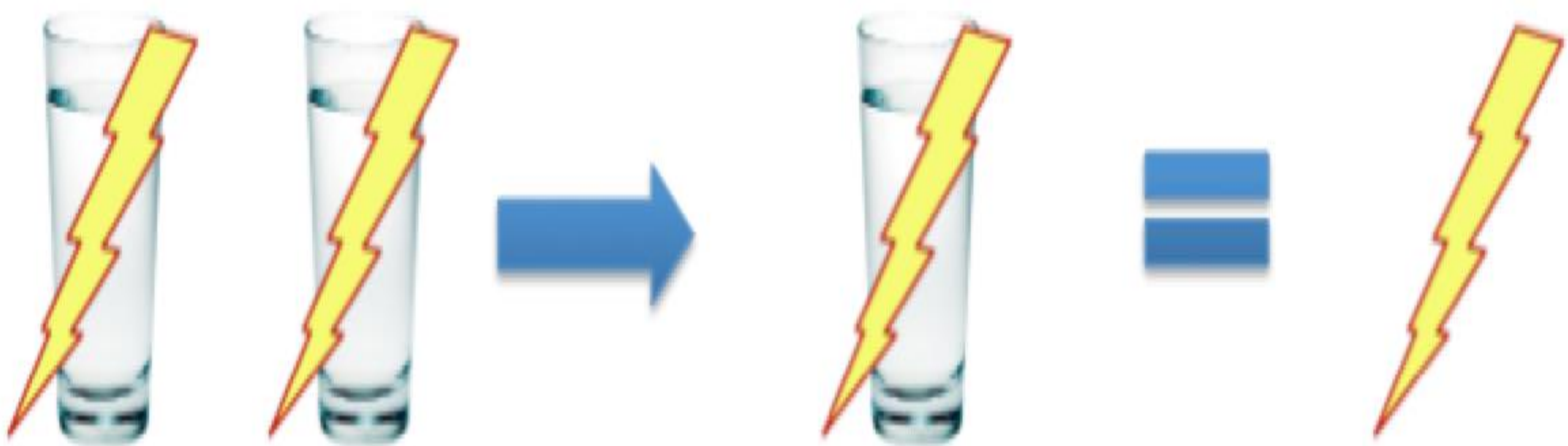
A New Paradigm: Electric Utilities Investing in Water Conservation?

Lon W. House, Ph.D.

