WATER RESOURCES
IMPACT

A NEW PARADIGM: ELECTRIC UTILITIES INVESTING IN WATER CONSERVATION?

LON W. HOUSE, Ph.D.

INTRODUCTION

One of the state of California's largest end uses of electricity is in the treatment, heating and cooling, and conveyance of water. In 2005, the California Energy Commission estimated that water-related energy accounts for almost 20% of the state's electricity requirements. The California Public Utilities Commission (CPUC) followed this observation by authorizing water-energy pilot projects designed to validate claims that saving water can save energy and explore whether energy savings may be realized through water conservation measures and incorporated into electric utility energy efficiency programs (http://www.cpuc.ca.gov/PUC/energy/Energy+Efficiency/Water+Energy+Nexus+Programs.htm).

CALIFORNIA WATER-ENERGY PILOT PROGRAMS

The Investor Owned Electric Utilities (IOEU) in the state have offered a number of incentive programs in the areas of energy efficiency and demand response related to the water sector for years (such as pump efficiency testing, incentives for more efficient water treatment, and demand response programs) but these pilots were different. In these, the IOEUs partnered with the water agencies in the state to provide incentives in what were traditionally water conservation programs and evaluated the energy savings associated with water conservation (Table 1).

Water use across the United States has reached its lowest recorded level in nearly 45 years according to the recent U.S. Geological Survey report ... Countervailing this downward trend in water use is the increasing complexity and energy use required for water treatment.

The CPUC asked the following questions;

- Is the program cost effective from energy ratepayer perspective (what are the energy avoided costs from water saving programs)?
- Is the program cost effective from water rate payer perspective (what are the avoided costs to the water provider from water saving programs)?

Table 1. California Water Energy Pilot Programs.

Large Commercial Customer – Audits and Incentives: Offered water audits to large commercial, industrial, and institutional customers to recommend water efficiency improvements and offered financial incentives to help offset the cost of improvements. Types of eligible improvements included: ozone laundry systems, winery and food processing changes, detention facility toilet and shower upgrades, and recycled water retrofit projects.

Large Customer Incentives: Provided capital funding to install water conservation measures at sites that had received prior water audits and where the customer had not yet acted to implement the identified measures.

Commercial Customer – pH Controllers and Irrigation: Provided systems pH controllers for cooling towers and Weather Based Irrigation Controllers (WBICs) to commercial customers with chilled water HVAC and/or large landscape irrigation systems.

High-Efficiency Toilets – Single Family: Direct install of high efficiency toilets (HETs) to low-income customers living in single-family residences.

High-Efficiency Toilets – Multi-Family: Direct install of high efficiency toilets to low-income customers living in multi-family residences.

Emerging Technologies – Water Systems: Integration of real-time electricity consumption data from water pumping into existing water system SCADA systems.

Leak Detection – Water Systems: Detailed water audits that complied with International Water Association and American Water Works Association protocols were completed for three water agencies. There was also an active leak detection effort for each water agency and the water agencies repaired all of the found leaks.

Landscape: Converted conventional irrigation controllers into controllers that utilize daily evapotranspiration (ETo) and weather information to automatically and dynamically control the amount of water used for irrigation.

Recycled Water Program: Expanded recycled water use by providing capital funding for planned retrofit projects that switched from a potable water source to a recycled water source.

- Is the program cost effective from the combined perspective (if both the water and electric utility contributes dollars, are the benefits commensurate with the dollars invested)?
- Is the program cost effective from a societal perspective?

EMBEDDED ENERGY IN WATER DETERMINATION

Determining how much energy is embedded in the water saved via these pilot programs was a critical component of the program evaluation. The investor-owned electric utilities can only invest in programs up to the value of the energy saved by that program. The electric utility cost effectiveness requires proving that there are electric/gas ratepayer benefits from saving water.

