detailed audit/technical assessment, measurement of success in meeting goals, and positive public recognition may be successful.
- Understanding water utilities' funding cycles is critical to program success; especially given their regulatory requirements to justify capital expenditures to ratepayers and/or public utilities commissions. It is also important to understand the measure payback period requirements and investment hurdle rates to overcome energy efficiency funding adoption hurdles.
- Creative financing options, such as on-bill financing and low-cost loans, rather than rebates and incentives, can help overcome the funding cycle barriers. .
- Process changes and behavior modification without capital investment, such as reducing needlessly redundant systems, can yield significant low cost energy savings.
- Collaboration between the electric utilities and the water industry is critical and should continue. Energy management is a high priority interest for water and wastewater utilities, as they are engaged and involved in promoting efficiency and conservation in their industry. This conversation started by the research efforts in this study should be continued as an ongoing dialogue between utilities and the industry in order to develop effective efficiency programs.

1. Project Background

The industrial sector consumes over 30 percent of the nation's energy, [3] presenting enormous opportunities for energy efficiency.[4] Many market forces beyond simple energy cost drive industrial customer decision making. Attaining a better understanding of the customer's world will assist Pacific Gas and Electric Company (PG&E) and Southern California Edison Company (SCE) in their design and implementation of industrial energy efficiency programs. PG&E and SCE engaged KEMA, Inc. to prepare market intelligence on nine key energy-intensive industrial sectors, including the water and wastewater sector.

The research objective of this project is to provide critical industry information to assist PG&E and SCE staff with marketing of energy efficiency products and support face-to-face engagement with industrial customers. More generally, this study identifies key barriers to greater uptake of energy efficient equipment and practices and recommends solutions to overcome those barriers.

To address the objective of this study, the work was organized into four key elements. These include:

- Perspectives about broad trends affecting California and the nation's industrial sectors (section 2)
- Detailed in-depth, industry-specific analysis of business and process drivers developed from secondary research (section 3)
- Energy usage, target technologies and process, and energy efficiency opportunities (section 4)
- Real-time perspectives and intelligence gained from key industry insiders through interviews and Webinar/Forum group discussions (section 5)
- Recommendations (section 6)
- Attachments containing interview and forum guides
- Utility-specific appendices containing proprietary data and customer information.

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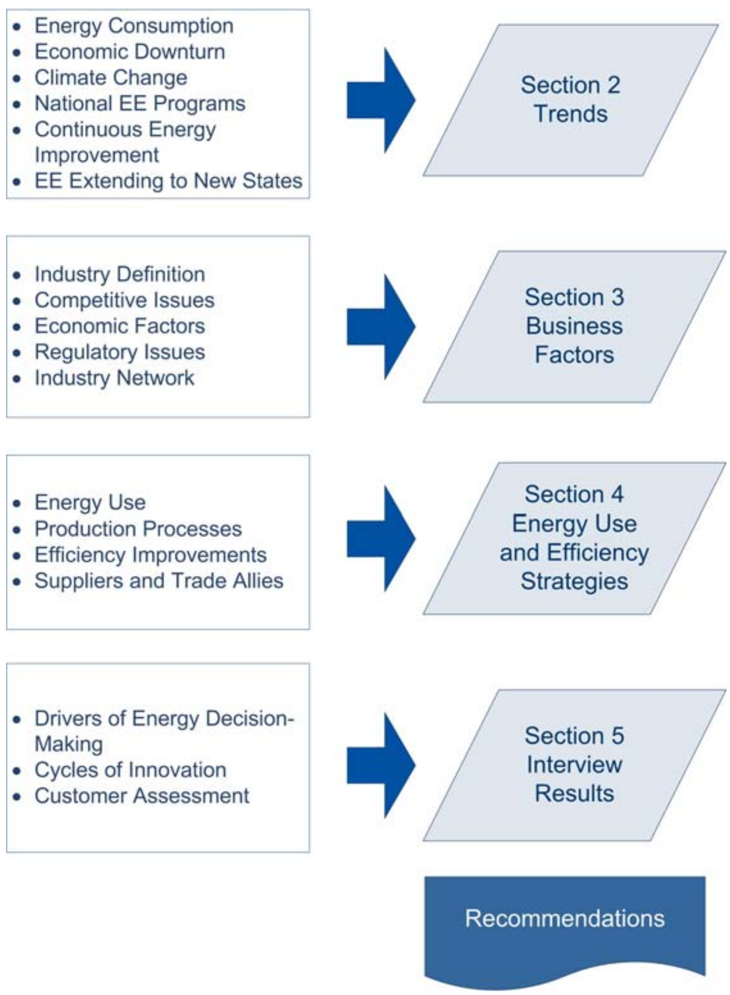
[3] Quinn, Jim. 2009. *Introduction to the Industrial Technologies Program*. Save Energy Now Series Webinar. January 15.
http://www1.eere.energy.gov/industry/pdfs/webcast_2009-0115_introtoitp.PDF

[4] U.S. Census Bureau, 2008. *Energy Consumption, by End-Use Sector*.
http://www.census.gov/compendia/statab/2010/tables/10s0892.xls

In practice, these report elements are built stepwise—broad national trends inform industry-specific secondary research and industry-specific analysis informs the primary interviews and roundtable discussions. The outcome is a thorough research report intended to provide PG&E and SCE staff members the breadth necessary to position their industrial energy efficiency products optimally and the depth necessary to knowledgeably engage their customers.

Figure 1 below provides a graphic overview of the report.

Figure 1: Overview of Report



2. Trends in Industrial Energy Efficiency

The industrial sector consumes an immense amount of energy, nearly 32 percent of total U.S. consumption in 2008,[5] to produce goods and materials for wholesale and retail sales. In the past three decades, the overall energy efficiency of the industrial sector in the U.S. has increased dramatically. Energy efficiency potential savings have been estimated at 20 percent or more by 2020, both nationally[6] and in California.[7] It has thus been an attractive target sector for utilities and government looking to reach new levels of energy savings through efficiency.

In the water and wastewater industry, up to one third of a municipality's energy bill can be attributed to wastewater plants and drinking water systems.[8] In many cases, facilities were built at a time when energy costs were not a significant concern, and were not designed with regard for wasted energy.[9] In addition to the treatment facilities, improving pumping efficiency throughout the distribution and collection systems represent a significant opportunity.

Changing energy markets and climate change policies are driving greater interest in energy efficiency technologies. Key trends discussed include climate change and energy legislation; national energy efficiency programs; combined heat and power, the rise of continuous energy improvement; and energy efficiency adoption outside California. These trends are discussed in more detail below.

2.1 Climate Change and Energy Legislation

Industry's energy-related carbon dioxide emissions have decreased in the last decade, while rising more dramatically in other sectors, as shown in Figure 2. In the water and wastewater sector, some local governments are establishing plans and programs to reduce their carbon footprint. For example, the City of San Jose's Green Vision[10] seeks to beneficially reuse 100

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[5] U.S. Census Bureau, 2008. *Energy Consumption, by End-Use Sector*. http://www.census.gov/compendia/statab/2010/tables/10s0892.xls

[6] McKinsey & Co. 2009. *Unlocking Energy Efficiency in the U.S. Economy.* July. http://www.mckinsey.com/clientservice/electricpowernaturalgas/downloads/US_energy_efficiency_exc_summary.PDF

[7] KEMA. 2008. *Strategic Industrial Report for PG&E.*

[8] U.S. Environmental Protection Agency. 2009. *Clean Energy Lead by Example Guide: Strategies, Resources, and Action Steps for State Program.* Washington, D.C.

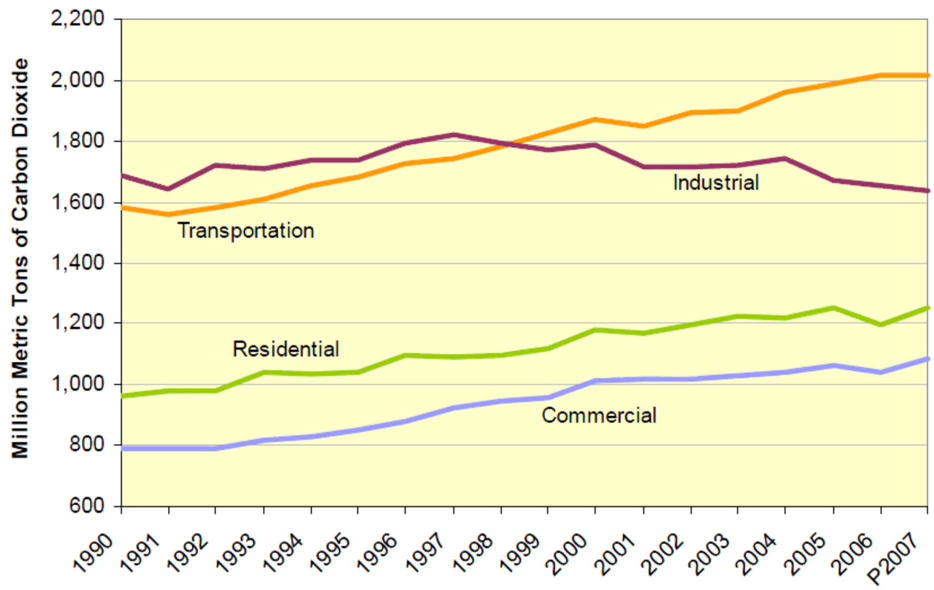
[9] American Council for an Energy Efficient Economy. 2010. Local Technical Assistance Toolkit: Energy Efficiency in Water and Wastewater Facilities. http://www.aceee.org/sector/local-policy/toolkit/water

[10] City of San Jose, Green Vision website. http://greenvision.sanjoseca.gov/RecycledWater.aspx

percent of wastewater that would have otherwise been lost to the Bay— 100 million gallons per day—through a combination of water conservation, expanded use of recycled water, and habitat protection. Many municipal climate action plans in California include measures for more efficient use of water systems and installation or optimization of anaerobic digester gas energy generation. For example, the Marin County Sanitation district is currently planning to install an additional digester and mix food waste and wastewater in an anaerobic digester to boost the production of renewable energy.

Greater energy efficiency will almost certainly be an important component in local, national—and global—strategies for managing energy resources and climate change in the future. Energy efficiency is generally acknowledged to be the lowest-cost and fastest-to-deploy resource to slow the growth of carbon dioxide emissions, and it also results in positive economic impacts. Congress is not expected to approve any policy mechanisms to reduce CO_2 emissions in the short term although legislation encouraging greater energy efficiency is possible.

Figure 2: U.S. Energy-Related CO_2 Emissions by End-Use Sector, 1990-2007



Source: ACEEE[11]

2.2 National Programs

Typical utility programs address only a subset of the energy efficiency improvement opportunities, focusing primarily on retrofits and capital improvements. Less attention is given to behavior or maintenance. Federal, regional, and state government agencies, utilities, and others have developed a range of programs to improve industrial energy efficiency. These include providing incentives, audits and technical assistance, and continuous improvement programs.

Many of PG&E and SCE's customers participate in these programs which can yield insights and best practices to inform utility programs, such as energy assessments offered by the Department of Energy's (DOE) Advance Manufacturing Office (AMO), formerly the Industrial Technologies Program.

In addition to performing audits, the Industrial Assessment Center (IAC), also trains the next generation of industrial energy engineers. Twenty-six centers at U.S. engineering universities

[11] American Council for an Energy Efficient Economy. *Trends in Industrial Energy Efficiency Programs: Today's Leaders and Directions for the Future*. September 2009.

train students to identify energy savings opportunities and perform no-cost assessments for small and medium industrial customers. In California, the San Francisco State University and San Diego State University run IAC programs. The IAC program has a public database of recommendations dating back to 1981, a resource for customers on industrial energy efficiency improvements. In California, 49 assessments were completed for small and medium facilities in 2009 through 2011 and 38 assessments for large facilities between 2006 and 2011. Two of these assessments were wastewater treatment facilities.[12]

2.3 Fuel Switching and Cogeneration/Combined Heat and Power

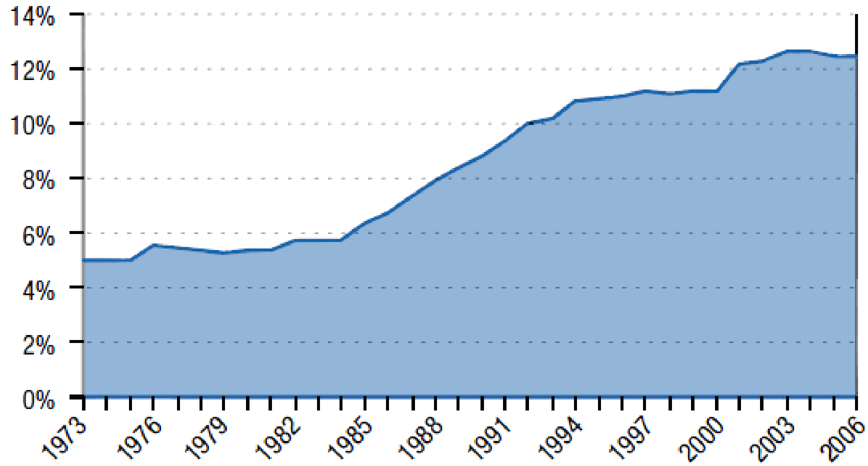
Combined heat and power, or cogeneration, is a significant and growing share of United States generation (see

[12] U.S. Department of Energy, Energy Efficiency and Renewable Energy, Advanced Manufacturing Office Activities in California website http://www1.eere.energy.gov/industry/states/state_activities/map_new.asp?stid=CA

Figure 3). CHP is the concurrent production of electricity or mechanical power and useful thermal energy (heating and/or cooling) from a single source of energy. This technology is first and foremost an energy efficiency resource that allows users to produce needed electricity, heat, and mechanical energy while using as little fuel as possible.

Natural gas continues to be the preferred fuel for CHP systems, representing 50–80 percent of annual CHP capacity additions since 1990. This is primarily because natural gas is readily available at most industrial sites, is clean burning, and has historically been relatively plentiful and affordable. California maintains effective policies that encourage adoption of CHP.

Figure 3: CHP as a Percentage of U.S. Annual Electricity Generation



Source: ORNL[13] Combined Heat and Power: Effective Solutions for a Sustainable Future, Dec. 1, 2008.

In the wastewater industry, CHP is fueled by digester gas, which may be supplemented by natural gas or other waste sources. For example, at East Bay Municipal Utility District, combines digester gas with trucked in food processing waste and wastewater sludge to maximize their CHP capacity.[14]

2.4 Rise of Continual Energy Improvement

Utilities, private organizations, and governments around the world have developed programs in the last few years that focus on setting goals and targets to achieve continual energy improvement (CEI) in industry. National programs in the United States have been developed by DOE (Superior Energy Performance) and EPA (ENERGY STAR). In the water and wastewater

[13] U.S. Department of Energy. 2008. *Combined Heat and Power: Effective Solutions for a Sustainable Future*. Prepared by Oak Ridge National Laboratory, ORNL/TM-2008/224, December 2008.

[14] Wallis, M., M Ambrose, C. Chan. 2008. *Climate change: charting a water course in an uncertain future.* American Water Works Association Journal 100:6, June 2008. http://www.ebmud.com/sites/default/files/pdfs/Journal-06-08_0.PDF

industry, EPA and others provide guidelines for program design that include clearly communicated strategy and measurable goals.[15]

This year, two important developments are expected to heighten interest and activity around energy management: the release of ISO 50001, a global energy management standard, and the launch of Superior Energy Performance, a national program to support energy intensity reductions for industrial plants and commercial buildings.[16] Although not designed specifically for publicly owned water and wastewater facilities, the rollout of these programs provides relevant concepts that are applicable to this subsector.

The recent work on United States and international energy management standards will have a significant impact on how energy is used in the industrial sector. The International Standards Organization (ISO released an international energy management standard, ISO-50001 in June 2011.

The U.S. Department of Energy is in the process of launching the Superior Energy Performance (SEP) program to promote industrial energy management and increased energy efficiency. This voluntary program will focus on fostering an organizational culture of energy efficiency improvement in U.S. manufacturing facilities, targeting mid to larger sized plants. Large, sophisticated organizations, such as EBMUD, should be considered prime candidates for these programs.

Participants establish an energy management system that complies with ISO 50001 and meets other SEP program requirements, including robust measurement and verification of energy savings. Pilot programs have been launched in Texas and the Pacific Northwest, and the full SEP program is expected to begin in 2013. A California pilot is also planned within the next 2 years. The American National Standards Institute (ANSI) is developing companion standards to support SEP. ANSI MSE 50021 will provide the additional energy performance and management system requirements for SEP certification that goes beyond basic conformance

[15] American Council for an Energy Efficient Economy. 2010. *Local Technical Assistance Toolkit: Energy Efficiency in Water and Wastewater Facilities*. http://www.aceee.org/sector/local-policy/toolkit/water

[16] McKane, Aimee, Lawrence Berkeley Laboratory, 2011. Presentation at the ACEEE Market Transformation Conference, Piloting Energy Management Standards for the U.S and the Globe. http://www.aceee.org/conferences/2011/mt/program

with ISO 5000; and ANSI 50028 will provide the requirements for verification bodies for use in accreditation or other forms of recognition.[17]

Regional CEI programs have been developed under the Northwest Energy Efficiency Alliance,[18] working with the Bonneville Power Administration and the Energy Trust of Oregon. California has identified CEI as an important aspect of its strategic plan.[19] Similarly, Wisconsin's Focus on Energy employs an internally developed tool called Practical Energy Management.[20] CEI is still in its infancy, with few CEI programs beyond the pilot stage.