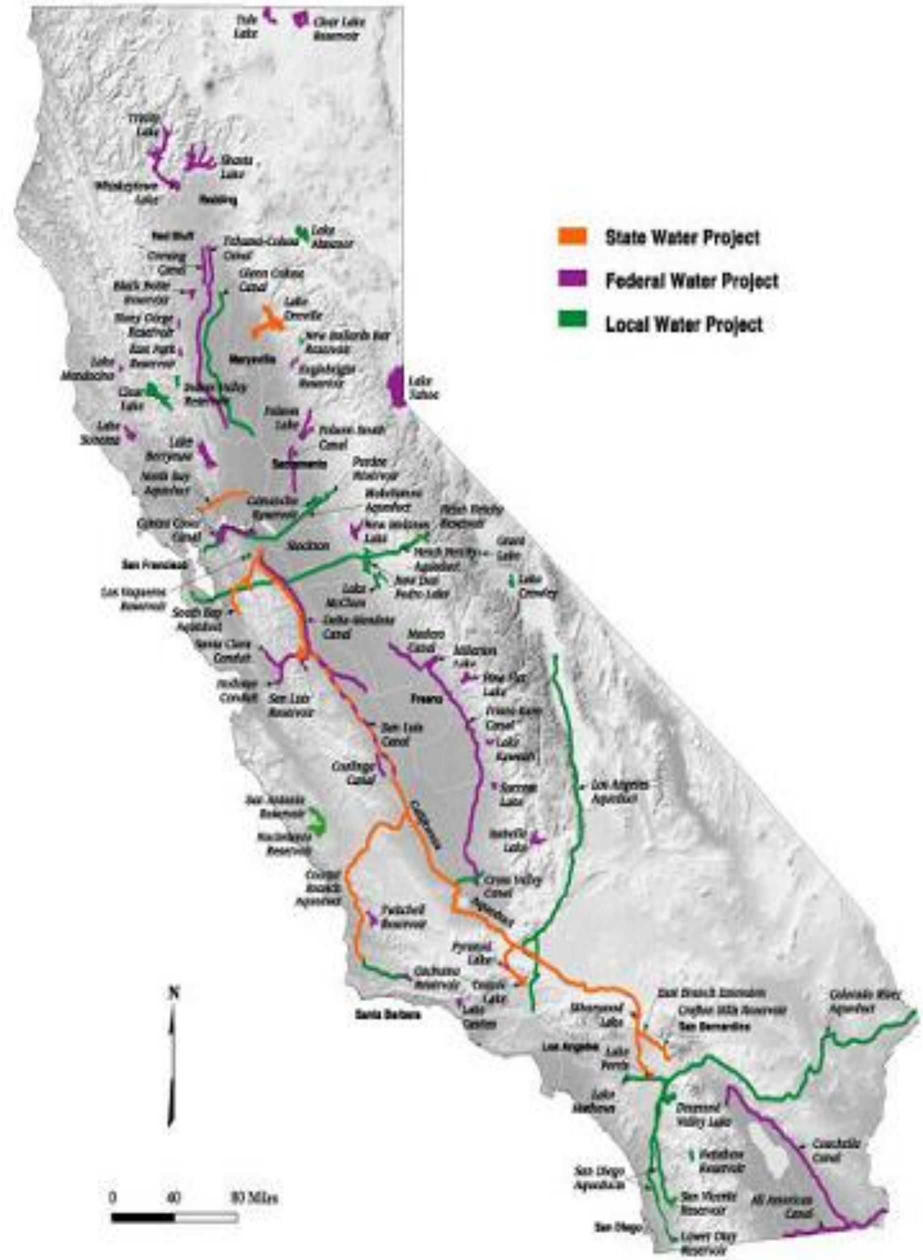
Water and Energy Consulting

530.409.9702

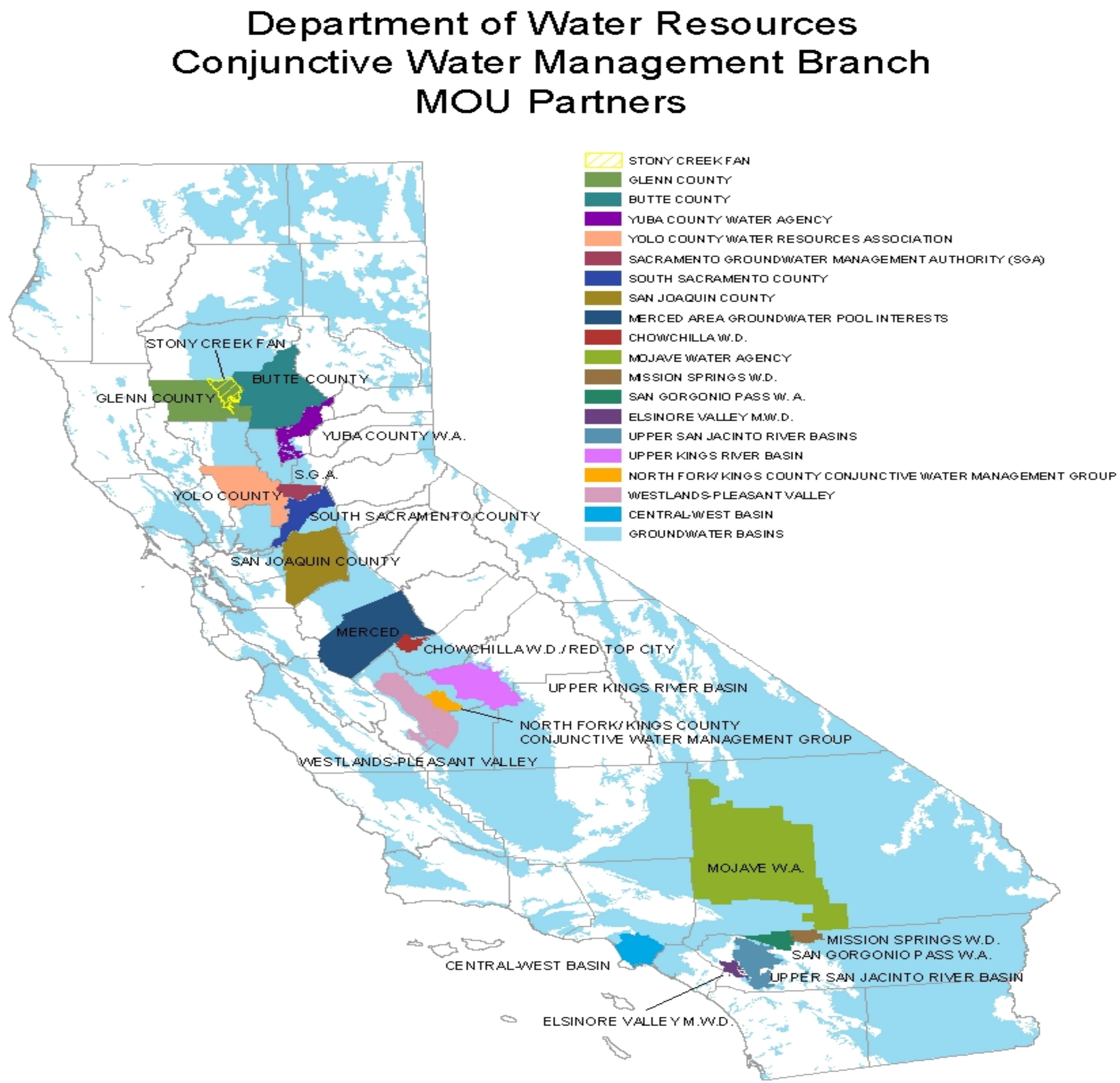


California Hydrologic Characteristics

- 2/3 of Precipitation in North
- 2/3 Demand in the South
- Mediterranean climate
  - 80% of precipitation between late November and early April
  - majority of water use in summer
- Water Use: 43 maf
  - 9 maf Urban
  - 34 maf Agricultural
- Energy Use:
48,000-50,000 GWh; 4,300 MTh
- Population by 2030:
48 million
- 2030 Water Demand:
50 maf



