Questions for Lon House
Water and Energy Consulting

Committee on Energy and Natural Resources Hearing- March 10, 2009

Responses provide by Lon W. House, Ph.D., are in Bold.

<u>Questions from Senator Bingaman:</u>

1. *<u>Question for All Panelists</u>* – Several of you talked about the opportunity to reduce energy consumption by reusing or conserving water. Mr. Bolze, your testimony specifically references that the U.S. presently reclaims and reuses 6% of its wastewater compared to other countries with much higher percentages.
   - *Can each of you comment on the magnitude of potential you see for significant water savings yielding significant energy savings in this country? Are we just at the tip of the iceberg with respect to the water & energy savings possible through water conservation efforts? Has any established entity quantified the potential?*

<u>Federal Facilities:</u> Estimates of 24% of Federal water use can be saved using cost-effective, existing "off the shelf" technologies, primarily domestic water fixtures[1]. Even more can be saved using advanced technologies and improved process water using equipment such as cooling towers, steam systems, and irrigation. The GSA found that federal water conservation potential is estimated at 121 million gallons per day[2].

<u>Water Systems:</u> The most promising areas for intervention within water supply systems are: improving the pumping system, managing leaks, automating system operations, and regular monitoring (preferably with metering of end use)[3]. While the water and energy savings are system specific (but can reach 30%), it should be noted that these improvements often pay for themselves in months, most do so within a year, and almost all recover their costs within three years.

<u>Customer Use:</u> There are multiple state and regional estimates of water conservation potentials. In California, the state Department of Water Resources, in its current draft of the California Water Plan, is using estimates of agricultural water conservation savings potential of 2 million acre-ft per year (with an

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[1] "Update of Market Assessment for Capturing Water Conservation Opportunities in the Federal Sector", Pacific Northwest National Laboratory, PNNL-15320, August 2205

[2] Water Management Guide: A Comprehensive Approach for Facility Managers" , General Services Administration, available at: http://www.gsa.gov/gsa/cm_attachments/GSA_DOCUMENT/waterguide_new_R2E-c-t-r_0Z5RDZ-i34K-pR.pdf

[3] "WATERGY: Energy and Water Efficiency in Municipal Water Supply and Wastewater Treatment", The Alliance to Save Energy, February 2007.

investment of $75 million per year)[4] and urban water savings potential of 2.1 million acre-ft per year (35% of total use)[5].

2. *Question for All Panelists* – As discussed today, one of the hurdles to coordinated energy and water policy is that energy policy is developed at a national level and water policies are more local and regional in nature.
   - *How much of an impediment is that to integrating energy and water policy and what other impediments do you see to this goal?*

   <u>Appliances/Plumbing Fixtures:</u> There are a number of federally regulated appliances or equipment in the water sector. "Federally-regulated commercial and industrial equipment" is commercial and industrial equipment for which there exists a test method and an energy conservation standard prescribed by or under EPAct. "Federally-regulated consumer product" is a consumer product for which there exists a test method and an energy conservation standard prescribed by or under NAECA.

   One issue that should be addressed is the methodology on how the federal standards are established. EO 13211 requires federal agencies to conduct an analysis of energy and use it to develop a statement of energy effects in any proposed rulemaking. However, only direct energy use included. In particular, while energy savings are used in the determination of standards for hot water using appliances and equipment there is not a consideration of the energy savings associated with cold water savings (e.g., with toilets).

   <u>Buildings:</u> There are proposed green building ANSI standards including ASHRAE Proposed ANSI Standard 189.1P Standard for the Design of High-Performance Green Buildings Except Low-Rise Residential Buildings, GreenGlobes-Green Building Initiative (GBI) Proposed American National Standard 01-2008P, and Green Building Assessment Protocol for Commercial Buildings and National Association of Home Builders (NAHB) National Green Building Standard[6].

   <u>Recycled/Reclaimed Water:</u> Regulations on the use of recycled water vary across the U.S.A. There are no national standards. California has the most stringent regulations, as set by the Department of Public Health ("multiple barrier" approach).

   The California State Water Resources Control Board recently adopted a Recycled Water Policy in which established goals to increase recycled water by

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[4] "California Water Plan Update 2009 - Draft", Volume 2 Resource Management Strategies, Chapter 2, Table 2-2.
[5] "California Water Plan Update 2009 - Draft", Volume 2 Resource Management Strategies, Chapter 3.
[6] Alliance for Water Efficiency, available at: http://www.allianceforwaterefficiency.org/Green_Building_Introduction.aspx

an additional million acre-ft of water per year by 2020 and substitution of as much recycled water for potable water as possible by 2030[7].