2.5 Additional States Adopt Industrial Energy Efficiency

California has long been perceived as a leader in energy efficiency programs. Historically, energy efficiency trends and best practices tended to spread from California to other states involved in industrial energy efficiency. More recently, a sizable contingent of states have made significant commitments to energy efficiency programming as shown in **Error! Reference source not found.**6. The flow of information is changing as energy efficiency programs spread to locations in the Midwest and South that typically had provided modest or little ratepayer funding for energy efficiency. Program development efforts in many of the aforementioned states are in their early stages compared to California.

These states have signaled their commitment to energy efficiency by adopting aggressive Energy Efficiency Portfolio Standards[21] (EEPS) policies[22] that exceed those in California. As shown in Figure 4, California ranks number 14 for cumulative electricity savings targets by 2020, below states primarily in the Northeast and Midwest.

[17] Superior Energy Performance [cm] Certification Protocol, November 2011. http://www.superiorenergyperformance.net/pdfs/SEP_Cert_Framework.PDF

[18] Northwest Energy Efficiency Alliance (NEEA). 2011. *Continuous Improvement for Industry.* February. http://www.energyimprovement.org/index.html

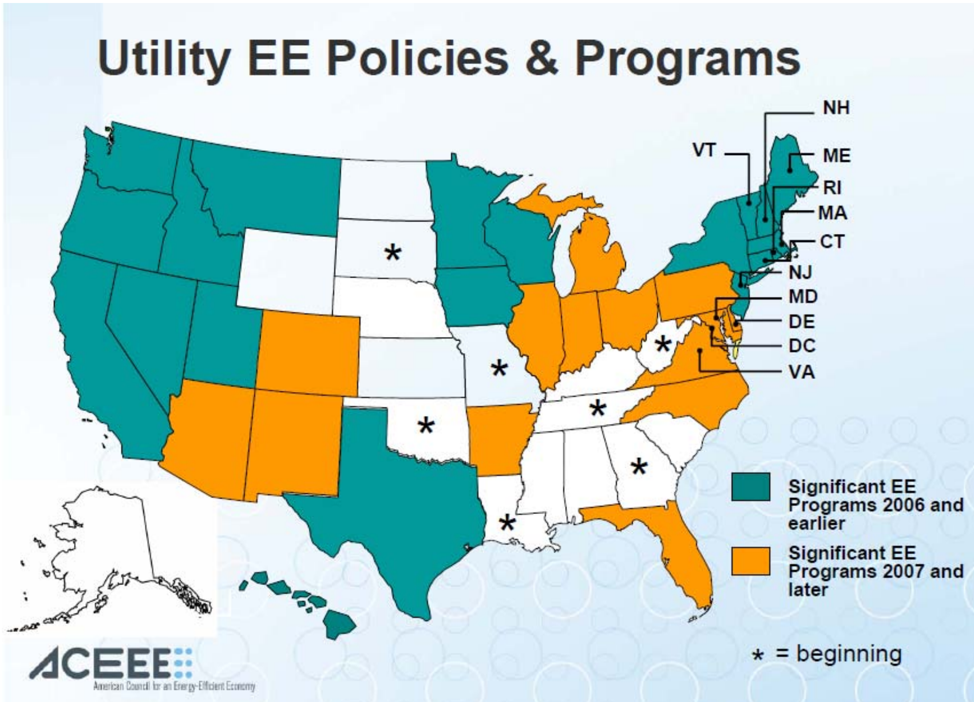
[19] California Public Utilities Commission. 2011. *CA Energy Efficiency Strategic Plan, January 2011 Update*. http://www.cpuc.ca.gov/NR/rdonlyres/A54B59C2-D571-440D-9477-3363726F573A/0/CAEnergyEfficiencyStrategicPlan_Jan2011.PDF

[20] Wisconsin Focus on Energy. 2011*. Practical Energy Management*. http://www.wifocusonenergy.com/page.jsp?pageId=368

[21] Covers all sectors including residential, commercial and industrial efficiency.

[22] These include: Illinois, Maryland, Michigan, New Mexico, Ohio, Pennsylvania, and Virginia (provisionally).

Figure 4: Utility Energy Efficiency Policies and Programs, 2006 vs. 2007+



Source: ACEEE[23]

The electric EEPS targets in most of these states rise to 1-2 percent of retail sales per year within the first 5-10 years of the standard, rivaling the annual savings levels currently being achieved in only a handful of leading states. For example, North Carolina has until recently been relatively inactive in energy efficiency, but has enacted a Renewable Portfolio Standard (RPS). Under this RPS, energy efficiency can meet up to 40 percent of the total requirements of the state's investor-owned utilities (IOUs) and an unlimited amount of the publicly owned utilities' requirements.

The rise of energy efficiency policies and programs indicates that California utilities can increasingly draw on program experience in other states to inform their own experiences.

[23] Nadel, Steven. 2011. *Program Introduction*. (Presentation, ACEEE 2011 National Symposium on Market Transformation, Washington DC, April 10–12, 2011). http://www.aceee.org/files/pdf/conferences/mt/2011/Introduction%20-%20Steve%20Nadel.PDF

Table 1: 2020 Cumulative Electricity Savings Targets, by State[24]

State	2020 EE Target	State	2020 EE Target
Vermont	30%	Indiana	14%
New York	26%	Rhode Island	14%
Massachusetts	26%	Hawaii	14%
Maryland	25%	California	13%
Delaware	25%	Ohio	12%
Illinois	18%	Colorado	12%
Connecticut	18%	Utah	11%
Minnesota	17%	Michigan	11%
Iowa	16%	Pennsylvania	10%
Arizona	15%	Washington	10%

Source: ACEEE[25]

[24] Includes extensions to 2020 at savings rates that have 26been established.

[25] Nadel, Steven. 2011. *Program Introduction*. (Presentation, ACEEE 2011 National Symposium on Market Transformation, Washington DC, April 10–12, 2011). http://www.aceee.org/files/pdf/conferences/mt/2011/Introduction%20-%20Steve%20Nadel.PDF

3. Industry Characterization

The following sections describe the water and wastewater industrial sectors, including an industry definition (Section 3.1), a description of primary energy uses (Section 3.2), the industry landscape (Section 3.3), major players in PG&E and SCE territory (Section 3.4), competitive issues (Section 3.5), economic issues (Section 3.6), regulatory issues (Section 3.7), and finally industry network (Section 3.8).

3.1 Industry Definition

The water and wastewater industry collects surface water or groundwater, treats water to agricultural or potable standards, transports water to local distribution networks, delivers water to end users, and finally, collects and treats wastewater for discharge into the environment. Some organizations that provide water to end users also collect and treat the resultant wastewater.

The water and wastewater industry is described by 3 NAICS codes. They are:

- 221310 – Water Supply and Irrigation Systems – Systems that collect, treat, and distribute water to customers.
- 221320 – Sewage treatment facilities – Facilities that collect wastewater from homes and businesses to be treated to the standards suitable to be released into the environment.
- 221300 – Water, Sewage and Other Systems – A catch all designation that includes all other water and or wastewater systems not characterized under 221320 and 221310

Water collection, conveyance, and treatment consume a significant amount of energy in California, according to the California Energy Commission.[26] This large energy consumption is driven by the need to pump water from north to south. Because Northern California has two thirds of the state's precipitation while two-thirds of the population resides in Southern California, water is pumped from north to south through large canal systems such as the Central Valley Project and the State Water Project. Southern California cities such as Los Angeles consume water that has been lifted up over 3,000 ft. through the Tehachapi Mountains.

[26] California Energy Commission, 2005. *California's Water – Energy Relationship.* California Energy Commission, CEC-700-2005-011-SF, November 2005.

3.2 Energy Use

Californians use approximately 43 million acre-feet (about 14 trillion gallons) per year. Seventy-nine percent of that water goes to agricultural uses and 21 percent goes to the urban sector.[27] The relationship between water and energy resources is linked since energy is needed to pump, treat, transport, heat, cool, and recycle water. Water also generates electricity in hydroelectric dams found throughout the state. The U.S. EPA estimates that drinking water and wastewater treatment services account for approximately 3 percent of the electric load in the United States. Furthermore, as populations grow and environmental requirements become more stringent, demand for electricity at such plants is expected to grow by approximately 20 percent over the next 15 years.[28]

The energy use by NAICS code in PG&E and SCE territory is depicted below in

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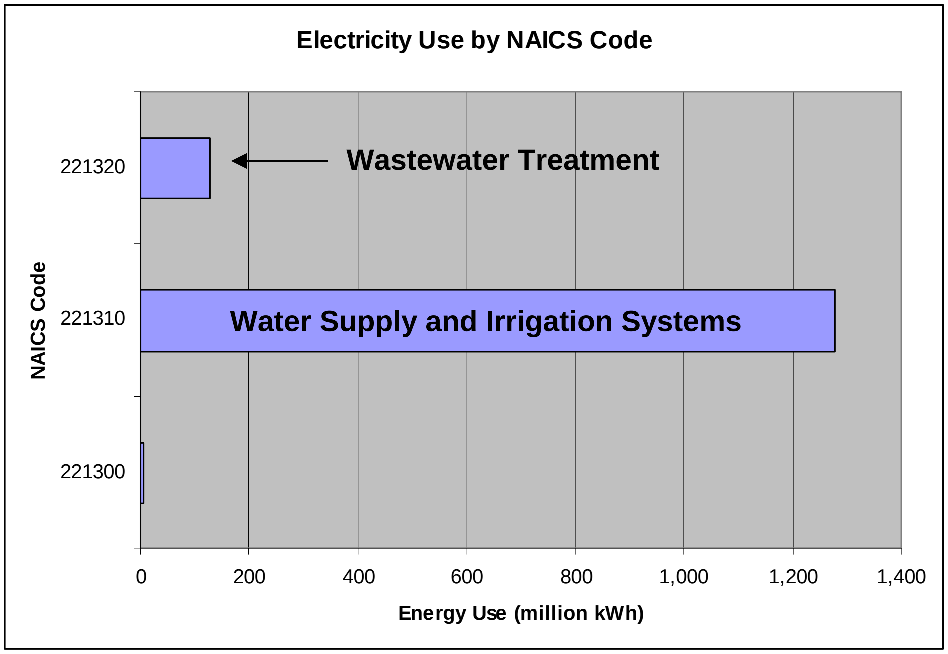
[27] Department of Water Resources. 2005. *California Water Plan Update 2005.* Volume 1, page 3.9, Table 3-1.

[28] U.S. Environmental Protection Agency. 2009. EPA's Clean Energy-Enviornment Tech Forum, Clean Energy Opportunities in Water and Wastewater Treatment Facilities. January 15. http://www.epa.gov/statelocalclimate/documents/pdf/background_paper_wastewater_1-15-2009.pdf

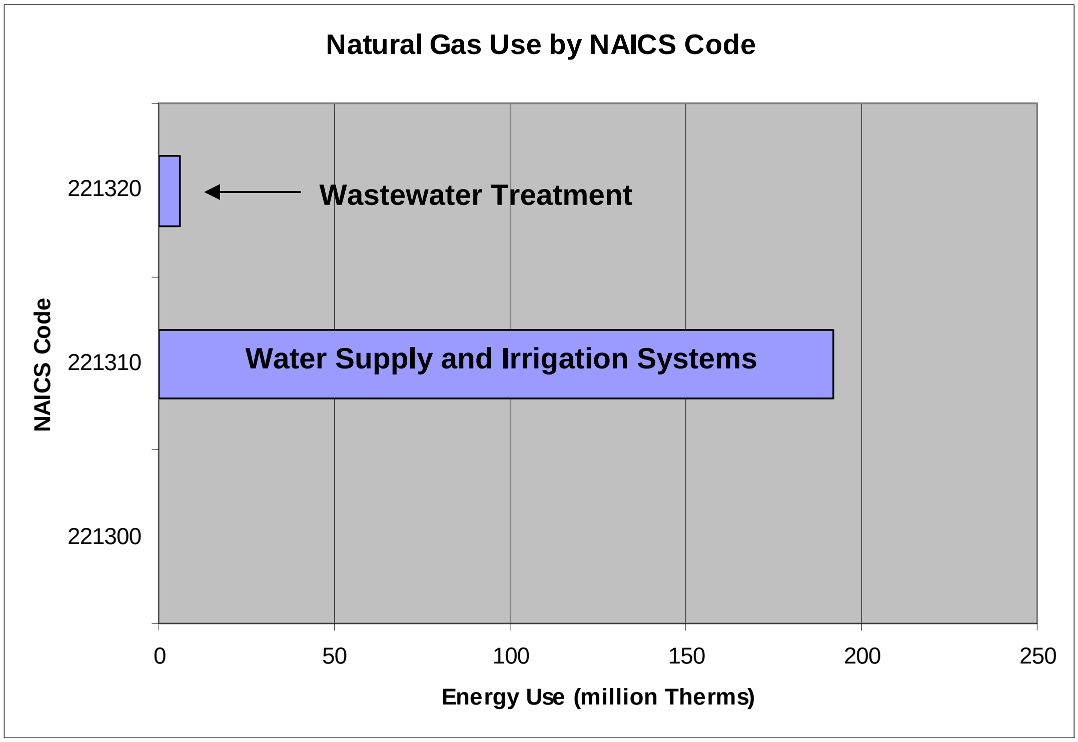
Figure 5, Figure 6, and Figure 7.

Figure 5: Electricity use by NAICS Code in PG&E Territory



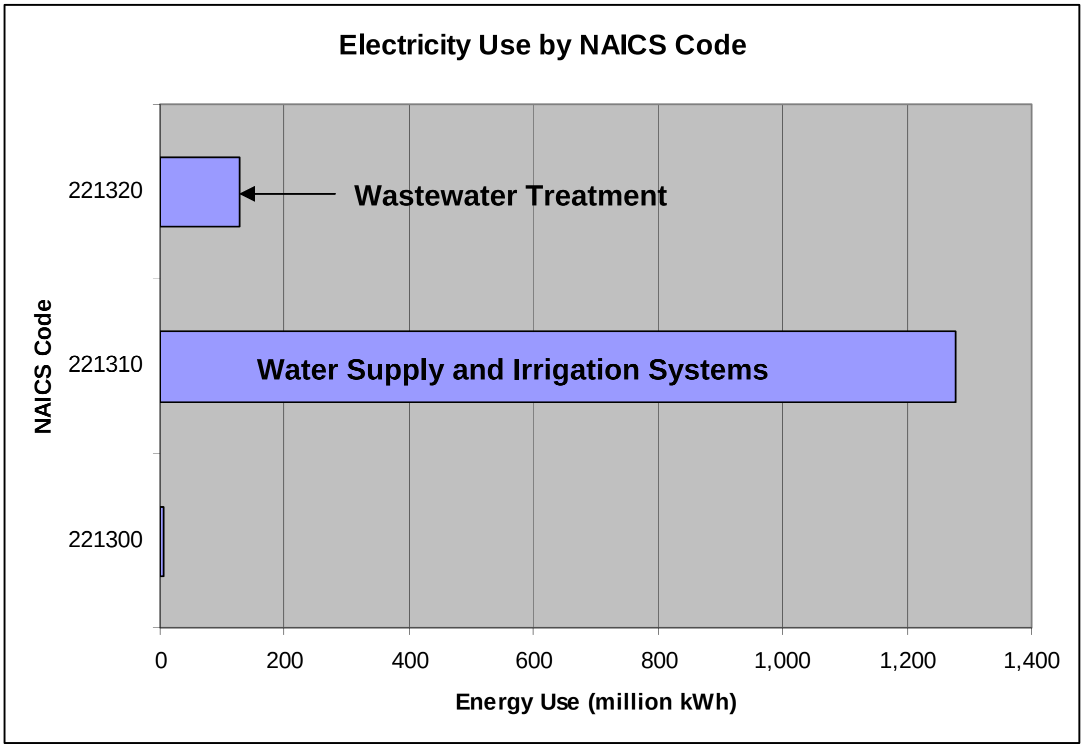
Source: PG&E data

Figure 6: Natural Gas Use by NAICS Code in PG&E Territory



Source: PG&E data

Figure 7: Electricity Use by NAICS Code in SCE Territory

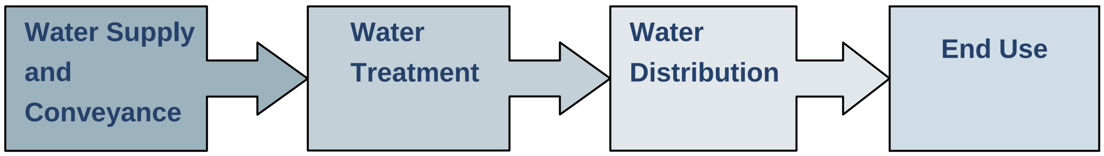


Source: SCE data

The charts above show that the vast majority of both natural gas and electricity is consumed by organizations categorized by NAICS code 22310 – Water Supply and Irrigation Systems. These organizations consume large amounts of electrical energy through pumping water to end users. Natural gas use is driven by power generation by water supply entities such as the Turlock Irrigation District, the Modesto Irrigation District, and the Kings River Irrigation District. To a much smaller extent, natural gas may also used in the wastewater treatment process to provide process heating, dry solids and co-fire with biogas for electricity generation.