Existing California Conjunctive Use Sites

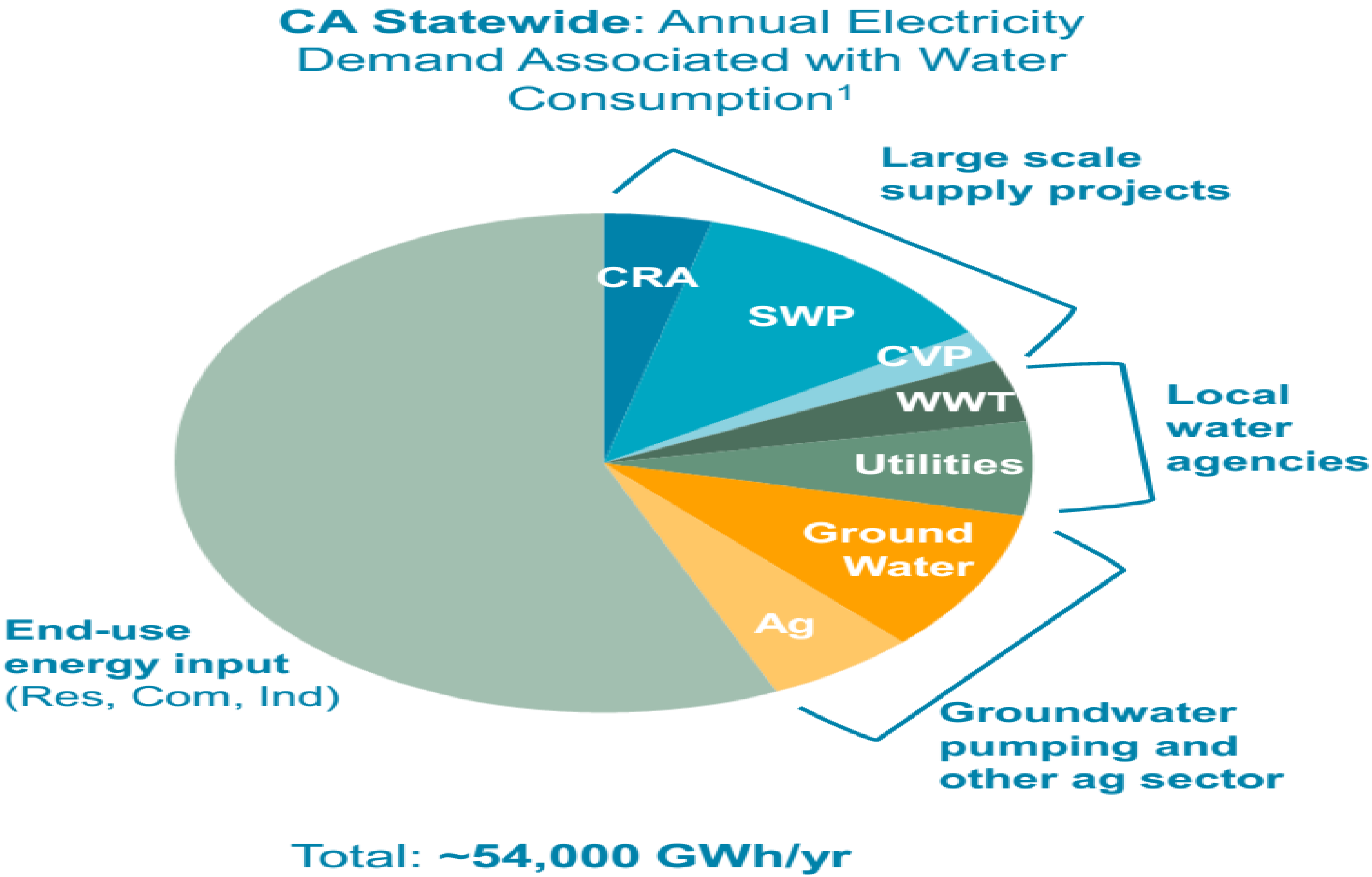


California Seawater Desalination Projects (18)