What is Embedded Energy in Water? Embedded energy in water is the amount of energy (in kWh or therms per MG) needed to supply, move, and treat water delivered to a user, and to pump and treat the water post-use. Figure 1 illustrates the components of embedded energy in water determination.

The requirement to demonstrate verifiable energy savings at the end of a program requires determining the energy intensity of the water supply, treatment, and distribution, energy added by the customer for end use, and wastewater collection and treatment.

Table 2 compares the embedded energy in various water systems in Northern California (in the Pacific Gas and Electric Company area). A couple of things are noteworthy from this table: (1) the embedded energy for the various water system components can vary by over an order of magnitude between different water systems, depending upon their source(s) of water, treatment requirements, and distribution system configuration; and (2) for the same water systems, embedded energy values can vary by 50% or more, depending upon the year the study was done and the assumptions used.

RESULTS OF THE PILOTS

The reported results of the pilots were (CPUC, 2011):

Water System Leak Detection program offered the greatest energy savings potential (at relatively low cost) among all the pilot programs.

Detention Facility Projects that installed efficient toilets, urinals, and toilet flush timers in detention facilities generated high energy savings in a relatively untapped market.

Recycled Water Retrofit Projects can offer large potable water savings, but additional research is needed to determine the embedded energy in recycled water treatment (which offsets energy savings from potable water).

For the other pilots, the program costs are likely to exceed the energy benefits.

Additional research is needed on actual program spending, measure lifetimes, and potential changes