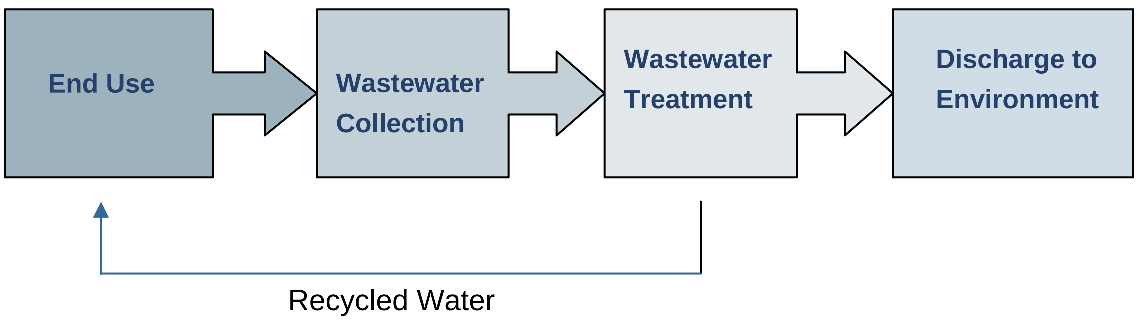
Each process along the water supply chain has varying energy requirements. The water supply chain is depicted in Figure 8 below.

Figure 8: Water Supply Chain



The wastewater supply chain is depicted in Figure 9 below:

Figure 9: Wastewater Supply Chain



The energy used by each of these segments of the water supply chain is discussed below.

Water Supply and Conveyance – Pumping water is the primary driver of energy use in this sub-sector. Some systems collect water in the Sierra Nevada Mountains and deliver it to points of need. These systems require very little energy. However other systems transport water long distances on relatively flat valley floors. The State Water Project, the largest state-built multipurpose water project in the world, must pump water more than 3,000 feet over the Tehachapi range to reach end users in Southern California.

The extraction of groundwater supplies about 30 percent of the state's water needs on average[29], but the use of this resource can increase at times to satisfy as much as 60 percent of

[29] SBW Consulting, 2006. *Municipal Water Treatment Plant Energy Baseline Study.* Pacific Gas and Electric Company, August 2006. http://www.pge.com/includes/docs/pdfs/mybusiness/energysavingsrebates/incentivesbyindustry/wastewater/watertreatmentbaselinestudyreport.PDF

the state's needs during times of severe drought conditions. Several hundred million acre-feet of water are stored in 450 groundwater aquifers in the state. Almost all of the 450 groundwater aquifers are in decline, forcing users of that water to pump from greater and greater depths, requiring more and more energy. The process of artificially storing groundwater for future withdrawal is called aquifer storage and recovery. The Kern Water Bank is one such example. Surplus water is pumped into wells or allowed to percolate into aquifers from ponds and lakes, then pumped from wells when needed. Pumping is the major user of electricity for extracting water from these groundwater sources. Energy intensity varies according to the depth at which the groundwater resides and the efficiency of the pumps and motors used to lift it.

Water Treatment – Some sources of water need very little treatment, so their energy intensity is low. Other sources of water, including salt or brackish water, require large amounts of energy to be made potable. Water for urban use requires more energy intensive treatment than water for agricultural uses. Energy intensity for water treatment is increasing due to stricter standards for water quality under the Safe Drinking Water and Clean Water Act.

Water Distribution – Some fresh water distribution systems are gravity fed, but most require some pumping. The majority of energy use in this sub-segment comes from pumping water and maintaining sufficient pipe pressure to assure that flows can be made at scheduled rates while maintaining sufficient pressure for fire services.

Wastewater Collection – Some wastewater collection systems use gravity to bring the wastewater to a treatment plant. Others need energy to lift or transfer the wastewater.

Wastewater Treatment – All wastewater systems require energy, though some require more than others depending on the quality of the waste stream, the level of treatment required, the distance and elevation of the treatment plant in relation to water sources and water distribution systems, and the treatment technologies used. The primary drivers of energy consumption are the level of contaminants of the influent and the level of treatment. Consequently, energy requirements have risen to meet increasingly stringent water quality discharge requirements.

Electric loads at water and wastewater treatment plants consist primarily of pump motors but also include air blowers, injection equipment, controls, lighting, and in some cases ultraviolet light disinfection and ozonation. Wastewater treatment requires much more energy than water treatment for a given volume of water, with each progressive level of treatment requiring still more. In secondary treatment, most of the energy is used for aeration to promote biological activity. Energy is also required for pumping of wastewater, liquid sludge, biosolids and process water; and processing, dewatering, and drying of solids and biosolids. The drying process, where furnaces generate heat to boil off liquid, is one of the largest users of natural gas in the wastewater treatment process. Tertiary treatment is a filtration process, which requires some additional pumping energy. Wastewater treatment tends to rely heavily on gravity so pumping is not as significant a portion of the load for wastewater as for water.

Wastewater treatment plants often employ anaerobic digesters to generate biogas for electricity generation. Biosolids are added to a heated enclosed tank with an oxygen poor environment where anaerobic microbes can breakdown the solids and produce methane. That methane is captured and burned in an engine that either drives a pump or compressor or runs a generator that produces electricity for on-site use or direct sales to the grid. As such, these companies can reduce their energy consumption from fossil based natural gas and electricity from the grid. It should also be noted that some plants co-fire their engines with pipeline natural gas in order to boost generation.

Wastewater Discharge – Many wastewater discharge systems use gravity to return wastewater to the environment. Others need energy to lift or transfer the wastewater to the discharge point.

Recycled Water and Distribution – In general, only tertiary treatment, which is primarily filtration, is required to reuse greywater for non-potable uses. More energy is needed if additional treatment is required. Most recycled water distribution systems also require additional energy to pump water to intended users.

3.3 Industry Landscape

With approximately 53,000 systems nationwide, the level of industry concentration is very low. Municipalities own and operate nearly 40,000 of the community water supply systems while investor-owned utilities operate the rest. Of the 53,000 water systems, only about eight percent (4,034) of those systems serve eighty-one percent of the nation's population. While most water systems are small-scale, groundwater based, and located in rural areas; the majority of the population drinks from surface water systems.[30] This is because a relatively small number of water utilities serve the majority of the population. Private sector water/wastewater firms comprise a small but growing segment of the market.

[30] U.S. Environmental Protection Agency. 2006. *FACTOIDS: Drinking Water and Ground Water Statistics for 2005*. Office of Water, EPA 816-K-03-001. December 2006. http://www.epa.gov/ogwdw/databases/pdfs/statistics_data_factoids_2005.PDF

Municipalities own and operate about 98 percent of wastewater systems consisting of 21,000 wastewater collection (pipe) systems and 16,000 public wastewater treatment plants.[31] Each system is the exclusive provider for a designated local area.

3.4 Summaries of Major Water and Wastewater Utilities in PG&E and SCE Territory

Following are brief summaries of major water and wastewater utilities, most of which operate in the PG&E and/or SCE territory. The source of the following information is the websites of these organizations.

3.4.1 Public Sector Water and Wastewater Utilities

The following paragraphs discuss the varying types of large municipal water and wastewater utilities in PG&E and SCE territory.

- The **East Bay Municipal Utility District** (EBMUD), colloquially referred to as "East Bay MUD", provides over 216 million gallons of water per day to over 1.3 million customers in portions of Alameda County and Contra Costa County in California.[32] EBMUD operates 4,110 miles of water mains, and 160 storage reservoirs. The company also provides recreational services at five of its reservoirs. Ninety percent of EBMUD's water supply comes from the Mokelumne River watershed in the Sierra Nevada. Water is transported west through large steel pipe aqueducts to regional reservoirs located in the hills of the East Bay region. Water is then transported from the regional reservoirs to treatment plants, delivered to local reservoirs and tanks, and distributed by gravity to customers. EBMUD's wastewater system serves only a portion of its water supply service territory, collecting wastewater from 650,000 people in an 88-square-mile area of Alameda and Contra Costa counties along San Francisco Bay's east shore. EBMUD has a seven-member Board of Directors publicly elected from wards within the service area.

  The majority of EBMUD's energy use stems from pumping drinking water. In 2006, the year from which the previous table's data is based, EBMUD's wastewater treatment

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[31] U.S. Environmental Protection Agency. 2002. *The Clean Water and Drinking Water Infrastructure Gap Analysis*. Office of Water, EPA-816-R-02-020. September 2002. http://www.epa.gov/ogwdw/gapreport.PDF

[32] East Bay Municipal Utility District website. http://www.ebmud.com/about-ebmud/our-story/district-history

plant used PG&E gas to supplement its supply of anaerobically generated biogas to fuel engines used to cogenerate power and hot water for process heating. However, recent plant upgrades have increased the production of anaerobically generated biogas, which has allowed the EBMUD plant to reduce its purchases of PG&E gas.

- Established in 1887, the **Turlock Irrigation District (TID)** was the first publicly owned irrigation district in the state and is one of only four in California today that also provides electric retail energy directly to homes, farms and businesses. TID supplies electricity to a retail customer base in excess of 98,000 residential, farm, business, industrial and municipal accounts in an electric service area that encompasses 662 square-miles in portions of Stanislaus, Merced, Tuolumne and Mariposa counties. TID provides irrigation water to more than 5,800 growers in a 307 square-mile service area that incorporates 149,500 acres of Central Valley farmland. The Tuolumne River is the District's primary source of water. Water for irrigation and hydroelectric power production is stored at Don Pedro Reservoir about 50 miles east of Turlock in the Sierra Nevada foothills. TID is not a large user of PG&E electricity since it generates its own electricity, mostly through hydropower plants. However, TID does purchase natural gas from PG&E for its three natural gas power plants.

- Like the Turlock Irrigation District, the **Modesto Irrigation District (MID)**, is an independent, publicly owned utility that provides electricity and irrigation and treats surface water for drinking. MID extracts water from the Tuolumne River. Don Pedro Reservoir is the District's primary water storage facility, while Modesto Reservoir is a small holding reservoir. The District's 208 miles of canals operate on a gravity flow system. MID provides irrigation water to approximately 60,000 acres, typically between mid-March and late October each year. MID's electric service area includes the greater Modesto area (north of the Tuolumne River, Waterford, Salida, Mountain House (Northwest of Tracy) and parts of Ripon, Escalon, Oakdale and Riverbank. Like TID, MID generates electricity through natural gas power plants powered by PG&E natural gas.

- The **Kern County Water Agency** was created in 1961 by a special act of the California State Legislature and serves as the local contracting entity for the State Water Project. The Agency participates in a wide scope of water management activities to preserve and enhance Kern County's water supply. The Kern County Water Agency is the second largest participant in the State Water Project, a water storage and delivery system of reservoirs, aqueducts, power plants and pumping plants. The State Water Project, extends for more than 600 miles and was planned, built and is operated by California

Department of Water Resources. The Agency has long-term contracts with 14 local water districts for SWP water.

The Cross Valley Canal serves as the Kern County Water Agency's primary conduit for water deliveries to and from the California Aqueduct. In the mid-1970s, the Agency contracted with various water districts for the construction and operation of the canal. The first 17 miles of its 21.5-mile length are concrete-lined to minimize seepage losses. The remainder is unlined to facilitate groundwater recharge. The Canal has the ability to deliver up to 1,830 acre-feet of water per day through seven lift stations to a combination of Cross Valley Canal participants and water banking projects. The delivered water is used for agricultural, municipal and water recharge purposes.

- The **Kern Water Bank** is a Joint Powers Authority, formed in October 1995, which owns 20,000 acres in California's southern San Joaquin Valley southwest of the city of Bakersfield. The Joint Powers Authority includes water districts and a mutual water company that form a board of directors to operate the project. The primary purpose of the Kern Water Bank is to provide a local reservoir of water for its participants during periods of drought. Water is withdrawn from the State Water Project during wet years and stored in the groundwater aquifer by adding water to water ponds. During periods of low water supplies, bank stored water is removed using extraction wells for use of the Bank's primarily agricultural participants.

- **Semitropic Water Storage District** – Like the Kern Water Bank Authority, Semitropic Water Storage District is one of eight water storage districts in California and is the largest in Kern County. The District delivers water to nearly 300 customers for the irrigation of approximately 140,000 acres for agricultural uses. Semitropic Water Storage District covers an area of more than 220,000 acres. Semitropic currently banks 700,000 acre-feet of water in a groundwater storage bank with a capacity of 1.65 million acre-feet. Semitropic is run by a board of directors staffed by a group of farmers within the district, who are elected by ratepayers to serve four-year terms.

- The **Central Contra Costa Sanitation District (CCCSD)** is a sanitary district providing wastewater collection and treatment services to approximately 450,000 people and 3,000 businesses in 10 cities covering a 146 square mile in the central Contra Costa area. CCCSD's Martinez, California based facility has a treatment capacity of 54 million gallons per day. The plant incinerates 200 tons of sludge removed each day, reducing that volume to only 10-12 tons of sterile ash. Their cogeneration facility uses a combination of methane from a landfill and natural gas to produce approximately 3,200 kilowatts of power—more than 90 percent of the plant's daily power needs as well as steam for process uses. The plant produces nearly 600 million gallons of recycled water each year for plant operations, industrial uses, and landscape irrigation.

- The **City of San Jose** provides both water and wastewater services to its residents. Since its inception in 1961, the San Jose Municipal Water System has grown from a relatively small water utility to the fourth largest water retailer in the County of Santa Clara, with almost 27,000 connections serving a growing population currently estimated at over 100,000. The City also operates the San Jose/Santa Clara Water Pollution Control Plant, one of the largest advanced wastewater treatment facilities in California. It treats and cleans the wastewater for over 1,500,000 people that live and work in the 300-square mile area encompassing San Jose, Santa Clara, Milpitas, Campbell, Cupertino, Los Gatos, Saratoga, and Monte Sereno. The Water Pollution Control Plant has the capacity to treat 167,000,000 gallons of wastewater per day. It is located in Alviso, at the southernmost tip of the San Francisco Bay.

- The **Sanitation Districts of Los Angeles County** provides wastewater collection and treatment services for over 5.7 million people in Los Angeles County. In 1923, twenty-four independent districts were created to construct, operate, and maintain facilities that collect, treat, recycle, and dispose of domestic and industrial wastewater. The individual districts operate and maintain their own portions of the collection system. Cities and unincorporated parts of the county are responsible for the collection of wastewater through local sewers and for the collection of solid waste. To maximize efficiency and reduce costs, the districts work cooperatively under a Joint Administration Agreement with one administrative staff headquartered near the City of Whittier. Each Sanitation District has a Board of Directors consisting of the mayor of each city, and the Chair of the Board of Supervisors for unincorporated territory within the District. Each District pays its proportionate share of joint administrative costs.

- The **Coachella Valley Water Department** was formed in 1918, specifically to protect and conserve local water sources. The Department has since has grown into a multi-faceted agency with more than 525 employees helping the district deliver irrigation and domestic (drinking) water, collect and recycle wastewater, provide regional stormwater protection and promote water conservation. Its service area covers approximately 1,000 square miles mostly within the Coachella Valley in Riverside County, California. The boundaries also extend into small portions of Imperial and San Diego counties. The Valley delivers drinking water to more than 102,000 customers and comes from a vast underground aquifer which requires little treatment to meet all the state and federal water quality standards. Almost all of the 60,000 acres of farmland in the region is irrigated by water from the Colorado River transported by the Coachella Canal. A five-member board of directors elected at large for four-year terms runs the CVWD.

- The **Rancho California Water District** is a local, independent Special District organized and operating pursuant to the California Water Code. The District serves the area known as Temecula/Rancho California, which includes the City of Temecula, portions of the City of Murrieta and unincorporated areas of southwest Riverside County. More than 120,000 people are served in the District's service area, which is bounded on the southwest by the Santa Ana Mountains and on the northeast by Gavilan Hills. The District's current service area represents 100,000 acres, containing 940 miles of water mains, 36 storage reservoirs, one surface reservoir (Lake Vail), 47 groundwater wells, and 40,000 service connections. The District's seven-member governing body, the Board of Directors, is directly elected by the voters for a fixed term of four years and is responsible for setting policy and decision-making. Legally a political subdivision of the state, Rancho California Water District operates in an open and public environment.