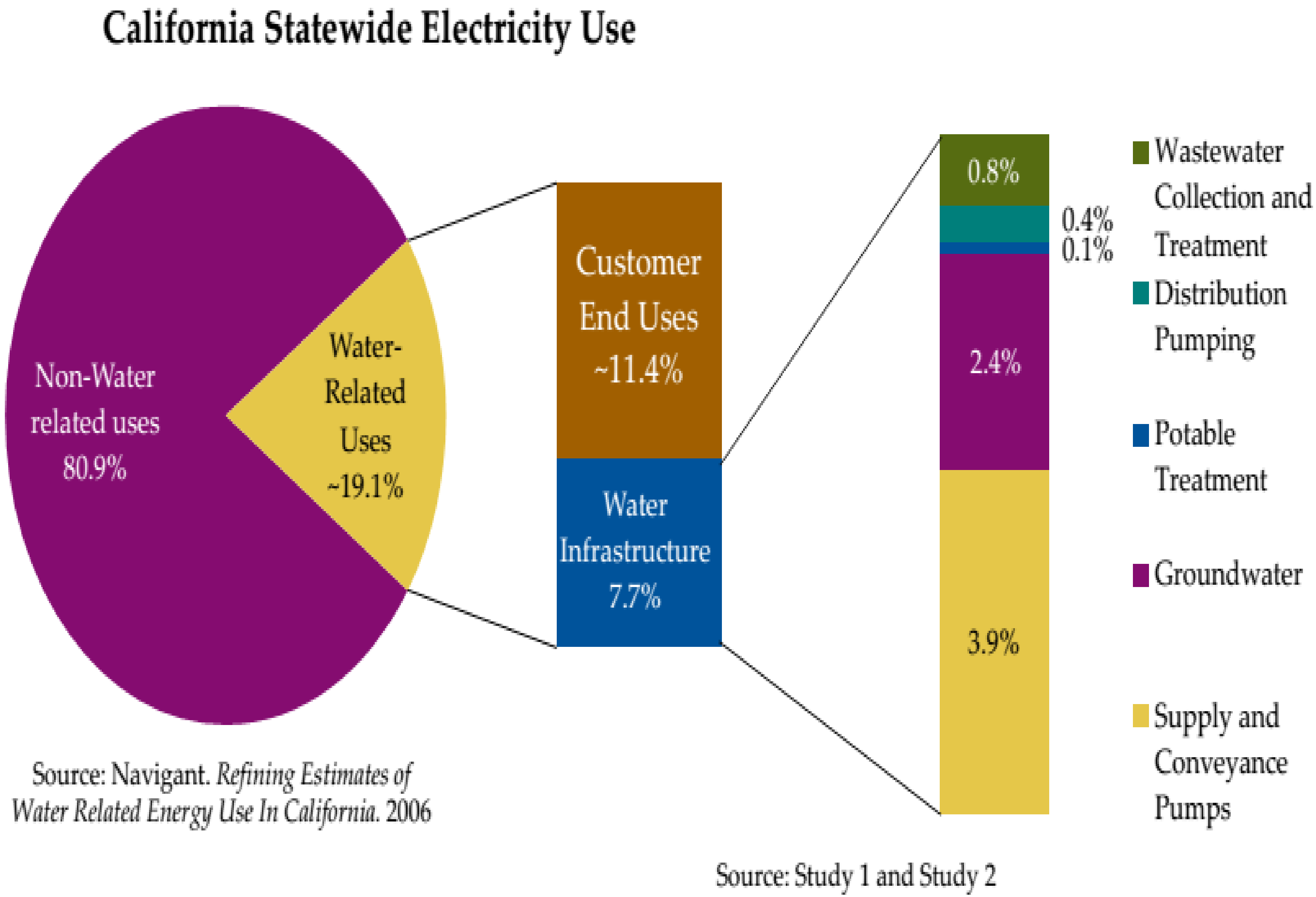
10 Northern California, 8 Southern California Proposed