It is important to note that water issues are generally local/regional issues and there is a need to be able to respond to these issues on a much smaller scale than at the national level. The Association of California Water Agencies recently adopted water conservation and efficiency policy principles that state it succinctly:
"***Water conservation and water use efficiency programs must have the flexibility to adjust to widely varying local circumstances. … Effective water conservation and water use efficiency programs must be responsive to local circumstances, including changing water supply sources, water uses and demands, and water reliability challenges***."[8]

3. Lon House, Water and Energy Consulting – While the majority of water-related electricity use is by end users to pressurize, heat, cool and condition the water, treatment of water is still a significant area of energy consumption. Programs which encourage water conservation can minimize costs of both drinking water and wastewater.
   - *Which treatment type – drinking water treatment or wastewater treatment – has the greatest potential for reduction of energy intensity?*
   - *Follow-up: In addition to water conservation and efficiency programs, are there additional policies, incentives, or technologies that could further minimize either drinking water or wastewater treatment?*

There are two responses: improving the efficiency of the treatment process, and increasing the amount of renewable generation provided by the water/wastewater treatment facilities.

Improve Treatment Efficiency: Water treatment facilities can decrease their energy use by 10-20% energy savings thru treatment process optimization and another 10-20% energy savings thru equipment modifications[9]. The following table provides a summary of typical standard equipment and high-efficiency equipment available for water/wastewater treatment systems[10]. Drinking water typically starts with cleaner water, but is generally treated to a higher quality (at least in the past). Wastewater is generally "dirtier" than fresh water when it starts the process, and the increased emphasis upon recycling water use generally makes the wastewater treatment slightly more expensive. However, as the industry shifts to lower quality water for

[7] http://www.waterboards.ca.gov/water_issues/programs/water_recycling_policy/docs/final_policy_021109.pdf
[8] "Water Conservation and Water Use Efficiency Policy Principles", Association of California Water Agencies, adopted March 27, 2008.
[9] ACEEE Water and Wastewater Energy Road Map, American Council for an Energy Efficient Economy, available at: http://www.aceee.org/industry/water.htm.
[10] "Municipal Water Treatment Plant Energy Baseline Study" submitted to Pacific Gas and Electric Company by SBW Consulting, August 28, 2006

potable water, the energy requirement differences between fresh and waste water are becoming increasingly blurred.

Category		Baseline Design	Energy Efficiency Measure Example
Treatment Technique			
	Screening Aeration Coagulation and Flocculation Sedimentation Granular Filtration Ion Exchange	EPAct motors	Premium efficient motors
	Membrane Filtration	EPAct motors	Premium efficient motors
		Limited pretreatment	Coagulation/Flocculation/Sedimentation
	UV Disinfection	Medium pressure lamps	Low pressure lamps
	Ozone	Fine bubble diffusers	No
		Ozone generation starting from air	Ozone generation starting from LOX
	Ozone/Peroxide	same as ozone	same as ozone
	UV/Peroxide	Medium pressure lamps	Low pressure lamps
	Raw Water Pumping	EPAct motors	Premium efficient motors
		Throttling or by-pass	VFD
	Finished Water Pumping	EPAct motors	Premium efficient motors
		High pressure for entire system	Booster pump for high elevation customers
		Throttling or by-pass	VFD
Equipment			
	Motors	EPAct motors	Premium efficient motors
		Constant speed	VFD
	Pumps	Standard components	High durability components
		Standard interior surface	Liner to reduce friction
	Booster pump	High distribution system pressure	Localized booster pump
	Blowers	Constant speed, multi-stage	High efficiency single stage
	Compressors	Modulating	Load/unload with receiver
		No sequencer	Sequencer
	Valves	High head loss	Low head loss valve or VFD
	Water storage capacity	Standard capacity	Increased storage capacity
	Information and controls	Limited data collection & controls	Integrated data collection & control system
	Piping	Standard interior surface	Liner or coating to reduce friction
	Lighting	Title 24	Motion detector to activate lighting
			Multi-level switching
			Use of day-lighting
			Photocell to control exterior lighting

<u>Increase Renewable Energy:</u> Water/wastewater treatment facilities have several characteristics that make them ideal locations for certain types of renewable generation: they have a large amount of electricity use on site; they are comfortable with up-front capital expenditures for long lived projects; and they usually have a lot of open land available at the site (treatment facilities maintain a buffer of land around the treatment plant for aesthetic and siting purposes).

***Solar* – most of the over 200 kW solar generation facilities in California are located at treatment facilities for the above mentioned reasons. Indeed, one of the criticisms of the current California solar program is that the renewable generation is limited to the amount of electricity the treatment facility uses annually. The water agencies have the space and inclination to install more solar generation if they could be compensated for the excess electricity generated.**

***Biogas* – shifting wastewater treatment from aerobic to anaerobic treatment systems allows the wastewater treatment facility to generate significant amounts of biogas**

(methane) for use in producing electricity (via internal combustion engines, microturbines, or fuel cells) and reduces the amount of natural gas used to keep their digester beds warm. In California, the majority of wastewater treatment facilities are using their own biogas for generation, and the remainder of the facilities are in the process of converting to biogas generation in order to meet Greenhouse Gas limit requirements. This biogas generation is not limited to municipal water treatment. Farms, dairy plants, and heavy industries could reduce or eliminate their energy bills by running their high-strength organic wastewater streams through treatment systems that generate methane biogas. In California, several of the electric utilities have contracts to purchase biogas generated by dairy farms and biogas produced electricity.