- Located in Orange County, the **Irvine Ranch Water District** serves the city of Irvine and portions of Costa Mesa, Lake Forest, Newport Beach, Tustin, Santa Ana, Orange and unincorporated Orange County. The District provides potable water to a population of 330,000. The District purchases approximately 35 percent of its drinking water from the Metropolitan Water District of Southern California. Imported water comes from the Colorado River and from Northern California. The remaining 65 percent of the water supply comes from the District's extensive well system from local groundwater sources. The District also collects and treats wastewater through its sewer distribution system. Sewage is conveyed to two treatment plants: the Michelson Water Reclamation Plant in Irvine treats up to 18 million gallons of wastewater per day while the Los Alisos Water Reclamation Plant in Lake Forest treats up to 5.5 million gallons per day. The District's water reclamation plants treat wastewater to tertiary, or advanced levels of treatment. The District uses the majority of recycled water for landscape irrigation in parks, golf courses, school grounds, city street medians, homeowner associations and other public areas. The District also supplies recycled water for use in toilet flushing in over 25 office buildings, for cooling towers and for industrial uses such as carpet dyeing. As an independent public agency, a five-member, publicly elected board of directors governs IRWD. These officials are responsible for the District's policies and decision-making. A general manager and his staff supervise day-to-day operations.

3.4.2 Private Sector Water and Wastewater Utilities

While most water and wastewater utilities are public and accountable to their rate payers through elected boards, a small proportion of California residents are served through investor-owned firms regulated by the California Public Utilities Commission. The following private firms represent some of the largest energy users in PG&E and SCE territory.

- The **California Water Services Group,** a privately held water utility headquartered in San Jose, California, is a holding company with six operating subsidiaries: the California Water Service Company, the Washington Water Service Company, the New Mexico Water Service Company, the Hawaii Water Service Company, the CWS Utility Services and HWS Utility Services. These subsidiaries provide regulated and non-regulated water services to 2 million people in 100 California, Washington, and New Mexico communities. The Group obtains about half of its water from wells and purchases the rest from wholesale suppliers. A negligible proportion of its water supplies consist of surface water. The **California Water Service Company**, widely known as **Cal Water**, is the largest investor-owned American water utility west of the Mississippi River. It provides services to 463,400 customers in 83 California communities, and is regulated by the California Public Utilities Commission.

- The **San Gabriel Water Company** is an investor-owned public utility water company headquartered in El Monte in the San Gabriel Valley. The company provides water utility service to a population of over 321,000 in the company's Los Angeles County and Fontana Water division service areas. San Gabriel Valley Water Company operates under the regulatory jurisdiction of the California Public Utilities Commission which sets the water rates and charges and governs the rules and regulations for providing water utility service.

- The **Golden State Water Company,** a subsidiary of American States Water Company, provides water to over 1 million Californians. The company is regulated by the U.S Environmental Protection Agency, the California Department of Public Health and the California Public Utilities Commission. Golden State Water Company purchases and treats water from groundwater and surface water sources to serve numerous communities in Southern California. It does not treat wastewater.

3.5 Competitive Issues

The level of competition in the water and wastewater sectors is low, primarily due to the fact that regulated monopolies supply water services in defined by service territories. Competition is also low due to the fact that this industry has an extremely high barrier to entry due to large capital requirements and regulatory obligations.

3.5.1 Operational Models

Water and wastewater organizations operate under a number of different models and configurations. Municipalities more often own and operate utilities, but private investors may also own utilities. The same organization may often supply both water and wastewater treatment services or separate entities may provide each service separately.

Investor owned utilities operate as regulated monopolies. The state public utility commission approves utility rates such that investors receive a modest (but stable) rate of return and ratepayers are protected against price gouging. Utilities justify their rate increases through a multiyear rate case process.

Publicly owned municipal utilities tend to operate under a board of directors model. Directors are either appointed by elected city officials or more commonly directly elected by ratepayers. For example, East Bay MUD has a seven-member Board of Directors, elected by ratepayers for four-year terms. The board is responsible for deciding overall policies that are implemented under the direction of the General Manager. EBMUD has approximately 2,000 full-time employees under the administrative direction of an appointed General Manager and management staff.

Some water utilities are also electric utilities. For example, the Turlock Irrigation District provides electric and water/irrigation service to central valley residents and farmers. Another example is the City of San Francisco, which owns and operates Hetch-Hetchy dam for drinking water and generating hydro power. The power is delivered through PG&E transmission and distribution systems to San Francisco's municipal buildings and to two large wastewater treatment plants owned and operated by the city.

Although most municipal utilities prefer to operate their water/wastewater systems themselves, they can transfer the responsibility for water/wastewater management to private companies. A private company may purchase a municipal system outright. A municipality may make a single purpose investment, in which it contracts with a private company to build, own, and service a plant. Alternatively, the two parties could form a public-private partnership, in which the municipality may finance the improvement of a private water system, or could contract with the private firm for operations, maintenance, billing, or other services. Nationally, more than 1,300 government entities contract with private firms to provide water and wastewater facilities.

Privatized municipal utilities are a small but growing segment of the market. A number of factors have driven the trend toward privatization, including a huge backlog of deferred maintenance to the water storage, treatment, and distribution systems in the United States; the challenges posed for municipalities by increasingly stringent water quality standards; the increasingly complex operations of water utility plants and the associated need to keep abreast of technological developments; and the presence of several large water firms (based in both the United States and abroad) with appropriate resources and expertise seeking market opportunities in the water utility sector. Yet, despite these pressures towards privatization, the market share of private firms in the United States water business has remained fairly steady over the past fifty years and is unlikely to shift dramatically in the near future.

3.5.2 Cost Structure

The cost structures of public utilities vary widely depending on their structure. Some utilities own and maintain vast infrastructure systems spanning hundreds of miles, while others just deliver or treat water through their local distribution system. Utilities that provide both water delivery and treatment spend more money on chemicals than those who just deliver water. Utilities that engage in extensive groundwater and surface water pumping spend much more on energy than those who primarily rely on gravity.

One common expense for all utilities is depreciation and interest for capital investments in infrastructure. For example, in fiscal year 2009, nearly 40 percent of East Bay MUD's expenditures for water and wastewater stemmed from depreciation and interest. The remaining 60 percent went to operations and maintenance.[33]

Operational expenses for water treatment primarily consist of purchases such as chemicals and purchased water. While water from lakes or rivers is sometimes free, utilities must often pay wholesale fees for water owned by private owners or local or regional public water authorities.

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[33] East Bay Municipal Utility District. 2009. *East Bay Municipal Utility District 2009* [Annual Report]. http://www.ebmud.com/sites/default/files/pdfs/FY09annual10_0.PDF

Typical long-term wholesale water prices in California are $500 to $600 per acre-foot.[34] Water from wells is often cheaper than surface water. Wages, administrative costs, professional services, offices, insurance, regulatory costs, taxes, maintenance, and fuel comprise the remaining operational costs. Water supply utilities require very little natural gas for treatment and transport of water, but use substantial amounts of electrical energy for water pumping.

Wastewater treatment plants spend a considerable amount of money on energy. According to the Environmental Protection Agency[35], energy costs can account for 30 percent of the total operation and maintenance (O&M) costs of Wastewater treatment plants. Natural gas is used for process heating and solids drying at wastewater treatment plants, however some plants offset their demand for natural gas by generating and combusting their own anaerobically digested biogas for process heating needs and electricity generation. Rate receipts provide capital funding for energy and with Prop 218, public agencies have limited authority to increase tax rates without rate payer consent. Prop 218 is thus one of the limiters for the publicly owned water/wastewater utilities when investing in energy.

3.5.3 Pricing

Both public and private water and wastewater utilities earn revenue through user fees. Pricing schemes vary, from flat fee to per gallon pricing and some combinations of both. Revenue is used to pay for operations and provide capital for maintenance and new projects. Publicly owned utilities are managed by Directors who are responsible to ratepayers in election cycles. Thus, keeping constituents happy requires keeping water rates as low as possible. More sustainability minded communities typically have higher tolerance for higher rates in exchange for environmental benefits.

Regulated investor-owned water and wastewater utilities make rate case filings to the Public Utility Commission to cover expenses and earn a moderate return on investment. Regulators enforce a low-cost mandate such that all capital projects need to be demonstrated to be absolutely necessary or money saving in the long run. The growth in real industry revenue has outstripped growth in the consumption of water, reflecting rising water prices. A number of

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[34] Pacific Institute for Studies in Development, Environment, and Security. 2001. *Economic Evaluation of the Cadiz Groundwater Storage and Dry Year Supply Project, Metropolitan Water District of Southern California*. July 2001.
http://www.pacinst.org/reports/cadiz/cadiz.PDf

[35] U.S. Environmental Protection Agency. 2009. EPA's Clean Energy-Enviornment Tech Forum, Clean Energy Opportunities in Water and Wastewater Treatment Facilities. January 15.
http://www.epa.gov/statelocalclimate/documents/pdf/background_paper_wastewater_1-15-2009.pdf

factors underpin the increase in prices, including the need to raise earnings in order to maintain aging water supply infrastructure and the need to fund necessary expenditure for compliance with new water quality regulations.

Generally speaking however, as a commodity required for human survival, regulators keep water utility rates held to a minimum. The EPA considers water to be the lowest cost utility and believes that a cost equal to 2 percent of household income is affordable.[36] The current cost is 0.5 percent of average household income. For example, in 2000, East Bay MUD charged customers a base rate of $6.67/month plus $1.27 per 748 gallons of water. In 2009, East Bay MUD charged customers $9.53/month plus $1.82 per 748 gallons of consumption.

Water supply accounts for 85 percent of industry revenue and sewer services for 15 percent.[37] The consumption of water is determined primarily by shifts in population and increasing levels of affluence. These two variables explain virtually all the year to year movements in water consumption, with population playing a particularly important role. Increasing affluence is generally linked with higher demand of potable water for yard irrigation needs and pool maintenance.

Overall, water consumption grows relatively slowly. The average annual increase in water consumption for the five years ending in 2009 is expected to be close to the average annual population growth, at about 0.9 percent.[38]

3.5.4 Technology Change

The level of technology change in municipal water and wastewater treatment and supply is moderate. Increasingly stringent water quality regulations require municipally and investor-owned utilities to spend time and capital to upgrade their facilities to comply. A key area of technological change is increasing sophistication in both the treatment of water and wastewater and the monitoring of its purity.

Both EPA and California mandate maximum contaminant levels for drinking water. Periodically, additional chemicals may be added to the list or standards tightened. For example, California

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[36] Raucher, Bob. Stratus Consulting. 2004. "Affordability of Water Service: What does it mean? How is it Measured? Why does it matter?" (Presentation to EFAB Affordability Workshop. August 18, 2004.)

[37] First Research. 2009. Industry Profile Water and Sewer Utilities. http://www.firstresearch.com/Industry-Research/Water-and-Sewer-Utilities.html

[38] IBIS World. 2009. *Industry Report: Water Supply & Irrigation Systems in the US: 22131*

required tighter standards for arsenic in 2008. Arsenic is a toxic heavy metal that occurs naturally in certain types of geologic formations, and treatment of arsenic requires additional technology. Tight standards for other heavy metals and chemicals such as pesticides, solvents and colorants may also push technological change.

Typically wastewater treatment facilities are granted discharge permits which quantify the maximum amount of allowable contaminants or chemicals. When a permit is up for renewal, these maximum allowable limits may be lowered and additional chemicals may be added to the list. To comply with the revised permit, the facility may be required to upgrade its treatment technologies and add specific treatment steps to address the contaminants that must be removed from the water.

In addition to new technologies at the utility level, innovative technologies are being applied to treat wastewater on-site within buildings. The U.S. Green Building Council, developers of the LEED standards, reward buildings that install innovative on-site treatment systems such as composting toilets and greywater reuse. While innovative, these strategies have not had a material effect on energy use in the water and wastewater sectors.

3.6 Economic Factors

The following sections describe the business cycles and availability of capital and credit for water and wastewater utilities.

3.6.1 Business Cycles

Nationwide, the water supply and irrigation systems sector was expected to supply about 46.3 billion gallons of water per day in 2009. The household sector is the major user of water supplied by the water supply and irrigation systems sector, accounting for almost 60 percent of total water consumption. [39] The remaining water, not accounted for by the water supply and wastewater treatment industries, is drawn directly from groundwater and surface water primarily for nuclear power plants, irrigation, and industry.

The water and wastewater sector is effectively recession proof since the demand for water and water services is highly inelastic and prices are low due to price regulation or ratepayer pressure. Growth in the residential sector is the primary driver for growth in water supply and

[39] IBIS World. 2009. *Industry Report: Water Supply & Irrigation Systems in the US: 22131*

treatment. The primary determinants of water demand growth are population growth, climactic conditions, and general levels of affluence.

Climate is the primary driver of demand in the agricultural sector. Demand for water is higher in dry and arid regions, such as the western United States than in areas where natural rainfall is plentiful and year round. Conversely, climate patterns also affect water supply. In the west, it is common to experience multi year drought and wet cycles. During dry cycles, increased demand for water strains the storage system and results in a depletion of the groundwater aquifer. In highly wet years, aging infrastructure becomes a liability for dam and levee ruptures.

3.6.2 Availability of Capital and Credit

The water supply and wastewater treatment industries are very capital intensive. The industry relies on investment in infrastructure such as dams, pumping stations, treatment plants, and extensive pipe networks to earn revenue. The American Society of Civil Engineers (ASCE) found that investments of $390 billion is needed over the next 20 years to update or replace existing water and wastewater systems and to build new ones. The ASCE has estimated that leaking pipes lose about seven billion gallons of clean drinking water per day while aging systems discharge billions of gallons of untreated wastewater into U.S. surface waters each year. Urgent infrastructure needs include fixing deteriorating pipes and mains, and the construction of large-scale water treatment plants.

Capital expenditures related to municipal water supply, treatment and distribution and wastewater collection and treatment facilities are typically funded by water and wastewater rates, taxes or the issuance of bonds. Raising large amounts of funds is challenging for municipal water utilities and is likely to remain so even as the global financial crisis eases. In order to meet their capital spending challenges, many municipalities are examining a combination of privatization and partnerships with the private sector.

In the private sector, firm consolidation offers an ability to pool enough capital to make the necessary investments. Larger firms enjoy economies of scale and stronger technological expertise that would not be feasible in a smaller organization. Scale improves capacity to meet increasingly stringent environmental regulations and an enhanced ability to deal with technological and regulatory challenges and fund necessary capital investment. Water supply systems owned by municipalities will remain the major source of potential acquisitions and partnerships, due to the high cost of maintaining, upgrading and, where necessary, expanding existing systems.

The wastewater treatment industry is supported by a variety of government funding programs. The major program is the Clean Water State Revolving Fund, operated by the Environmental Protection Agency. This fund provides over $1 billion annually to the states, who manage individual revolving loan funds for wastewater and other water quality projects. Loan funds are available at low or zero interest, with repayment periods of up to 20 years.

The California Energy Commission provides low interest rate loans to fund up to 100 percent of the cost of water/wastewater energy efficiency and self-generation projects. Eligible projects must have an average simple payback of less than 11 years. If projects have a greater simple payback, the Energy Commission can provide a loan equal to 11 times the annual energy cost savings. Eligible projects include pumps and motors, variable frequency drives, lighting, building insulation, HVAC modifications, automated energy management systems, automated energy management controls, energy generation, streetlights and light emitting diode signals. The Energy Commission has provided more than $11.2 million in loans for projects associated with both improving the energy efficiency of water and wastewater facilities and reducing the energy costs of these facilities. These projects have saved public facilities about $1.9 million annually in lower energy bills. This is equivalent to saving 23 million kWh annually, with billing demand savings of about 2.3 MW.

The Rural Utilities Service of the U.S. Department of Agricultural provides water and waste disposal loans and grants in rural areas and towns with 10,000 or fewer residents. These funds are available to public entities and nonprofit organizations.

3.7 Regulatory Issues

Since water is ingested it requires public health oversight. Various entities regulate municipal and investor-owned water utilities. Health and safety regulations for water have become increasingly stringent over the past ten years. Investor-owned utilities are regulated economically.

3.7.1 Environmental

The Safe Drinking Water Act (SDWA) of 1974 is the primary law driving regulation of water utilities. The SDWA establishes criteria and procedures for the Environmental Protection Agency to develop national quality standards for drinking water. The SDWA was amended in 1996 to include additional water quality standards. Disinfection by-product limits were lowered in 1998 and more stringent surface water treatment performance standards became effective in 2002. In 2001, the EPA adopted a limit for arsenic in water of 10 parts per billion. The new limit, which became effective in 2006, is one-fifth the previous allowable level and required considerable investment spending by water utilities. Removing trace elements such as arsenic from water requires higher energy expenditures in treatment.

The Clean Water Act regulates wastewater treatment discharges into the environment. The National Pollutant Discharge Elimination System permit program, overseen by the EPA's Office of Wastewater Management, controls water pollution by regulating point sources that discharge pollutants into waters of the United States. State and federal laws and regulations under the Resource Conservation and Recovery Act mange the handling and disposal of residuals and solids from water and wastewater treatment facilities. Wastewater residuals and solids generated from the treatment of municipal wastewater are disposed of in approved landfills, land farmed, anaerobically digested for biogas energy, or are composted and applied to farmland. Operators are required to obtain permits for wastewater treatment facilities and landfills.