- ¼ to 50 MGD Capacity, \$2.75/k gal – \$5.12/k gal ~4700kWh/acre-f

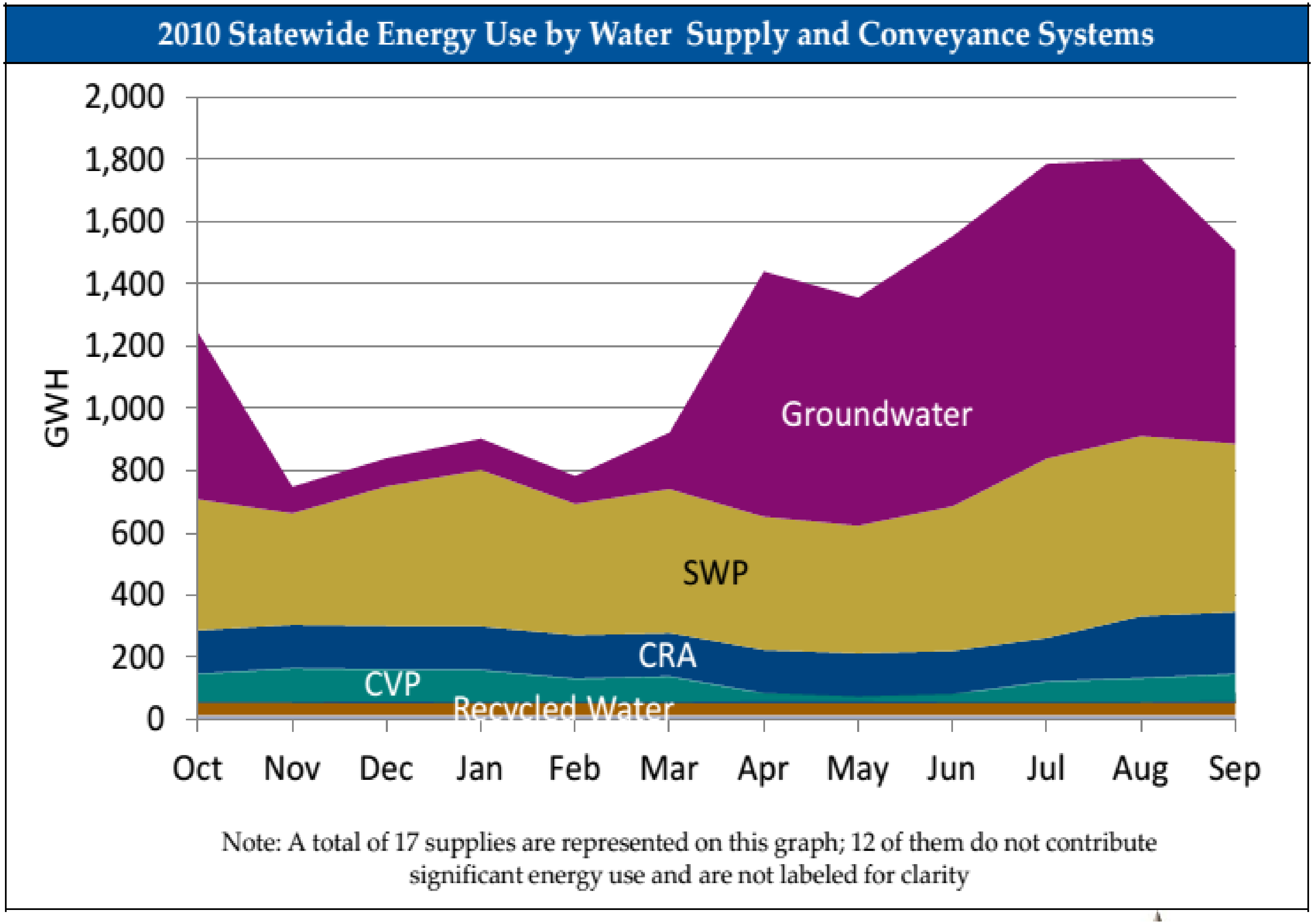
California Electricity in Water



The Infamous 20%



Statewide groundwater pumping accounts for more electricity use during summer months than pumping for the state's three largest water conveyance systems – SWP, CVP and CRA – combined.



Energy Intensity and Embedded Energy are two terms that are key to understanding the Water-Energy nexus

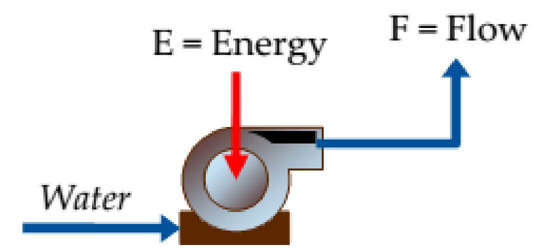
» **Energy Intensity (EI)**

- The average amount of energy needed to transport or treat water or wastewater on a per unit basis (kilowatt hours per acre-foot of water [kWh/AF]).
- The energy intensity is associated with a particular facility and is similar to a measure of efficiency.
- The energy intensities of individual facilities within a water agency can be aggregated to represent the energy intensity of water supply.

» **Energy Embedded in Water**

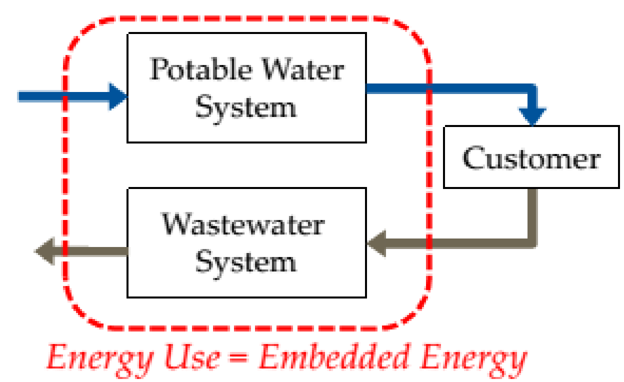
- The amount of energy that is used to collect, convey, treat, and distribute water to end users, and the amount of energy that is used to collect and transport wastewater for treatment prior to safe discharge of the effluent.
- Captures the entire energy picture both upstream and downstream of an end use customer.
- Embedded energy is not associate with a particular facility but with the water itself.