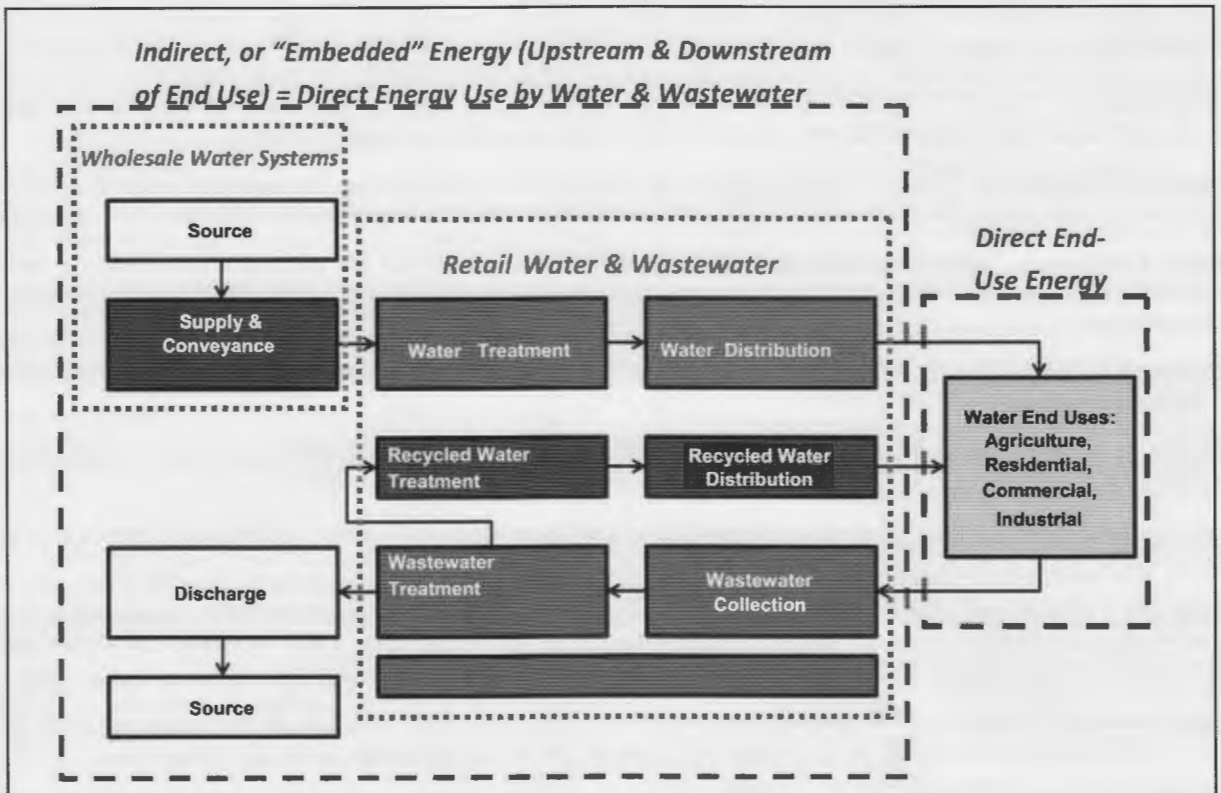

Figure 1. Embedded Energy in Water Determination.

Table 2. Embedded Energy in Water Systems: PG&E Territory.

	Supply (kWh/MG)	Treatment (kWh/MG)	Distribution (kWH/MG)	Wastewater kWh/MG)
California American Water, Monterey[1]	1,319	390	1,375	6,223
California American Water, Monterey[2]		2,681		4,739
City of Fresno[1]		1,264		1,724
City of Santa Cruz[1]	1,034	325	393	1,593
City of Santa Rosa[1]	2,384	6	512	4,541
City of Watsonville[1]		1,608		2,129
East Bay Municipal Utility District[1]	163	110	924	1,448
East Bay Municipal Utility District[2]	310	220	510	NA
North Marin Water District[1]		2,433		NA
San Jose Water Company[1]	1,912	129	592	2,074
San Jose Water Company[2]	1,778	469	944	NA
Santa Clara Valley Water District[1]	2,304	359	982	2,074
Sonoma County Water Agency[1]		2,890		3,544
Sonoma Valley Area[1]	1,859	6	1,921	4,299
Northern California (California Energy Commission)[1]	2,117	110	1,270	1,912
Pacific Institute Model[1]	798	169	1,212	1,350
Contra Costa Water District[2]	1,159	1,060	1,058	NA
Marin Municipal Water District[2]	276	296	617	1,619
Monterey Regional Water Pollution Control Agency[2]	NA	NA	266	1,537
Natomas Mutual Water Company[2]	3	NA	NA	NA
Semi-Tropic Water Storage District[2]	963	NA	NA	NA

Sources:

[1]PG&E Water Agency Energy Use Study: Supply and Demand Side Water-Energy Efficiency Opportunities Final Report, January 2007.

[2]CPUC Water/Energy Nexus Program Study on Embedded Energy. Embedded Energy in Water Studies. Study 1: Statewide and Regional Water-Energy Relationship; Embedded Energy in Water Studies; Study 2: Water Agency and Function Component Study and Embedded Energy Water Load Profiles; August 2010.

Available from http://www.cpuc.ca.gov/PUC/energy/Energy+Efficiency/EM+and+V/Embedded+Energy+in+Water+Studies1_and_2.html; and <http://www.cpuc.ca.gov/PUC/energy/Energy+Efficiency/EM+and+V/Embedded+Energy+in+Water+Studies1_and_2.html>.

in end-user energy. Program cost-effectiveness could be increased by reducing energy program funding levels and/or targeting programs to the most energy intensive water systems water savings.

FOLLOW-UP

Leak Detection: The CPUC ordered the IOEUs in the state to fund trial water system leak detection programs for evaluation. These are currently being evaluated.

Embedded Energy Determination and Reporting: The California Department of Water Resources, as part of their 2015 Guidebook for Urban Water Management Plans (UWMPs), has requested that the states' water agencies voluntarily include energy intensity information in their plan submittals.

Water-Energy Calculator. The CPUC has developed a water-energy calculator model, available on the CPUC

website (http://www.cpuc.ca.gov/PUC/energy/Energy+Efficiency/Water-Energy+Nexus+Programs.htm) that water systems can use for evaluating electric utility investments in water conservation programs.