3.7.2 Climate

In 2006, California's Global Warming Solutions Act (AB32) became the first legislation signed into law in the United States to establish mandatory limits on greenhouse gas emissions. The California Air Resources Board (ARB) is the lead agency tasked with developing the regulatory structure to achieve emissions reductions targets. California facilities that emit more than 25,000 metric tons of CO_2 equivalents (CO_2e) must report their emissions to the Air Resources Board. Organizations that generate electricity and emit more than 2,500 metric tons of CO_2e must also report. This would require water utilities with power generation facilities, such as the Turlock Irrigation District, to report GHG emissions. California based municipal wastewater treatment plants that generate electricity from biogas are required to report their GHG emissions and electricity generation data. All reporting entities must have their emissions reports verified by an accredited third-party auditor.

In January 2009, ARB adopted a Scoping Plan that provides the blueprint for achieving the reductions through a mix of incentives, direct regulatory measures, and market-based compliance mechanisms. It is unlikely water and wastewater utilities would be captured in a cap-and-trade system since biogas is considered carbon neutral. However, the scoping plan recommends (but does not mandate) that local governments work to achieve a 15 percent reduction in greenhouse gasses. Since municipal governments own most water and wastewater utilities, they would likely be targets for emissions reductions opportunities.

The U.S. EPA's recent rules mandating reporting GHG from facilities that emit 25,000 metric tons of GHG or more starting March 31, 2011, does not apply to most municipal water and waste water operations since these facilities usually do not meet the EPA threshold for reporting.

3.7.3 Economic Regulation

The California Public Utility Commissions (CPUC) regulates the rates and profits of investor-owned utilities. There are approximately 140 companies under CPUC jurisdiction providing potable and irrigation water service to about 20 percent, or more than 6 million, residents of California. The CPUC has broad authority to establish rates for service, prescribe service standards, and to review and approve rules and regulations. In most instances, long-term financing programs, transactions between water utilities and affiliated interests, reorganizations, mergers and acquisitions require state commission approval to proceed.

The Commission's objectives in regulating water utilities rest on four key principles: 1) safe, high quality water; 2) highly reliable water supplies; 3) efficient use of water, and; 4) reasonable rates and viable utilities.

Economic regulation deals with many competing, and often conflicting, public interests and policy goals. Normally, the water utility initiates rate adjustment proceedings. Commission staff investigates claims and holds public hearings. The hearings form the basis for a commission decision. The purpose of this regulatory process is to set rates that will cover the reasonable operating costs of providing quality service to customers that will also allow the water utility the opportunity to earn a fair return on the investment necessary to provide that service. A rate proceeding generally focuses on four areas: the amount of investment in facilities which provide public service; the operating costs and taxes associated with providing the service; the capital costs for the funds used to provide the facilities; and the tariff design which allocates revenue requirements equitably across the customer base.

The regulatory rate setting process is time-consuming. After considering the time required to complete the regulatory process, water utilities file for rate adjustments that will reflect as closely as possible the cost of providing service during the time new rates are intended to be effective.

3.8 Industry Network

The industry network for this sector provides a list of potential partners for energy efficiency. Major industry associations promote standards, and provide education and networking for water and wastewater professionals.

The American Water Works Association serves as the primary industry group in the water supply and wastewater treatment sectors. Founded in 1881, AWWA is an authoritative resource on safe water, with more than 60,000 members worldwide sharing knowledge on water resource development, water and wastewater treatment technology, water storage and distribution, and utility management and operations. AWWA provides knowledge, information and advocacy to improve the quality and supply of water in North America and beyond and advances public health, safety and welfare by uniting the efforts of the full spectrum of the water community.

AWWA publishes Journal AWWA. An annual conference is held in the United States for the entire organization and several regional meeting and conferences around the world. AWWA provides information on technology, trends, and news through its periodicals, website, and media outreach. AWWA publishes books, manuals, videos, electronic databases, and reports for use by water professionals and others. AWWA also develops industry standards for products, processes and best practices that advance public health and safety. Currently, there are over 145 AWWA standards covering filtration materials, treatment chemicals, disinfection practices, meters, valves, storage tanks, pumps, and ductile iron, steel, concrete, asbestos-cement, and plastic pipe and fittings.

The Association of California Water Agencies (ACWA) is the largest coalition of public water agencies in the country. Its nearly 450 public agency members collectively are responsible for 90 percent of the water delivered to cities, farms and businesses in California.

Formed in 1910 by five irrigation districts, ACWA's mission is to assist its members in promoting the development, management and reasonable beneficial use of good quality water at the lowest practical cost in an environmentally balanced manner.

ACWA identifies issues of concern to the water industry and the public it serves; accumulates and communicates the best available scientific and technical information to the public and policy makers; facilitates consensus building; develops reasonable goals and objectives for water resources management; advocates sound legislation; promotes local service agencies as the most efficient means of providing water service; provides additional services of value to its members; and fosters cooperation among all interest groups concerned with stewardship of the state's water resources.

ACWA engages on an array of legislative and regulatory issues to promote a more reliable and sustainable water system. It also works hard to assist its members as they implement local resource programs and respond to challenges such climate change. In addition, ACWA undertakes focused policy initiatives aimed at protecting members' pocketbooks, promoting local management of groundwater basins, protecting water rights and promoting regulatory decisions that facilitate member interests.

The National Association of Water Companies (NAWC) represents all aspects of the private water service industry. The range of business includes ownership of regulated drinking water and wastewater utilities and the many forms of public-private partnerships and management contract arrangements. NAWC was founded in 1895 by 16 small water companies in Pennsylvania, NAWC today has members in every region of the United States. NAWC's membership ranges in size from large companies owning and/or operating many hundreds of utilities in multiple states to individual utilities with only a few hundred customers.

The mission of the NAWC is to promote the value of the private sector as the provider of quality, sustainable water services and innovative solutions. Water and energy are inextricably linked., Prodigious amounts of water are needed to generate electricity and huge amounts of energy are needed to produce, treat and deliver clean, safe and reliable water and wastewater. Therefore, NAWC supports energy efficiency, responsible use of natural resources, and using renewable energy sources and conservation strategies whenever possible.

The **California Water Environment Association** (CWEA), is a California nonprofit public benefit corporation, tax-exempt under section 501(c)3 of the internal Revenue Code and its California counterpart. Approximately 9,100 wastewater professionals are members of CWEA. Most of CWEA's members (about 80 percent) work for wastewater agencies, both large and small, throughout the state. About 13 percent work for consulting engineering firms that work closely with agencies. And approximately 3 percent work for equipment manufacturers serving the wastewater industry. CWEA sponsors an annual state-wide conference, regional conferences, specialty conferences, and local section educational events. They publish an E-Bulletin, an electronic member-only publication offered six times a year, and The Wastewater Professional a print member-only publication offered four times a year. CWEA is governed by a volunteer 17-member board of directors at the state level.

3.8.1 Supplier and Trade Allies

Large engineering and environmental consulting companies primarily service water supply and treatment. These trade allies provide technical assistance in operations, design, energy efficiency and renewable energy, including planning, energy audits, feasibility studies, permitting, engineering, and construction. Often, municipalities will turn to these firms to provide advice on appropriate technology and design to aid in investment decision making.

A survey of the major water and wastewater-focused firms include:

- **Brown and Caldwell** is a major supplier of engineering and environmental services to the water supply and wastewater treatment industries. Previously, Brown and Caldwell and KEMA have partnered to implement innovative wastewater treatment energy efficiency programs.
- **Black and Veatch** is a global engineering, construction and consulting firm specializing in energy, water, environmental federal, and telecommunications markets.[40] Black & Veatch's global water business provides innovative, technology-based solutions to utilities, governments and industries worldwide. Local project teams work with multi-national water and wastewater treatment process experts to address site-specific challenges through a broad range of consulting, study, planning, design, design-build and construction management services.
- **CH2M Hill** is a multi-disciplined planning, design, management, construction and operations firm that is a global leader in water, wastewater, energy and industrial projects. CH2M Hill has more than 350 offices worldwide and is a $3.8 billion revenue company.
- **Carollo Engineers** has provided planning, design, and construction management services for municipal clients since 1933. They are the largest firm in the United States that is dedicated solely to water and wastewater treatment. Historically, Carollo has worked primarily in the western United States, however, over the past decade, the firm has expanded into a nationwide service provider. Since its inception, Carollo has completed more than 15,000 projects for public sector clients.

[40] Hoovers website, Black & Veatch Corporation.
http://www.hoovers.com/company/Black__Veatch_Corporation/ctftif-1.html

- **HDR** is an employee-owned architectural, engineering and consulting firm that provides its clients with water and wastewater experts with experience in all aspects of water management, including membrane treatment, advanced treatment research, regulatory compliance, nutrient reduction, reclaimed water technology, security/threat protection, management consulting, master planning/computer modeling, storage, pumping stations, operations and maintenance and corrosion control.

- **Kennedy/Jenks** is an engineering, environmental science, and architectural services, firm. Kennedy/Jenks offers comprehensive services in both water and wastewater engineering and management.

- **Metcalf and Eddy/AECOM,** founded in 1907, Metcalf & Eddy first won national recognition when it pioneered what would become known as "environmental engineering" through its water and wastewater work. Today M&E provides a full range of services for water resource management; water and wastewater system planning, design, and construction; wet weather controls; and hazardous waste remediation. M&E is now a member of the AECOM family of professional service companies.

4. Target Technologies / Processes and Energy Efficiency

The following sections discuss the water and wastewater processes as well as common energy efficiency opportunities.

4.1 Production Processes

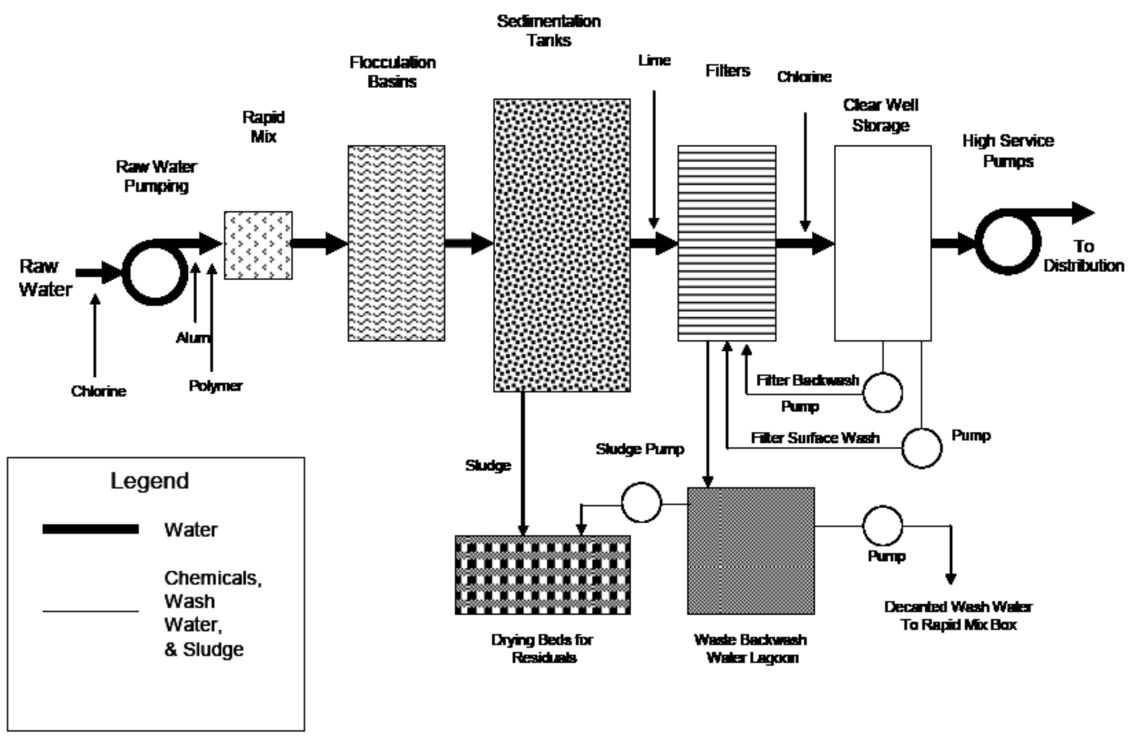
A water system consists of a water source, a system of storage reservoirs, a water treatment facility, and a pipe distribution system. Water is first diverted, collected, or extracted from a source. The water source may be surface (lakes or rivers) or ground water (springs and wells). To ensure that water is available during periods of peak use (which often coincide with periods of low accumulation, like the summer months), utilities may operate various types of reservoirs, including tanks, artificial lakes, and covered ground reservoirs. On average, surface water accounts for more than 60 percent of water supply and groundwater accounts for about 30 percent. Recycled water and desalinated water comprise the rest.

Water is supplied for either agricultural or urban use. Urban wastewater is collected, treated, and discharged back into the environment. In general, wastewater from agricultural uses does not get treated before discharge directly back to the environment as runoff into natural waterways or into groundwater basins. A growing trend is to recycle some portion of the wastewater stream for non-potable (greywater) uses such as landscape irrigation or industrial process cooling.

4.1.1 Water Treatment

Water treatment consists of various steps to remove contaminants. The figure below shows a schematic of a representative water treatment plant.[41]

Representative Water Treatment Plant



Source: Klein 2005

The quality of the water source as well as the planned end use of the water determines the level of treatment required. In the case of surface water sources and potable water uses, a typical sequence of operations is a series of process stages. The raw surface water passes through screens, and then is treated by chlorine or ozone to kill organisms. Next, the water is treated with coagulants such as alum and/or polymeric materials to promote settling. Particles are

[41] Klein, G. 2005. *California's Water – Energy Relationship.* California Energy Commission, CEC-700-2005-011-SF, November 2005.
http://eec.ucdavis.edu/events/documents/water-energy_cec_california_water-energy-relationship.PDF

removed from the water by flocculation, sedimentation, and filtration. The water then passes through another disinfection stage to kill remaining organisms, usually a chlorine treatment.

Upon completion of treatment, fluoride may be added to reduce tooth decay and calcium hydroxide to prevent pipe corrosion before the potable water is metered and distributed to customers. Throughout the process, water is periodically tested for quality.

4.1.2 Water Distribution

A network of pipes, pumps and storage tanks distributes potable water to customers. The water must be pressurized and moving, and the water tanks and pipes periodically flushed to prevent water from stagnating, which could allow microbes to proliferate and pipes to corrode.[42]

Cities with hilly terrains can use hilltop tanks both as storage and to provide pressure into the distribution system; San Francisco is perhaps the best example of this, serving virtually all of its customers from hilltop tanks. But the water must first be pumped up to the tank, often several hundred feet in elevation. In addition, water supply utilities often must flush water from the tanks to prevent microbial contamination and then fill them up once again through the pumping station. In fact, this flushing accounts for the bulk of electricity used in East Bay Municipal Water District's distribution system.

4.1.3 Wastewater treatment

Wastewater treatment utilities provide two related services: collection and treatment. Primary treatment uses screens to remove large solids and large settling basins, called clarifiers, to physically separate remaining solid wastes from wastewater through gravity sedimentation and floatation. Secondary treatment typically uses a biological process to remove the remaining organic waste from the water. Sometimes a third step is taken to remove salts and certain metals. Once wastewater is treated to regulatory standards, it is released into lakes, streams, or groundwater sources. Tertiary treatment is sometimes employed to further treat water for recycling. Tertiary treatment uses media such as sand, diatomaceous earth, or anthracite coal to filter out and remove tiny particulates prior to discharge into the recycled water system.