Illustrative Energy Intensity Calculation for a Pump



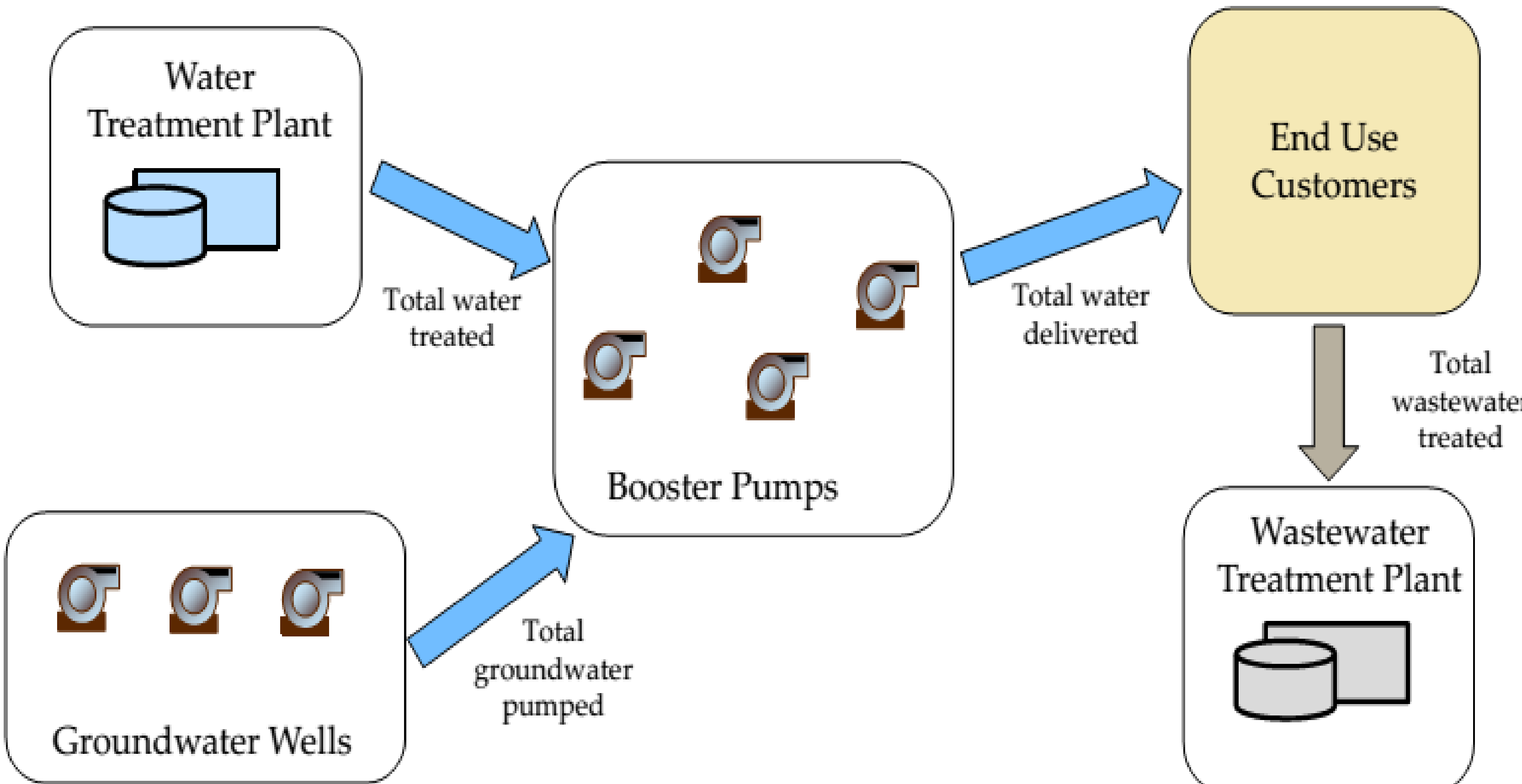
$$EI = \frac{E}{F}$$

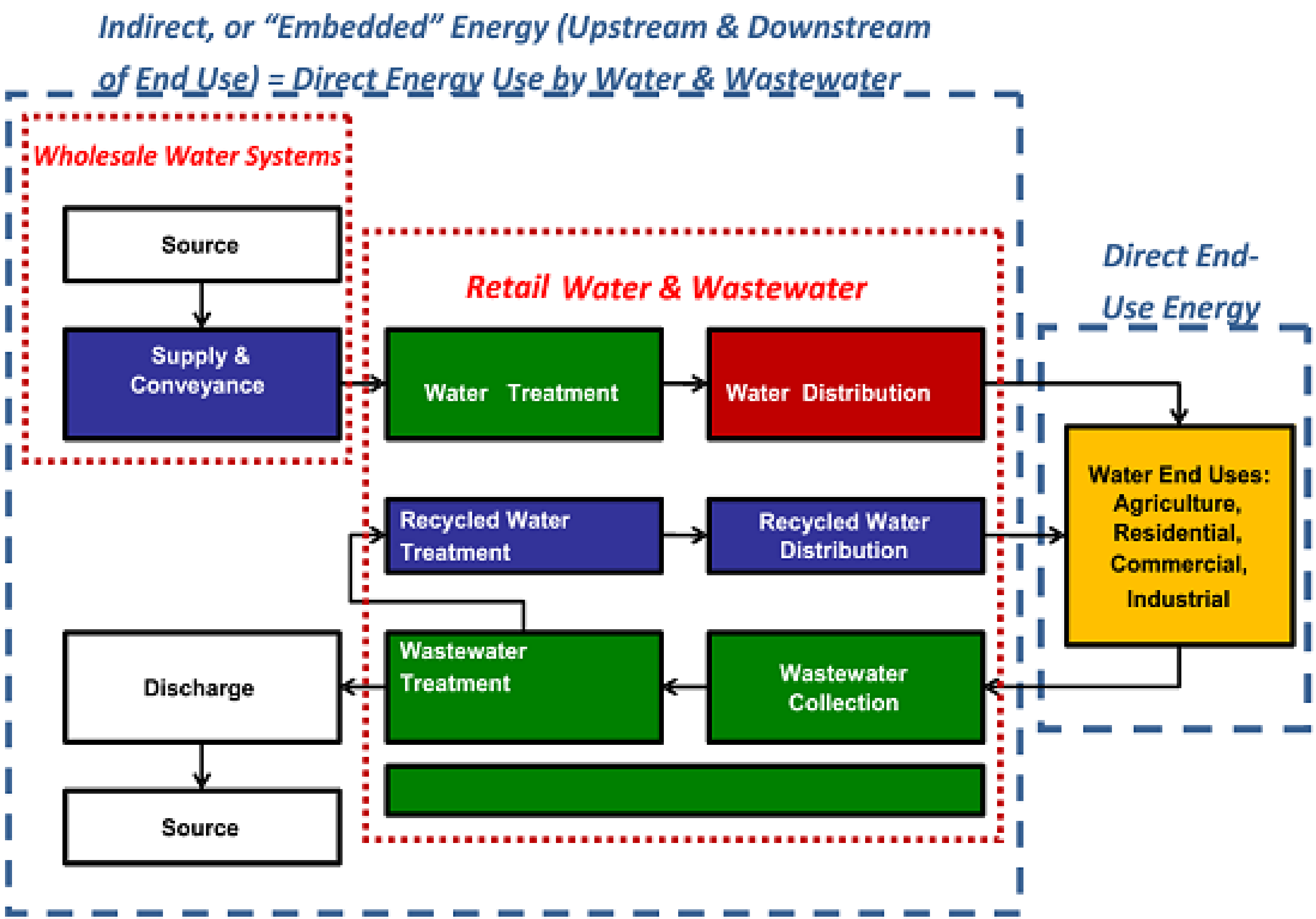
Embedded Energy



Energy intensity of water supply is calculated aggregating energy and water data for each agency.

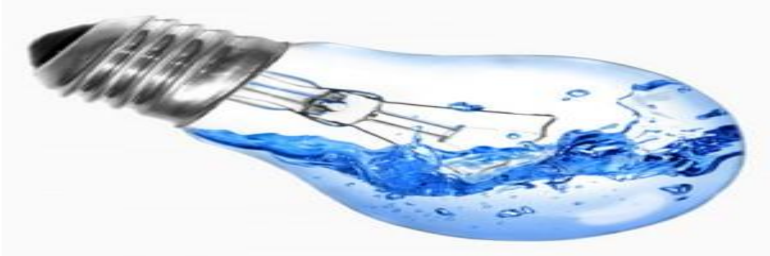
» Energy data may be available for each individual facility, water flow data may be available only for groups of faculties





Indirect, or "Embedded" Energy (Upstream & Downstream
of End Use) = Direct Energy Use by Water & Wastewater
Wholesale Water Systems
Source
Supply & Conveyance
Retail Water & Wastewater
Water Treatment
Water Distribution
Direct End-Use Energy
Water End Uses: Agriculture, Residential, Commercial, Industrial
Recycled Water Treatment
Recycled Water Distribution
Wastewater Treatment
Wastewater Collection
Discharge
Source

Water-Energy Pilots



California Energy Commission: 19% of state electricity production is for water-related uses, recommends water savings included in electric utility EE portfolios

California Public Utilities Commission (CPUC) requests 4 largest investor owned energy utilities (IOEUs) to develop Pilot programs to investigate potential embedded energy savings. Specifically:

- IOEUs must partner with water provider
- Programs should be jointly funded
- Programs must quantify embedded energy in water to calculate potential energy savings

California Water-Energy Pilot Program

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.