4. You advocate the installation of Advanced Metering Infrastructure (AMI) as it is relatively inexpensive, and can provide cost savings through the rapid identification of water leaks.
   - *Can you estimate how expensive it would be to install such infrastructure throughout California?*

The investor owned electric utilities in the state are spending $4 billion on Advanced Meter Reading (AMR) / Advanced Metering Infrastructure (AMI) installations for their customers, so this may serve as a reasonable estimate (except that the electric utility systems are significantly more expensive that the AMR/AMI systems considered by the water systems). A lot of the AMR/AMI infrastructure is currently being installed in California water systems anyway. Through a California Energy Commission study it was determined that over one-half of the water agencies in the state have some level of AMR on their system, and for 34% of the water systems AMR is the predominant type of water meter[11]. Additionally, over 75% of the water systems in California are interested in adding more AMR or AMI to their systems in the next several years.[12]

- *Follow-up: Could cost-savings from improved leak detection and reduced system loss offset the price of AMI in a reasonable timeframe?*

Administrative impacts are currently the primary reasons for selecting AMR among the water systems in California. The overwhelmingly dominant benefit expected from AMR is reduced meter reading costs, followed by more efficient billing and increased customer service. Operational benefits: the use of AMR in conservation programs, loss detection, and in increasing safety/security for personnel followed administrative benefits as reasons for selecting AMR. The operational benefits from AMR are expected to change as systems become more familiar with the technology and due to changes in tariff design, as water conservation becomes increasingly

[11] CEC 500-07-022

[12] House, L. W., "Smartmeters and California Water Agencies: Overview and Status", California Energy Commission, in press.

more important in California and as more water systems switch from traditional tariff design to water budget tariffs.[13]

5. Your testimony notes that a number of current financial incentives for renewable energy do not work for publicly-owned water systems.
   - *Notwithstanding that problem, have California water agencies proceeded with developing renewable energy supplies to integrate into their systems? If so, what benefits are driving this integration?*

<u>Compensating Incentives for Non Tax Payers</u>: In California, we have adjusted the financial incentives for solar installation to provide increased incentive levels for those customers who do not pay taxes and cannot take advantage of tax credits, as the following table shows. This table is the incentive payments for solar installations in California under the California Solar Initiative (CSI). Note that the payments are higher for government/non-profits to account for their lack of ability to take advantage of tax incentives.

		EPBB Payments (per Watt)			PBI Payments (per kWh)		
Step	MW in Step	Residential	Non-Residential: Commercial	Non-Residential: Government/ Non-Profit	Residential	Non-Residential: Commercial	Non-Residential: Government/ Non-Profit
1	50	n/a	n/a	n/a	n/a	n/a	n/a
2	70	$2.50	$2.50	$3.25	$0.39	$0.39	$0.50
3	100	$2.20	$2.20	$2.95	$0.34	$0.34	$0.46
4	130	$1.90	$1.90	$2.65	$0.26	$0.26	$0.37
5	160	$1.55	$1.55	$2.30	$0.22	$0.22	$0.32[3]
6	190	$1.10	$1.10	$1.85	$0.15	$0.15	$0.26
7	215	$0.65	$0.65	$1.40	$0.09	$0.09	$0.19
8	250	$0.35	$0.35	$1.10	$0.05	$0.05	$0.15
9	285	$0.25	$0.25	$0.90	$0.03	$0.03	$0.12
10	350	$0.20	$0.20	$0.70	$0.03	$0.03	$0.10

<u>Power Purchase Arrangements:</u> As the CSI rebates (above) continue to drop but the tax incentives do not, the water agencies in California are increasingly using Power Purchase Arrangements (PPA) as a means of procuring solar power rather than owning the solar systems themselves. Under a PPA, a water agency agrees to purchase electricity from a solar generation installation on its land. The owner of the generation equipment takes advantage of the accelerated depreciation and tax credits in determining the price of the electricity sold to the water agency.

<u>Remote Net Metering Programs</u>: Allow renewable generation at one location to be credited against a portion of retail rates at another system location. California's Assembly Bill (AB) 2466 is called the Local Government Renewable Energy Self-Generation Program and is codified as Section 2830 of the Public Utilities Code. It allows government entities to generate renewable energy at one location, and have it credited against part (the generation part only) of retail rates at another location. It is still under development but the size limit of 1 MW and the inability to access any

[13] Ibid.

other incentives in the development of the renewable project are limiting its usefulness.