SOME OBSERVATIONS

Determining Embedded Energy in Water is Not as Simple as it Looks. The amount of energy embedded in water depends upon, among other things:

- the source(s) of water (for example, during the drought this year in California, many water systems that had previously relied upon surface water had to switch to groundwater, with the resultant increase in pumping energy and treatment requirement);
- the treatment processes (switching from chlorination to ultraviolet disinfection significantly increases energy use);
- the amount of lost water (water lost to leakage is energy that is being dissipated to the environment);
- the efficiency of system infrastructure (changes in pump efficiency or treatment efficiency changes the amount of energy in the water); and
- the energy to include in the determination (many of the water systems in California generate a portion of their own energy use – from wind, solar, biogas, or small hydro – but the IOEUs can only claim credit for the amount of energy that they supply to the water system).

Program Development for Joint Programs is Challenging. Water systems entities are familiar with developing water conservation programs. When an energy utility becomes involved this becomes more challenging.

- Determining electric utility contribution (this is dependent upon the embedded energy saved via the water program, which can vary in a single water system from year-to-year depending upon the sources of water, leakage rates, water system efficiency, etc.).
- To whom the program applies (utilities like to have programs that are available to everyone they serve. However, in order to maximize electric utility contributions the joint water conservation program may need to concentrate on high energy use water systems).
- Verification of energy savings (energy utilities have to verify that their programs did save energy). This can be a little more challenging with the water sector. Not only are energy savings indirect (the water is what is being saved and, indirectly, the energy used, whereas something like a more efficient air conditioner directly saves energy) but the energy savings can vary considerably (if a water system has to switch from surface water to groundwater for supply the total water system energy use will increase, even if water is being saved).

CONCLUSIONS, AND RECOMMENDATIONS

Saving Water Saves Energy. Anytime that you save water, particularly in urban environments, you will also save the energy - that energy used to obtain, treat, and distribute that water, as well as any energy required to collect and treat the wastewater.

Partnerships Between Electric Utilities and Water Systems Can Benefit Both. Joint programs can allow combined water and energy audits, increased incentives for water conservation technologies, and reduced energy use in the water sector. The electric utility can claim energy credits as part of its energy efficiency portfolio, and the water system gets the water savings.

Investments in Water Systems Are Likely to Offer the Greatest Water and Verified Energy Savings. The California pilots found that water system leak detection was the best program from a verified water and energy savings perspective of any of the pilots. Other programs that improve the efficiency of the water system (e.g., increased pump or treatment efficiency) will also provide verifiable energy savings.

Water use across the United States has reached its lowest recorded level in nearly 45 years according to the recent U.S. Geological Survey report (Maupin *et al.*, 2014). Countervailing this downward trend in water use is the increasing complexity and energy use required for water treatment. In the desire to become more efficient on both the water and energy sectors, joint programs between water systems and energy utilities offers an exciting new opportunity to benefit both sectors of the economy and reduce energy and water use.

REFERENCES

CPUC (California Public Utilities Commission), 2011. Embedded Energy in Water Systems Pilot Programs Final Report. EcoNorthwest.

Maupin, M.A., J.F. Kenny, S.S. Hutson, J.K. Lovelace, N.L. Barber, and K.S. Linsey, 2014, Estimated Use of Water in the United States in 2010. USGS Circular 1405, 56 pp. Available at http://dx.doi.org/10.3133/cir1405.

AUTHOR LINK Lon W. House, Ph.D.
Water & Energy Consulting
2795 East Bidwell, Ste. 100-176
Folsom, CA 95630
(530) 409-9702

E-MAIL lonwhouse@waterandenergyconsulting.com

WEB SITE www.waterandenergyconsulting.com

Lon W. House, Ph.D., is the owner of Water & Energy Consulting, with offices in California and Arizona. He is an energy consultant for the Association of California Water Agencies and the California Rural Water Association, and a consultant on water-energy for the California Public Utilities Commission and California Energy Commission.

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