The following diagram illustrates a wastewater treatment plant owned by the Oro Loma Sanitary District in the Bay Area.[43]

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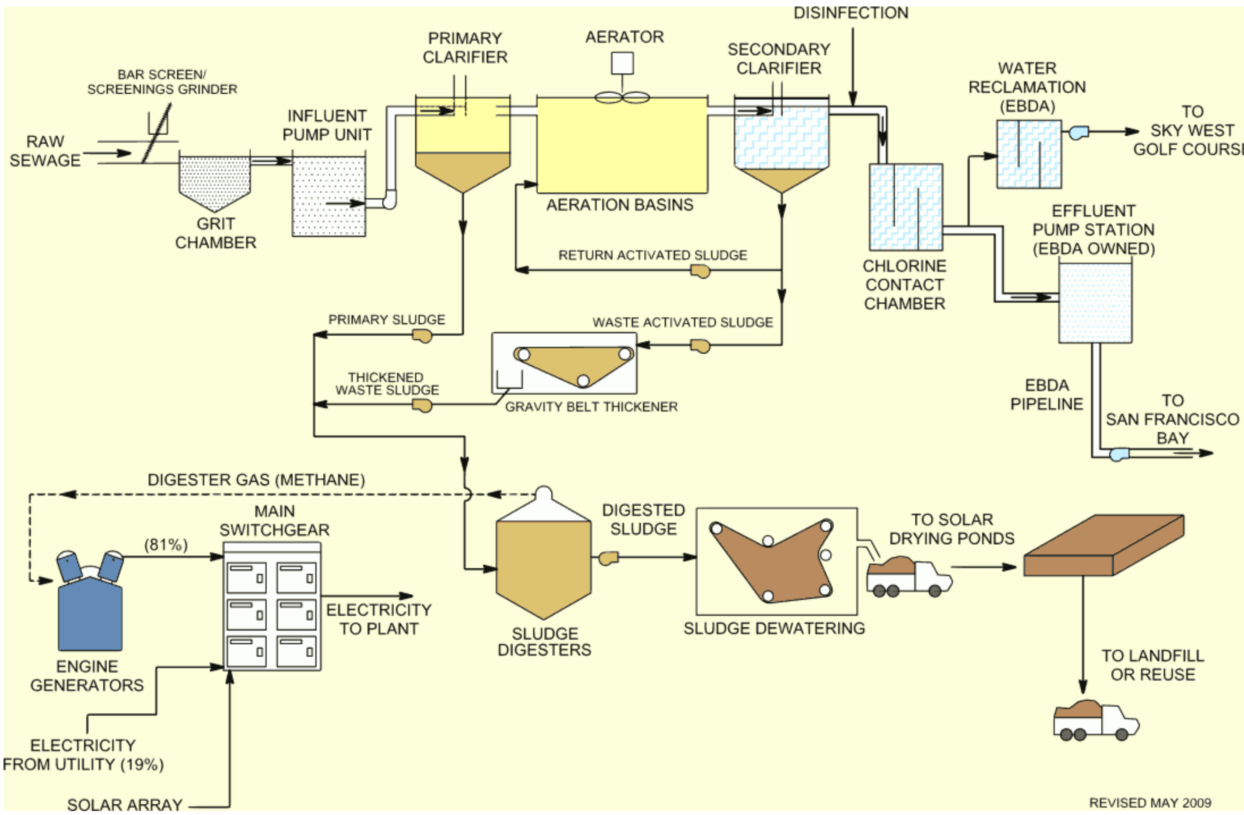
[42] Ibid.

Figure 10: Oro Loma Wastewater Treatment Plant



Source: Oro Loma Sanitary District

The diagram above demonstrates three levels of treatment, known as primary, secondary, and tertiary.

- **Primary Treatment –**The initial steps involved in sewage wastewater treatment are physical processes, which separate larger solids from liquid using screening and grit removal. Steps that remove larger solids are termed preliminary treatment. The solids separated by the preliminary processes are usually disposed of in a landfill. After removal of larger solids, primary treatment follows to separate the smaller solids. Primary treatment involves large settling basins (clarifiers) wherein heavy solids settle to the bottom to be removed by flight scrapers, and lighter solids float to the surface where they are skimmed off. Some chemicals may be added to assist with floating the lighter solids for removal.

[43] Oro Loma Sanitary District 2011. Sewage Treatment Diagram http://www.oroloma.org/sewer/treatment/diagram/index.html

- **Secondary Treatment –** The physical processes are sometimes followed by secondary biological aerobic treatment in which extended favorable aeration (oxygen) and environmental conditions are provided for microbes that break down organic material into carbon dioxide and water. This process is primarily used by larger plants**.** Equipment used for the aerobic treatment can include aerated basins, trickling filters ,and others. After aerobic treatment, the wastewater is separated from the remaining solids in a sedimentation tank (clarifier) creating a clear effluent and a waste sludge stream. Some of the bacteria laden sludge is re-introduced to the aeration basins and the remainder is extracted and sent to an anaerobic digester where the organic material is further broken down into a biogas, which is primarily methane and carbon dioxide. Some plants use the biogas, sometimes co-fired with natural gas, to fuel cogeneration engines. For example, the Oro Loma plant depicted above co-fires PG&E gas and digester gas to run its electrical generating engine. Other plants use biogas to fuel boilers to dry their sludge. Still others just flare the gas.

- **Tertiary Treatment –** The clear effluent, after the secondary treatment can be further treated with physical filtration, chemical, or ultraviolet disinfections if the water is to be recycled. In the diagram above, recycled water is pumped to the Sky West Golf Course.

- **Digester Energy –** The figure above shows that in this particular plant, bio-solids are broken down by bacteria in an anaerobic environment to create methane, which in turn is combusted in an engine to generate electricity.

- **Solids Handling and Disposal –** The end product of the primary and secondary processes, whether it includes a digester or not, is a sludge. This sludge stream is typically dewatered using either a belt press or a centrifuge and then dried with heat from process boilers, cogeneration engines or, as is the case at Oro Loma, spread and dried in solar basins. The dried solids can be landfilled, composted, or landfarmed.

The major driver of unit energy consumption is the degree of treatment required. As noted above, there has been a trend toward more thorough treatment, with upgrades or replacements of older systems that could not provide this higher level of treatment. This upward trend in unit electricity consumption is expected to continue as more thorough treatment is required.

Wastewater consumes electricity in three stages: transport to the facility, treatment, and disposal/recycle. The first stage, transporting from the generator to the wastewater treatment facility, requires about 150 kWh/million gallons of on average to pump the water, depending on topography, system size, and age. Given a choice, wastewater treatment utilities prefer to place water treatment facilities above their customers and the wastewater treatment facilities below, to take advantage of the pull of gravity where possible, and to place water intakes upstream from wastewater outfalls on rivers.

Decentralized wastewater treatment systems are also relatively commonplace in the United States. They consist of onsite, or cluster, wastewater systems that are used to treat and dispose of relatively small volumes of wastewater, generally from dwellings and businesses that are located relatively close together. They are commonly referred to as septic systems, private sewage systems, or individual sewage systems. About one quarter of the population is served by onsite wastewater treatment systems. Onsite septic systems use little or no energy operating entirely on gravity flow.

4.1.4 Efficiency Improvements

While the first cost of efficient equipment and processes is low or falling, energy prices are on the rise and threaten to overwhelm municipal budgets. A central motivation when municipalities consider upgrades or redesigns of their water-wastewater treatment operations is the need to reduce the amount of money being spent every month on unnecessary energy consumption. A key barrier to addressing energy costs is a predisposition of some designers and some in the supply community to meet the regulatory demands of the industry. They rarely identify or offer energy-efficiency as a viable source for cost reductions since energy efficiency actions tend to require some investment. Their offerings focus on meeting regulatory requirements at low costs since most public works contracts go to the lowest bidder by law.

Through our interview with energy users in the water and wastewater industry, we found that many have completed energy efficient equipment retrofits. Some of the energy efficiency measures installed by utilities we interviewed include:

- Upgrading aeration blowers
- Installing energy efficient pumps
- Installing energy efficient motors
- Installing VFDs on pumps
- Retrofitting lights
- Recovering digester gas for use in CHP/cogeneration engines

Though the water and wastewater sector is prioritizing for energy in their business operation, more untapped opportunities for reducing energy consumption still remain. According to an audit on water and wastewater plants conducted by Electric Power Research Institute (EPRI), they found potential estimated annual savings of 880 million kWh through the implementation of energy conservation measures.[44]

The following describes some of the best opportunities for energy savings in the water and wastewater sectors.[45]

- **Reducing Aeration Energy for Secondary Treatment –** Aeration in the secondary treatment process accounts for 30-60 percent of total energy consumption at the typical activated sludge wastewater treatment facility, based on KEMA's recent experience in assessing energy efficiency projects for this type of plant. Therefore, optimizing the efficiency of the aeration is usually the most significant energy efficiency opportunity at a facility. Air is introduced into the wastewater for two reasons: to provide oxygen to metabolize microorganisms to degrade organic matter to carbon dioxide and water, and to provide mixing such that the microorganisms contact the organic matter and to keep solids suspended in the liquid instead of building up on the bottoms of the aeration basins. Air can be introduced by mechanical means by agitators and blades, or injected through diffusers and other devices. There are a number of opportunities to improve the energy performance of aeration systems, including dissolved oxygen (DO) sensors and automated controls, fine bubble diffusers, efficient blowers, and variable speed drives.

- **Process Optimization –** Water and wastewater facilities are designed to meet the volume and purity standards that were applicable or foreseeable at the time the facilities were designed. When a facility is required to meet new discharge limits, new drinking water standards, or expand to serve more customers, the entire process can be reviewed for opportunities for energy efficiency. Optimizing the design for changing requirements can incorporate new technologies for quality, operations and energy efficiency.

- **Energy Management Systems Controls-** Computer based tools monitor, control, and optimize the operation of a plant. The energy management system could, for example, slow or shut down equipment that is not needed in times of lower flow-rate. These automated controls also provide continuous information about energy usage to support further improvements. Many older plants are not equipped with computer controls and

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[44] Electric Power Research Institute. 1996. *Water and Wastewater Industries: Characteristics and Energy Management Opportunities*, CR-106941, September 1996.

[45] KEMA and Lawrence Berkeley National Laboratory. 2005. *California Statewide Industrial Sector Energy Efficiency Potential Study* . Prepared for Pacific Gas and Electric Company.

instead use manual and pneumatic controls. Upgrading older plants with computer control such as Supervisory Control and Data Acquisition (SCADA) or Distributed Control Systems (DCS) generally provides many opportunities to improve energy efficiency.

- **Variable Frequency Drives –** A variable-frequency drive (VFD) is an electronic controller that adjusts the speed of an electric motor by modulating the power. Variable-frequency drives provide continuous control, matching motor speed to the specific demands of the work performed. Variable-frequency drives are enjoying rapidly increasing popularity at water and waste-water facilities, where the greatest energy draw comes from pumping and aeration—two applications particularly suited to variable-frequency drives. Variable-frequency drives can reduce a pump's energy use by as much as 80 percent.

- **Energy Efficient Motors –** Energy-efficient motors, also called premium or high-efficiency motors, are 0.5 to 3 percent more efficient than standard motors. Pump and blower motors account for 80 to 90 percent of the energy costs in water supply and wastewater treatment facilities, and the lifetime energy costs to run a continuous-duty motor are 10 to 20 times higher than the original motor purchase price. Thus, energy-efficient motors, particularly when replacements are necessary, can play a major role in reducing facility operating costs.

- **Minimizing Leaks –** Measuring the extent of leakage and taking steps to repair leaks can avoid unnecessary pumping as well as water loss. One method is to measure the minimum night flow, between 1 a.m. and 4 a.m. that should be close to a small percentage of the average flow[46] and then assess the system if it is not.

- **Optimizing Pump Systems –** Proper pump sizing, controls and pump system improvements allow maximum energy efficiency performance. Such improvements could include pump demand reduction, high-efficiency pumps, impeller trimming, and installing multiple pumps for variable loads**.**

- **Cogeneration Optimization** - Cogeneration is a common feature of many wastewater treatment plants. Biogas from the anaerobic digester, a byproduct of wastewater treatment, is used to fuel cogeneration engines to drive generators to produce electricity

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[46] Barry, J. 2007. *Watergy: Energy and Water Efficiency in Municipal Water Supply and Wastewater Treatment*. Alliance to Save Energy. Washington, D.C.

for plant use or for sale, and to produce thermal energy for process heating, heating work spaces, or dying sludge. Optimization strategies for cogeneration units can yield significant energy savings. Installing additional cogeneration engines or modifying digesters to produce more biogas can increase energy production, enabling wastewater treatment plants to purchase less electricity or to sell more offsite. Co-generation optimization studies can be done in-house or by qualified engineering consultants. Based on the scope of the evaluation and the complexity of the systems, such studies can cost from $5,000 to $50,000, not including design costs for recommended modifications. Because many strategies for optimizing cogeneration involve operational changes rather than equipment retrofits, implementation costs can be minimal.

- **Lighting Improvements –** Typically, outdoor lamps drive the primary light load at water and wastewater treatment plants. Replacing outdoor lamps with LEDs and induction lamps provide excellent opportunities to save energy. Some wastewater plants also have significant low efficiency indoor fluorescent gallery lighting that can be upgraded to 3rd generation super T-8 fluorescents.

- **Optimizing Oversized facilities[47] –** According to the Consortium for Energy Efficiency, many water-wastewater treatment plants are designed for flowrates that are significantly higher than their actual needs. Because plants are typically designed based on forecasts for the next 20 years and flowrates are often expected to increase, the plant will likely operate well below their design capacity for a significant portion of its lifetime. A facility designed for 10 million gallons per day average flow that operates at 2 million gallons per day is difficult to operate efficiently.

Significant energy savings opportunities lie upstream from the water treatment plant. Water efficiency measures that focus on water consumers can lower the amount of water requiring treatment. Wastewater recycling for such as “purple pipe” water reclamation for use in landscaping and even recycled water for human consumption[48] is increasingly used to reduce water treatment requirements.

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[47] Consortium for Energy Efficiency. Energy Efficiency RFP Guidance FOR Water-Wastewater Facilities. http://www.cee1.org/ind/mot-sys/ww/rfp/whattoinclude.php3

[48] PBS News Hour. *Californians Move to 'Toilet-to-Tap' Water Recycling*. Posted February 11, 2008. http://www.pbs.org/newshour/extra/features/us/jan-june08/water_2-11.html

4.1.5 Capital Expenditures for Energy Efficiency

For most plants, the best time to implement energy efficiency is when the plant is undergoing major modifications due to regulatory changes or when the population has grown to the point that they need to expand the plant. To finance major renovations and expansions, they often issue bonds or raise treatment fees. Proposals include energy saving design features to lower long term operating costs in order to help sell projects to voters and rate payers.. Given increasingly tighter municipal budgets, long-term savings through energy efficiency is an important long-term benefit for ratepayers.

Water and wastewater utility annual reports to rate payers as well as rate cases to the Public Utilities Commission include discussions of planned capital improvement projects. Given that most water and wastewater systems are aging rapidly and that billions of dollars will be spent nationally over the next decade to bring systems into compliance with environmental and safety regulations, many opportunities exist at this time for promoting energy efficient technologies.

5. Market Intervention

In the first quarter of 2011, KEMA held a roundtable discussion with water and wastewater experts from both PG&E and SCE territory. Participants represented water supply and treatment districts, as well as independent experts from Laurence Berkeley National Lab (LBNL), American Council for an Energy Efficient Environment (ACEEE), PG&E, and SCE. KEMA use a discussion guide designed to elicit insights into energy efficiency; decision-making, drivers, barriers, innovation, technologies, and utility programs.

KEMA supplemented the information from the roundtable discussion with in-depth interviews with water and wastewater customers. The discussion guide focused on themes similar to the discussion forum, including gaining feedback on utility efficiency programs.

The following sections describe the insights and conclusions from our primary research.

5.1 Drivers of Energy Decision-Making

Many of the questions we asked focused on the decision making process around investment in energy efficiency. We sought to understand the importance of energy in the operations of water and wastewater utilities, what the drivers are for investment, and what barriers inhibit wider adoption of energy efficient technologies and practices. The following paragraphs summarize the results of this investigation.

5.1.1 Energy Efficiency Planning

Water and wastewater utilities are highly regulated by the state of California for potable water quality and environmental protection for wastewater treatment. Because failures to achieve water quality or environmental standards can result in serious penalties, water and wastewater utilities tend to be highly risk averse. Well-functioning systems and redundancy take first priority over energy savings. Higher energy consumption tends to occur when water utilities perceive that they are reducing risk- for example, leaving on back-up or too many UV lamps in water treatment. National Pollution Discharge Elimination System (NPDES) compliance is the top priority and operators face personal liability if they breach safety standards. Managers are generally resistant to changing equipment or processes that may risk the functionality of the system for the sake of saving energy.

While regulatory compliance takes first priority, energy is nonetheless a growing priority for water and wastewater utility managers. We learned from our forum that energy constitutes about 15 percent of the operations budget on average at wastewater plants. Water supply is much more variable, depending on whether significant pumping is required for transport and delivery as well as if hydroelectric resources are available. Some of the largest energy users in the state are southern California and Central Valley water transport and storage organizations (e.g. Kern Water Bank) that rely on electricity to pump water uphill. Energy is high enough of a priority that some utilities have a full-time energy manager on staff. One respondent stated that energy was in their top three priorities. However, water and wastewater utilities conceded that without energy regulation, there is little impetus for action. They expressed interest in working with the Regional Water Quality Control Board (RWQCB) to develop regulatory drivers to push energy efficiency in the industry.

5.1.2 Investment Priorities

Environmental stewardship, in other words the interest to become a greener operation, can be a significant driver for water and wastewater utilities to invest in energy efficiency. One utility we spoke with has decided to seek carbon neutrality by 2015. To that end, they have been able to invest in projects with up to a 15 year payback. However, another utility we spoke with focused on minimizing costs and therefore were limited to projects with no more than a three year payback. Overall, we found political drivers to be the exception rather than a widespread trend. In certain locations, customers are willing to pay more in water rates for environmental benefits, but overall, rate protection and short payback period requirements for capital investments is the norm. Again, no utility will undertake energy efficiency investment if there is a risk of compromise to environmental, health, and safety performance.

Due to risk aversion to modifications of existing systems, renewable energy projects are a much easier sell to water utility managers. Most major wastewater systems already utilize digester gas to generate electricity while water supply utilities generate power from hydroelectric schemes. Many utilities are also looking at solar power at their facilities to meet load requirements. Because adding renewable generation does not interfere with core treatment responsibilities, risk aversion is less of a barrier.