Results of the Pilots

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

Water-Energy Efficiency Cost Effectiveness

Four tests to measure cost-effectiveness from four different perspectives:

- – Society: The Total Resource Cost (TRC) test ."Society" defined as Utility + Participant. Is the program cost effective from societal perspective? A variant of the TRC that includes externalities and uses a social discount rate.
- – Administrator: The Program Administrator (PAC) test. What are the energy avoided costs from water saving programs?
- – Ratepayers: The Ratepayer Impact Measure (RIM) test. Is the program cost effective from energy ratepayer perspective?
- – Participant: The Participant Test. Is the program cost effective from water ratepayer perspective?

If programs are not proven to be cost effective to electric and gas IOEU ratepayers, than ratepayer funds cannot be used.

	TRC\				PAC			RIM		Participant	
	Energy	Water	Combined	Societal	Energy	Water	Combined	Energy	Water	End-User	Water Agency
Administrative costs to energy utility	COST		COST	COST	COST		COST	COST			
Administrative costs to water agency		COST	COST	COST		COST	COST		COST		COST
Avoided costs of supplying electricity	BENEFIT		BENEFIT	BENEFIT	BENEFIT		BENEFIT	BENEFIT			
Avoided costs of water capacity		BENEFIT	BENEFIT	BENEFIT		BENEFIT	BENEFIT		BENEFIT		BENEFIT
Avoided embedded utility energy in water	BENEFIT	BENEFIT	BENEFIT	BENEFIT	BENEFIT	BENEFIT	BENEFIT	BENEFIT	BENEFIT		BENEFIT
Avoided embedded additional energy in water		BENEFIT	BENEFIT	BENEFIT		BENEFIT	BENEFIT		BENEFIT		BENEFIT
Energy and Water Bill Reductions										BENEFIT	BENEFIT
Capital (measure) costs to participant	COST	COST	COST	COST						COST	COST
Capital (measure) costs to energy utility	COST		COST	COST	COST		COST	COST			
Capital (measure) costs to water utility		COST	COST	COST	COST		COST		COST		
Incentives paid by energy utility					COST		COST	COST		BENEFIT	BENEFIT
Incentives paid by water utility						COST	COST		COST	BENEFIT	
Increased supply costs	COST	COST	COST	COST	COST	COST	COST	COST	COST		
Revenue loss from reduced energy sales								COST			
Revenue loss from reduced water sales									COST		
Tax Credits	BENEFIT	BENEFIT	BENEFIT	?						BENEFIT	BENEFIT

“Beyond Cost Effectiveness”

Energy Efficiency Savings must be Measured & Verified

- Requirement: demonstrate real savings at the end of a program: for water efficiency this will mean embedded energy savings
- Without energy intensity of supplier, wholesaler and retailer, water savings by customers cannot be translated into energy savings

W-E Follow-up

- <u>Leak Detection.</u> The CPUC ordered the IOEUs in the state to fund trial water system leak detection programs for evaluation. These are currently being evaluated.
- <u>Embedded Energy Determination and Reporting.</u> 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.
- <u>Water-energy Calculator.</u> 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 isn't as simple as it looks. The amount of energy embedded in water depends upon, among other things:
  - the source(s) of water
  - the treatment processes
  - the amount of lost water
  - the efficiency of system infrastructure
  - the energy to include in the determination: self generation, non IOEU energy
- Program development for joint programs is challenging. Water systems are familiar with developing water conservation programs. When an energy utility becomes involved this becomes more challenging:
  - determining electric utility contribution
  - who the program applies to
  - verification of energy savings
  - consistency of energy savings

EBMUD Energy Use (kWh/MG)

EBMUD 1923 2013

Water System	Normal Year	Dry Year
Supply/Conveyance	177	1,423
Treatment	156	1,610
Distribution	917	917
TOTAL	1,250	3,950

- Dry Year Scenario: Includes Mokelumne supply, supplemental water supply, desalination, groundwater and recycled water
- Gravity Water Customers (55%)= ~ 400 kWh / MG
- Pumped Water Customers (45%) ~ 2000 kWh/ MG

Embedded Energy in Water Systems: PG&E Territory

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

Why Water Savings Programs Are Better Than Energy Savings

- *Less overhead*
  - Energy projects are typically run by the electric utilities. Water efficiency programs typically deliver much more of the dollars spent in the actual on-the-ground projects.

- *Water efficiency savings more permanent*
  - Energy efficiency tends to be much more transitory, due to the substitution (Snackwell) effect. As population in California doubled during the last 30 years, electricity use has doubled, whereas water use has stayed the same.

- *Water efficiency saves both water and energy, energy efficiency savings save only energy*
  - Between 3-5% of all the electricity used in the U.S. is used to treat and distribute water (in California the number is over 7%). That means every time you save water you also are saving the energy that was previously used to treat and distribute that water.
  - When you save energy (with a more efficient refrigerator) you only save energy, no water. Water savings gives you double bang for your buck.

Conclusions and Recommendations

- Saving water saves energy. Anytime that you save water, particularly in urban environments, you will also save the energy - that energy that was 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.


SAVING WATER SAVES ENERGY