5.1.3 Project Financing

Typically, ratepayer receipts fund investments in energy efficiency;, as such, public water agencies have a fairly steady revenue stream and face few capital barriers to investment. At a certain point, however, project funding and logistics becomes difficult for water and wastewater utilities. According to some participants in our forum, plant managers' discretionary project funding typically only reaches $100,000; any higher and the project would have to go to the board of directors. Competitive bid requirements also make the bid process time- and human-resource-consuming.

State and federal grants as well as utility incentives also provide funding when needed. When a project is large enough to require borrowing, municipal utilities have access to low rate municipal bond markets. However, getting to that stage is the primary difficulty. Power Purchase Agreement (PPA) leasing agreements have worked well for renewable energy, as there is no need for going through the difficult funding process or assuming the ownership risk. Public/private partnerships are a strategy that can move efficiency forward.

One customer identified Proposition 218 as a barrier to funding efficiency projects. Prop 218,[49] passed by voters in 1996, restricts local governments' ability to impose assessments and property-related fees and requires elections to approve many local government revenue raising methods. This has made it difficult for water agencies to raise water rates as necessary, leading to restrictions on capital funding.

5.1.4 Barriers to Energy Efficiency Investment

The primary barriers we heard from our respondents were as follows:

- **Concentrated focus on compliance with water quality regulations.** Water and wastewater utilities must meet increasingly stringent water quality regulations. Water and wastewater utilities are hesitant to implement new technologies especially if they believe it risks the first priority of high quality water delivery or discharge.
- **Risk aversion and unwillingness to experiment with working processes.** Because the punishment for compliance failure is severe (fines, health risks, bad publicity), water utilities are reluctant to adopt emerging technologies or other energy efficiency projects. Respondents identified this as the biggest barrier. In fact, respondents admitted to using even more energy than necessary in cases they perceived would reduce health risks (for example, leaving on backup systems) regardless of actual risk reduction. Many facilities have oversized equipment which operates inefficiently.

[49] California Tax Data. 2011. *Property Tax Information, Factsheet: What is Proposition 218?* http://www.californiataxdata.com/pdf/Proposition218.PDF

- **Difficulty procuring financing.** Board of directors must usually approve investments over $100,000 and/or be specifically justified in the rate case cycle. This can mean long delays waiting for board and/or public approvals.
- **Lack of strong incentives for reducing energy consumption.** The disincentives for failing to meet health and environmental standards are much stronger than the incentives for saving energy.
- **No regulatory driver for energy management.** Utilities are not required to improve energy performance.
- **Poor understanding of energy efficiency opportunities and best practices.** Operators often use unnecessarily redundant systems to manage regulatory risk. A better understanding of best practices may mitigate this problem.

Possible solutions cited by respondents to overcome major barriers are:

- **Low-cost Loan and Financing Programs.** Customers also indicated interest in programs that would provide cost-shared money as well as on-bill financing. In particular, respondents cited an on-bill financing mechanism from SCE that was quickly oversubscribed, indicating that continuing to offer rebate programs will help overcome barriers to small and medium sized projects, though will not make or break large capital projects.

5.2 Cycles of Innovation

Usually energy efficiency investment occurs alongside capital improvement projects such as routine equipment overhauls and upgrades. Most respondents admitted that much of the existing infrastructure is old, and needs repairs. Upgrades are a good time to get the foot in the door for energy efficient equipment. One respondent indicated that his company was more open to taking risks with new technologies and participating in utility programs such as the California Wastewater Process Optimization Program (CalPOP) when the timing coincided with burnout of capital equipment.

There is a strong interest in new technologies. Our respondents expressed that they do not have the authority or capability to push breakthrough technology, as risk taking is extremely discouraged. That said, they are very interested in electric utility programs that research and demonstrate emerging technologies. Once a new technology is demonstrated as viable, the water utilities are much more likely to invest.

The most popular upgrades in recent years include pump efficiency upgrades and motor efficiency upgrades. They also expressed interest in technologies like LEDs once they become competitive. One utility we spoke with was working on a control optimization program and customer water conservation program. Another utility we talked to said that in the short term, they were looking at new aeration blowers, new pumps, dissolved oxygen system controls, new lighting, solar and wind projects. In the long term, they were not looking at capital projects. Instead, they were looking into programs such as tiered water rates, irrigation and landscaping standard enforcement, and golf course maintenance training.

Respondents also indicated that consultants are a key source of information regarding energy efficiency investment and best energy management practices. Trade associations such as the Association of California Water Agencies and the American Water Works Association maintain standing committees devoted to energy, climate, and sustainability. Though respondents reported being familiar and engaged with their utility account representatives at a satisfactory level, almost all reported engaging outside consultants at some point.

5.3 Customer Assessment

The regulated nature of the water and wastewater industry makes it uniquely non-competitive and open to knowledge sharing. Among other programs, many customers stated interest in utility involvement in advocating and adopting new technologies. The following sections describe customers' rating of utility program awareness, experience, and satisfaction.

5.3.1 Utility Program Awareness

We found that customers were generally familiar with the energy efficiency programs offered by their electric utility. Customers are in frequent contact with their account representatives. Some respondents said they have contact with their utility representative weekly or biweekly. Yet other customers indicated they spoke to their representative as often as they spoke to their doctors, only as necessary and that was enough. Customers typically gain awareness about utility programs from their account representatives, other treatment plants, and from utility presentations at industry conferences, such as the AWWA annual conference.

Customers indicated that there were many levels involved in the decision to participate in a program. Engineers are fully involved in decision-making, although upper management must buy-in on the final decision. One respondent's facility employs a full-time grant writer to seek out opportunities.

5.3.2 Customers' Experience

We heard some criticism of energy programs. One consultant to the industry was critical of the third party programs that send out insufficiently experienced engineers with a checklist and consider only the standard measures. This approach does not address the larger issues of overcoming risk in adopting technology. Attendees requested engineering analysis support from utility programs to aid in persuading management that an energy efficiency project is worth the risk and the trouble. Also, the attendees requested no restrictions on vendors who they can get to implement projects, not just a few utility-approved companies.

Customers in the water and wastewater industry also have access to a number of other energy efficiency resources, either through water-specific programs or as part of a resource pooling authority. Several respondents participated in the California Wastewater Process Optimization Program (CalPOP), a CPUC-led program implemented by QuEST. This program provided free facility audits and funded energy efficiency measures. Respondents provided favorable reviews for this program and one respondent indicated that they already had another CalPOP project in the pipeline. Utility-sponsored programs that customers regularly participated in were generally limited to lighting rebate programs. Respondents indicated strong interest in programs that provide free or cost-shared money.

5.4 Strategies

As stated previously, the most significant barrier is risk aversion due to regulatory requirements. The next most significant barrier is the funding cycle and tolerance for user rate increases.

Program Administrators can ease risk aversion through education and outreach. Management and operators would benefit from exposure to case studies showing how other utilities have saved energy through operational changes and through technology upgrades. Once management feels comfortable that energy saving strategies were successful elsewhere, they are more likely to seriously consider implementing those measures at their own plants. Account representatives should conduct outreach as well as present at water and wastewater industry conferences.

Financing high capital cost energy efficiency investments is a huge challenge for cash-strapped agencies. One of our respondents noted that on-bill financing, where the utility provides a loan for energy efficient equipment that the water agency can pay off through the energy bill, provides a creative solution to the traditional funding and rate case cycle. Low-cost funding, in many cases, is more attractive than incentives.

Water utilities have little incentive to prioritize energy savings given the perceived risk to not meeting water quality standards. Participants expressed a desire for utilities to engage with regulatory agencies such as, the Regional Water Quality Control Board (RWQCB) and the California Air Resources Board (CARB) to develop policy and regulatory drivers to encourage both energy efficiency and effective environmental stewardship.

Due to the unique nature of equipment and systems, custom efficiency programs are the most effective when it comes to water and wastewater utilities, and timing is the most important aspect. The energy utilities should work with the water utilities to understand their maintenance and upgrade needs far in advance. Replacement upon burnout is the best time to upgrade to efficient equipment, and standalone efficiency upgrades to capital equipment are rare.

Engaging local governments is one strategy that works to reduce the level of risk aversion. Key factors are programs that include measurement of baseline energy use, identification of energy efficiency measures that are cost-effective, and then creating a plan to measure and verify savings. According to ACEEE, the critical element to reducing risk, managing expectations and responsibilities is bringing together all levels of utility management with local government actors.[50]

PG&E and SCE should understand which water utilities are driven by sustainability concerns and public perception in addition to cost. For these customers, PG&E and SCE should be aggressive in promoting efficiency measures that achieve the highest energy savings. They should focus on low cost/no cost and short payback measures for water utilities with less of an environmental driver and lower tolerance of long payback periods.

[50] American Council for an Energy Efficient Economy. 2009. Local Technical Assistance Toolkit: Energy Efficiency in Water and Wastewater Facilities. http://www.aceee.org/sector/local-policy/toolkit/water

6. Summary of Recommendations

This investigation has revealed that water and wastewater customers are willing to consider a more comprehensive approach to addressing their energy needs, beyond simply retrofitting equipment. Some suggested elements of that approach are presented below, and additional research focused on the feasibility of each of these recommendations would be prudent. Two key components of a successful effort are the participation of regulatory staff in the development of the options and CPUC recognition of the utilities' role in changes to a customer's policies and procedures regarding energy.

Based on our research, KEMA recommends the following next steps:

1. **Continue the conversation** – Water and wastewater utilities are engaged and interested in promoting energy efficiency and conservation in their industry. Take advantage of the fact that water and wastewater agencies do not compete and therefore are more willing to share best practices. The conversation started by the study provides an opportunity to engage in ongoing dialogue between the electric utility and the industry. Consider information sharing workshops or webinars, ideally quarterly. Partner with trade associations such as the California Association of Sanitation Agencies. Joint white papers with trade organizations can be a powerful vehicle for moving energy efficiency forward in the industry. Although difficult to quantify the effects of the utility participation, utility representation on industry councils and working groups can have long term influence on energy-related decisions.

2. **Establish small group of dedicated expert account representatives**– Water and wastewater utilities expressed a preference for a few dedicated experts to handle all water and wastewater accounts rather than numerous, non-expert individual customer representatives.

3. **Establish an incubator technology and education program** – In collaboration with wastewater experts, the state should establish a dedicated research group to focus on energy savings opportunities in the water and wastewater industry. Building on the work done by EPA, NYSERDA, and others to identify best practices,[51] the group should

[51] American Council for an Energy Efficient Economy. 2009. *Local Technical Assistance Toolkit: Energy Efficiency in Water and Wastewater Facilities*. http://www.aceee.org/sector/local-policy/toolkit/water

publish and road show best practices for energy management as well as sponsor research and development for new technologies.

4. **Consider an on-bill program, low-interest loans, or other financing options** – Previous on-bill financing programs in SCE territory have proven successful over the last twenty years,[52] and utilities should consider using energy efficiency program funds to provide low cost loans to water and wastewater utilities and allow them to be paid off on the monthly utility bill. Creative financing options, rather than rebates and incentives, can help overcome the funding cycle barriers.

5. **Focus on operations first, technology second** – Significant opportunity for energy savings lies in management of water and wastewater facilities. Needlessly redundant systems are often used to minimize perceived regulatory risk. Energy utilities should work with water and wastewater utilities to identify energy wasteful practices, which are essentially no cost/low cost measures. Process changes and behavior modification without capital investment can yield significant savings. Equipment upgrades can be incorporated with behavioral opportunities when appropriate. .

6. **Tailor programs for small as well as larger water utilities** – There are 3,200 special districts in California, most of which are water and sewer. Programs need to work for the small jurisdictions as well as the large players. Operations-focused programs are more appropriate for small players who have less access to capital.

7. **Understand the difference between organizations driven by environmental concerns versus organizations driven by cost savings** – More environmentally conscious water utilities will have an easier time selling high-cost high-savings measures than water utilities more concerned about rate protection.

8. **Identify aging infrastructure as opportunities for energy efficient equipment** – Efficiency programs should focus on the equipment that requires regular maintenance and upgrades as infrastructure ages. These are the opportunities in which the case for energy efficient equipment is easiest to make. Account representatives can engage their customers to understand the timing of upgrades to capital projects and encourage working with the utility to identify opportunities for energy efficiency.

[52] SCE EnVEST program, 1992-2002, http://docs.cpuc.ca.gov/published/Final_decision/21625-02.htm

9. **Include Public Recognition Opportunities**. Water and wastewater utilities operate in a very public and sometimes political arena. Program offerings that provide positive public recognition of goals achieved or energy saved are valued by this sector.

10. **Include Energy Management System approaches**. Build on existing systems within goal-oriented organizations to engage sophisticated utilities in energy systems management approaches. A short-term, goal-based program that includes developing an action plan, baseline energy measurement, a detailed audit/technical assessment, measurement of success in meeting goals, and recognition may be successful. EPA provides a model for a Plan-Do-Check-Act process for this industry.[53]

[53] U.S. Environmental Protection Agency. 2008. *Ensuring a Sustainable Future: An Energy Management Guidebook for Water and Wastewater Utilities*. Washington, D.C., January 2008.

References

American Council for an Energy Efficient Economy. 2009. *Local Technical Assistance Toolkit: Energy Efficiency in Water and Wastewater Facilities*. http://www.aceee.org/sector/local-policy/toolkit/water

American Council for an Energy Efficient Economy. 2009. *Barriers to energy efficiency investments and energy management in the U.S. industrial sector*. October 20, 2009.

American Council for an Energy Efficient Economy. 2009. *Trends in Industrial Energy Efficiency Programs: Today's Leaders and Directions for the Future*. September.

American Council for an Energy Efficient Economy. 2011. National Symposium on Market Transformation. http://www.aceee.org/conferences/2011/mt/program

Barry, J. 2007. *Watergy: Energy and Water Efficiency in Municipal Water Supply and Wastewater Treatment*. Alliance to Save Energy. Washington, D.C.

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

California Institute for Energy and Environment. 2009. *Behavioral Assumptions Underlying Energy Efficiency Programs for Businesses.* January 2009. http://uc-ciee.org/downloads/ba_ee_prog_bus_wp.PDF

California Public Utilities Commission. 2011. *CA Energy Efficiency Strategic Plan, January 2011 Update*. http://www.cpuc.ca.gov/NR/rdonlyres/A54B59C2-D571-440D-9477-3363726F573A/0/CAEnergyEfficiencyStrategicPlan_Jan2011.PDF

California Tax Data. 2011. *Property Tax Information, Factsheet: What is Proposition 218?* http://www.californiataxdata.com/pdf/Proposition218.PDF

City of San Jose, Green Vision website. http://greenvision.sanjoseca.gov/RecycledWater.aspx

Consol. 2010. *Water Use in the California Residential Home.* January 2010.

Consortium for Energy Efficiency. 2010. *Energy Efficiency RFP Guidance for Water-Wastewater Projects*. Boston, MA http://www.cee1.org/ind/mot-sys/ww/rfp/whattoinclude.php3

Department of Water Resources, *California Water Plan Update 2005.* Volume 1, Table 3-1. http://www.waterplan.water.ca.gov/previous/cwpu2005/index.cfm

East Bay Municipal Utility District website. http://www.ebmud.com/about-ebmud/our-story/district-history

East Bay Municipal Utility District. 2009. *East Bay Municipal Utility District 2009* [Annual Report]. http://www.ebmud.com/sites/default/files/pdfs/FY09annual10_0.PDF

Electric Power Research Institute. 1994. *Energy Audit Manual for Water/Wastewater Facilities.* Prepared for California Energy Commission, CR-104300.

Electric Power Research Institute. 1996. *Water and Wastewater Industries: Characteristics and Energy Management Opportunities*, CR-106941, September 1996.

First Research 2009. *Industry Profile Water and Sewer Utilities*. http://www.firstresearch.com/Industry-Research/Water-and-Sewer-Utilities.html

Hoovers website, Black & Veatch Corporation. http://www.hoovers.com/company/Black__Veatch_Corporation/ctftif-1.html

Horvath, A., Price, L., de la Rue du Can, S. and H. Lu, 2010. *Evaluation of Efficiency Activities in the Industrial Sector Undertaken in Response to Greenhouse Gas Emission Reduction Target.* Berkeley, CA: Lawrence Berkeley National Laboratory (LBNL-3551E).

IBIS World. 2009. *Industry Report: Sewage Treatment Facilities in the US: 22132*

IBIS World. 2009. *Industry Report: Water Supply & Irrigation Systems in the US: 22131*

KEMA and Lawrence Berkeley National Laboratory, 2005. *California Statewide Industrial Sector Energy Efficiency Potential Study - Draft Report.* Prepared for Pacific Gas and Electric Company.

KEMA. 2008. *Strategic Industrial Report for PG&E.*

Klein, G. 2005. *California's Water – Energy Relationship.* California Energy Commission, CEC-700-2005-011-SF, November 2005. http://eec.ucdavis.edu/events/documents/water-energy_cec_california_water-energy-relationship.PDF

Lekov, A. L. Thompson, A. McKane, K.Song, M.A.Piette. 2009. *Opportunities for Energy Efficiency and Open Automated Demand Response in Wastewater Treatment Facilities in California*. April. Environmental Energy Technologies Division, Lawrence Berkeley National Laboratory. http://drrc.lbl.gov/system/files/lbnl-2572e.PDF

McKane, A. 2011. "Piloting Energy Management Standards for the U.S and the Globe." (Presentation at the ACEEE Market Transformation Conference) http://www.aceee.org/conferences/2011/mt/program

McKinsey & Co. 2009. *Unlocking Energy Efficiency in the U.S. Economy.* July. http://www.mckinsey.com/clientservice/electricpowernaturalgas/downloads/US_energy_efficiency_exc_summary.PDF

Nadel, S. 2011. *Program Introduction*. (Presentation, ACEEE 2011 National Symposium on Market Transformation, Washington DC, April 10–12, 2011). http://www.aceee.org/files/pdf/conferences/mt/2011/Introduction%20-%20Steve%20Nadel.PDF

National Academy of Sciences. 2010. *Real Prospects for Energy Efficiency in the United States*. National Academies Press.

Navigant. 2010. *Kaizen Blitz Pilot, Report 1*. Prepared for Energy Trust of Oregon. http://www.affiliatedrecon.com/studies/OR/Energy_Trust/General/ETO-Kaizen-Blitz-Pilot.PDF

New York State Energy Research and Development Authority. 2010. *Water & Wastewater Energy Management Best Practices Handbook*.

Northwest Energy Efficiency Alliance. 2011. *Continuous Improvement for Industry.* February 2011. http://www.energyimprovement.org/index.html

Oro Loma Sanitary District 2011. Sewage Treatment Diagram http://www.oroloma.org/sewer/treatment/diagram/index.html

Pacific Institute for Studies in Development, Environment, and Security. 2001. *Economic Evaluation of the Cadiz Groundwater Storage and Dry Year Supply Project, Metropolitan Water District of Southern California*. July 2001. http://www.pacinst.org/reports/cadiz/cadiz.PDf

PBS News Hour. *Californians Move to 'Toilet-to-Tap' Water Recycling*. Posted February 11, 2008. http://www.pbs.org/newshour/extra/features/us/jan-june08/water_2-11.html

Puget Sound Energy. *2010 Business Energy Management, Resource Conservation Manager Program*. February 2010. http://www.pse.com/savingsandenergycenter/ForBusinesses/Documents/3462_RCM.PDF

Quantec. 2005. *Energy Efficient Local Government Programs: 2003 Evaluation*. January 16, 2005.

Quinn, Jim. 2009. *Introduction to the Industrial Technologies Program*. Save Energy Now Series Webinar. January 15. http://www1.eere.energy.gov/industry/pdfs/webcast_2009-0115_introtoitp.PDF

Raucher, Bob. Stratus Consulting. 2004. "Affordability of Water Service: What does it mean? How is it Measured? Why does it matter?" (Presentation to EFAB Affordability Workshop. August 18, 2004.)

Savitz, et al. 2009. *DOE Industrial Technologies Program 2008 Peer Review*. http://www1.eere.energy.gov/industry/about/pdfs/itp_peerreview_report2008.PDf

SBW Consulting, 2006. *Municipal Water Treatment Plant Energy Baseline Study.* Pacific Gas and Electric Company, August 2006. http://www.pge.com/includes/docs/pdfs/mybusiness/energysavingsrebates/incentivesbyindustry/wastewater/watertreatmentbaselinestudyreport.PDF

SCE EnVEST program, 1992-2002, http://docs.cpuc.ca.gov/published/Final_decision/21625-02.htm

Standard & Poors. 2009. *Industry Surveys: Environmental and Waste Management.* New York, NY.

Sullivan, M. 2009. *Behavioral Assumptions Underlying Energy Efficiency Programs for Businesses*. California Institute for Energy and Environment. January 2009. http://uc-ciee.org/downloads/ba_ee_prog_bus_wp.PDF

Superior Energy Performance cm Certification Protocol, November 2011. http://www.superiorenergyperformance.net/pdfs/SEP_Cert_Framework.PDF

Taylor, M. 2011. "Letter to Honorable Dan Hogue, California Legislative Analysts Office." May 13, 2011. http://www.lao.ca.gov/reports/2010/rsrc/ab32_logue/ab32_logue_051310.PDF

Thomson Reuters Point Carbon. 2011. *California Emissions in 2010 Down by 11%.* August http://www.pointcarbon.com/aboutus/pressroom/1.1564622

U. S. Council for Energy-Efficient Manufacturing. 2010. *Superior Energy Performance*. http://www.superiorenergyperformance.net/pdfs/SEP_Cert_Framework.PDF

U.S. Census Bureau, 2008. *Energy Consumption by End Use Sector*. http://www.census.gov/compendia/statab/2010/tables/10s0892.xls

U.S. Department of Energy, Energy Efficiency and Renewable Energy, State and Regional Partnerships. 2011. http://www1.eere.energy.gov/industry/states/state_activities/map_new.asp?stid=CA

U.S. Department of Energy, Energy Efficiency and Renewable Energy 2010. *Energy Technology Solutions. Public-Private Partnerships Transforming Industry.* http://www1.eere.energy.gov/industry/pdfs/itp_successes.PDF

U.S. Department of Energy, Energy Efficiency and Renewable Energy, Industrial Technologies Program. 2003. "Neville Chemical Company: Management Pursues Five Projects Following Plant-Wide Energy-Efficiency Assessment." *Chemicals: Best Practices Plant-Wide Assessment Case Study.* DOE/GO-102003-1666. July 2003. http://www1.eere.energy.gov/industry/bestpractices/pdfs/ch_cs_neville_chemical_company.PDF

U.S. Department of Energy, Energy Efficiency and Renewable Energy, Industrial Technologies Program. 2002. *Combined Heat & Power: Cost Reduction Strategies*. Factsheet, January 2002. http://www1.eere.energy.gov/industry/glass/pdfs/chp.PDF

U.S. Department of Energy. 2002. Industrial Technologies Program, Combined Heat and Power, Cost Reduction Strategies. http://www1.eere.energy.gov/industry/glass/pdfs/chp.PDF

U.S. Department of Energy. 2008. *Combined Heat and Power: Effective Solutions for a Sustainable Future*. Prepared by Oak Ridge National Laboratory, ORNL/TM-2008/224, December 2008.

U.S. Department of Energy. 2010. Industrial Technologies Program, Manufacturing Energy and Carbon Footprint. http://www1.eere.energy.gov/industry/pdfs/glass_footprint.PDF

U.S. Department of Energy. 2011. *State Energy Consumption Estimates 1960 through 2009*. DOE/EIA-0214(2009). June 2011. http://205.254.135.7/state/seds/sep_use/notes/use_print2009.PDF

U.S. Environmental Protection Agency, 2010. *Evaluation of Energy Conservation Measures for Wastewater Plants .* Washington, D.C.

U.S. Environmental Protection Agency. 2002. *The Clean Water and Drinking Water Infrastructure Gap Analysis*. Office of Water, EPA-816-R-02-020. September 2002. http://www.epa.gov/ogwdw/gapreport.PDF

U.S. Environmental Protection Agency. 2006. *FACTOIDS: Drinking Water and Ground Water Statistics for 2005*. Office of Water, EPA 816-K-03-001. December 2006. http://www.epa.gov/ogwdw/databases/pdfs/statistics_data_factoids_2005.PDF

U.S. Environmental Protection Agency. 2008. *Ensuring a Sustainable Future: An Energy Management Guidebook for Water and Wastewater Utilities*. Washington, D.C., January 2008.

U.S. Environmental Protection Agency. 2009. *Clean Energy Lead by Example Guide: Strategies, Resources, and Action Steps for State Program.* Washington, D.C.

U.S. Environmental Protection Agency. 2009. EPA's Clean Energy-Environment Tech Forum, Clean Energy Opportunities in Water and Wastewater Treatment Facilities. January 15. http://www.epa.gov/statelocalclimate/documents/pdf/background_paper_wastewater_1-15-2009.pdf

U.S. Environmental Protection Agency. 2010. *ENERGY STAR for Wastewater Plants and Drinking Water Systems* *http://www.energystar.gov/index.cfm?c=water.wastewater_drinking_water*

U.S. National Academy of Sciences. 2010. *Real Prospects for Energy Efficiency in the United States*. Washington, D.C.

Wallis, M., M Ambrose, C. Chan. 2008. *Climate change: charting a water course in an uncertain future.* American Water Works Association Journal 100:6, June 2008. http://www.ebmud.com/sites/default/files/pdfs/Journal-06-08_0.PDF

Wisconsin Focus on Energy. 2011. *Practical Energy Management.* http://www.wifocusonenergy.com/page.jsp?pageId=368

XENERGY. 1998. *United States Industrial Electric Motor Systems Market Opportunities Assessment.* Prepared for the U.S. Department of Energy's Office of Industrial Technology and Oak Ridge National Laboratory. December 1998.

A. Customer Interview Guide

Strategic Industrial Research
Water and Wastewater Industry
Customer Interview Guide
PG&E/SCE

Hello. My name is [Interviewer Name] calling from KEMA Inc., an energy consulting firm. Your utility [Pacific Gas & Electric or Southern California Edison] has hired my company to conduct research to improve their industrial energy efficiency programs in the [name of sector] industrial sector. We have identified you as someone knowledgeable about decision regarding energy efficiency and participation in utility efficiency programs. Is this correct? [If no, ask for a colleague referral. If so, start the interview questions below.]

First, I'd like to ask you about what drives decision-making in energy efficiency first, then ask about your thoughts on your utility's energy efficiency programs. Your responses are confidential. This interview will take approximately 30 minutes.

What Drives Energy Efficiency Decision-Making?

1. What does energy efficiency mean to your organization?
2. On a scale of one to ten, with one being the highest and ten the lowest, how would you describe your organization's commitment to implementing energy efficiency practices or investments? (where 1 = your company has taken all or nearly all cost-effective actions to reduce energy costs, or invests heavily in energy efficiency)
3. Where does energy rank in terms of the priorities in your business operations? (Not at all a priority, low priority, medium priority, high priority, very high priority)
    a. Please explain why you give it that ranking? (i.e., need energy reliability for production/will pay any costs; energy costs in top 10 operating costs/huge impact on variable costs; or both?)

4. What are the primary energy efficiency improvements that you company intends to make or would like to make over the next 2-5 years? 5-10 years?

5. How does your utility acquire capital for investment? What does the appropriation cycle look like? What are the challenges involved with access to capital? How can the utility help with those barriers?

6. How short of a payback does your organization require to invest in energy efficient measures?

7. What other barriers are there to investment in energy efficiency in the Water/Wastewater industries? (What are the key differences between water and wastewater? Does it vary by region?)

Utility Programs: Communications

1. Please describe the typical process at your organization, from how you hear about energy efficiency programs offered by your utility to the final decision to participate or not. Who is involved? Who needs to participate in the decision-making process?

2. How do you gather the necessary knowledge about utility energy efficiency programs that allow you to make an informed decision?

Utility Programs: Experience

1. Do you feel you utility offers energy efficiency and/or energy management programs that address your important energy concerns? If no, what is missing?

2. Has your company participated in any recent (past 2 – 3 years) utility sponsored energy efficiency program? Which ones?

<u>If no</u>,

3.a. What factors have contributed the most to your decision <u>not</u> to participate in an energy efficiency program?

3.b. What would encourage you to participate? (i.e. different type of program offerings; better/more communication about program opportunities; business need; etc.) [then skip to question 4]

<u>If yes</u>,

3.c. What is the most effective and beneficial energy efficiency program you have participated in? Which organization sponsored it? Please explain what you found beneficial.

3.d. What key factors led to your company's decision to participate (i.e., how did you learn about the program, who at your company spearheaded the decision to participate?)

3.e. Did participating meet your expectations? If yes, how? If not, why not?

3.f. What aspects of the program could be improved?

3.g. Would you participate in this program again? Why or why not?

3. In the future, what type of utility sponsored program(s) are you most likely to participate? Least likely? Has this shifted over time? If so, why?
4. For future programs, what are your expectations in working with [PG&E/SCE] on Energy Efficiency Projects?
5. What does PG&E/SCE need to do to help your organization increase investment in energy efficient technologies and practices?

Would you mind if I contacted you again as needed?

Thank you for your participation.

B. Leader Forum Guide

Water Wastewater Industrial Research Forums: Question Set

Introduction:

- Introduce KEMA
- Go over the project and the objectives
- Go around the room for introductions: Tell us about your job. How do you contribute to the decisions around energy in your organization?

Section 1: What drives decision-making for energy? Who initiates ideas for projects?

How does energy fit in with key priorities in your industry? (**For KEMA forum leader: list priorities identified in each report here and prompt discussion as required. Typically, priorities are safety, quality, meeting regulations, cost, competition, suppliers.)**

1. Where does energy rank in the management and operations of your business? Would your senior management and/or board of directors agree with this ranking of importance?

    a. In your knowledge of the industry, is energy efficiency an integral part of strategic planning and risk assessment? Why or why not? If yes, in what ways? If not, what are other factors that are more important?

    b. Generally speaking, what proportion are energy costs relative to your operating costs? Do you see this proportion increasing in the future? By how much?

2. How have energy use patterns changed over the past 10 years? What drives the growth of energy use?

3. What drives investment in energy efficiency in the water and wastewater industries? What are the key differences between them?

4. What are the main opportunities for water and wastewater treatment organizations to save energy?

    a. Behavioral, operations? (i.e., Smart Mfr. – use of sensors, controls to optimize all operations including EE)
    b. Equipment upgrades?

5. What are the primary barriers to adoption of these opportunities?
6. Regarding capital and maintenance investments at your organization? (i.e. major capital projects of any type, including mid-sized retrofits)

a. How is energy efficiency financed at municipal utilities? Rates? Bonds? Public/Private Partnerships?
b. For private utilities; are all capital investments included in a rate case? How long does a typical rate case take to achieve a decision?
c. Has raising capital been challenging or not? Why or why not?
d. How difficult is it to acquire capital for investment? What does the appropriation cycle look like? How has the state budget crisis affected your access to capital? Similarly, how has ARRA funding affected capital purchases, now and in the future?
e. Does the industry have alternative or innovative ways of raising capital outside of a rate case or bond issuance? (i.e., private partnerships)
f. How aware are you of IOU programs to help you manage your energy? Their technical support? Their incentives?

7. Would you say it is typical or not for firms to solicit input from employees at various levels and departments into investment decision making? If not typical, does it happen at all If so, in what way(s)?

8. For major investment decisions, what is the typical process and timing from idea to start of implementation?

9. How are investment priorities determined?

   a. What is your investment criteria? How short of a payback period is needed to make an efficiency upgrade that requires capital investment attractive?

   b. How do you determine which project to invest in? How does management determine a project is worthwhile? What are the key deciding criteria to move forth on a project? (regulatory, safety, cost, increased water capability, etc). How would you rank these criteria in terms of influencing how projects are prioritized?

Section 2: Cycle of innovation. What kinds of changes or innovations would cause you to retool or rebuild? Examples?

(KEMA: list factors of innovation for your segment.)

10. How mature is the industry infrastructure in regards to age of equipment and systems? Do you foresee a need for substantial upgrades in the future? About how long? Near-term? Long-term?

11. What types of efficiency investments have been popular in the past ten years?

12. What do you see the trend will be (in regards to efficiency investments) in the future?

13. What organizations would you point to as particularly innovative? Why do you see these organizations as innovative, what are they doing that makes them innovative? (i.e. vendors? Utility engineers, consultants?)

14. What internal needs are shaping innovation? Cost, reliability, regulations?
15. If not mentioned, then prompt (i.e., need for better technology in pumping as aquifers decline?)

16. What external factors drive innovation that effect energy use?

17. Do you foresee that potential changes to the Safe Drinking Water and Clean Air Act or AB-32 or other upcoming regulations will make a difference in your operations? Do you see that this will change how you manage energy?).

18. How do water and wastewater organizations access the latest information on energy efficiency technology?

19. If not mentioned, may probe for comments on the following:

    a. Do you foresee more efforts to increase self-generation efforts to service electricity demand?

    b. Validate the trends in innovation in operations such as; storage to facilitate load-shifting; plant optimization; improvements in optimization technology beyond SCADA

Section 3: Experience with Utility Programs and Networks of Expertise

20. What roles do others play in moving EE projects forward, eg contractors and consultants?

21. Do you partner with the utility? Do you see the utility as a partner? What kind of resources and assistance do you look for from the utility? Is there more they could be doing to help you manage your energy use? What else should they be doing?

22. Have you participated in any energy efficiency or management programs offered by either the Department of Energy or your utility? Why or why not? Did the program address your needs? Would you participate again? Why or why not?

23. Have you participated in the CEC's low interest loan program for EE? If so, what type of project did you fund? If not, is this something you are considering?

24. What would encourage senior management to sign up for energy efficiency or demand response programs? Any past examples?