<u>Renewables Feed-In Tariffs:</u> Provide a utility standard contract with specified renewable energy price. California's Assembly Bill (AB) 1969 added Public Utilities Code Section 399.20, authorizing tariffs and standard contracts for the purchase of eligible renewable generation from public water and wastewater facilities. It has size limitations (1 MW) and the inability to access any other incentives in the development of renewable projects is resulting in less renewable generation that could be developed. However, several small in-conduit hydroelectric generation projects are being developed under this program.

<u>Questions from Senator Murkowski:</u>

1. Please describe how the United States can satisfy all the expected water needs of newly proposed power plants, including concentrated solar, in arid and semi-arid regions.

Providing sufficient water for power plants that use significant amounts of water in arid/semi-arid regions of the country will continue to be a challenge (PV solar, certain types of concentrating solar such as the Stirling engines, and wind use negligible amounts of water in their operation).

Water use for solar has become an issue in California. The Beacon Solar Energy Project is a proposed concentrated solar electric generating facility proposed on an approximately 2,012-acre site in Kern County, California. The project will use parabolic trough solar thermal technology to produce electrical power using a steam turbine generator (STG) fed from a solar steam generator (SSG). The SSG receives heated heat transfer fluid (HTF) from solar thermal equipment comprised of arrays of parabolic mirrors that collect energy from the sun.

As the California Energy Commission Status Report #6 notes " … one issue, use of potable water for power plant cooling, was highlighted in the Committee's scheduling order because 'The Committee is interested in alternative cooling technologies and alternative cooling water sources that may be used at the plant to reduce the projects need for groundwater..."[14]

2. Are there any regions in the country that are not expecting a significant water problem in the next decade?

While there are the chronic water shortage problem areas such California and the desert Southwest, we are seeing water problems in areas that previously never experienced them, such as the Southeast. A recent article stated that 36 of the states are facing water shortages within the next decade[15]. Combine shortage

[14] available at: http://www.energy.ca.gov/sitingcases/beacon/documents/index.html
[15] "At Least 36 U.S. States Face Water Shortage", by David Gutierrez, <u>Natural News</u>, March 31, 2008.

problems with climate changes with current concerns about radionuclides and pharmaceuticals in the water and there are virtually no major areas of the country that are immune to water problems in the next decade.

3. Please describe how policies aimed at climate mitigation and adaption may affect policies developed in the energy and water sectors, and, specifically, the energy-water nexus.

In California, Green House Gas (GHG) emission targets are pushing water utilities to improve efficiency of operation (to reduce energy consumption), increase water conservation programs (to reduce water provided and the associated energy used), are converting wastewater treatment to biogas operation (to reduce methane emissions) and are increasing renewable generation, primarily solar and small hydroelectric.

4. Please describe the impact on energy use with stricter treatment standards for water and wastewater. Are there any energy related tradeoffs that may occur with stricter treatment standards?

It is a truism that all of the increased treatment requirements increase energy use over past operations. As we control to lower and lower allowable limits, increase the number of contaminants treated for, and are investigating treating for even more problem chemicals such as radionuclides and pharmaceuticals, the treatment process and energy requirements for the treatment are increasing significantly. Combine increased treatment requirements for these contaminants with using poorer and poorer quality water for water supply (such as brackish or sea water) and in the next decade water systems are expected to add significant amounts of new electrical load as they access previously unused water sources and address increased treatment requirements[16].
A recent AWWA article details the increased energy costs associated with water regulations, finding that the 18 National Primary Drinking Water Regulations adopted between 1975 and 2006 cost 1.8 billion kWh per year in increased energy use and an additional $187 million per year in costs.[17]

5. Please describe the impact of energy policies and regulations on water demands and its availability.

The impact depends upon the generation technology used and the water used. Certain renewables such as PV solar and certain concentrating (non thermal) solar, wind, and hydroelectric generation do not materially impact water demands. If recycled water is used, the impact on fresh water is reduced. The largest geothermal generation field in the world, the Geysers in Northern California, is

[16] House, L. W.2007. "Will Water Cause The Next Electricity Crisis?" Water Resources Impact 9 (1), January 2007.
[17] "Drinking Water Regulations: Estimated Cumulative Energy Use and Costs", by S. J. Reiling, Journal AWWA, March 2009.

being "fueled" by recycled water from the City of Santa Rosa. Many of the new generation facilities in California likewise are using recycled water.

6. As we further examine the interrelationship between water and energy, what type of qualitative data do you believe is needed to better understand the connections to biodiversity and ecological health?

I think that the current data collection is adequate for biodiversity and ecological health analysis. What is lacking is good data on water use and water and energy savings, something California is attempting to obtain through its Water-Energy Pilot proceeding with the California Public Utilities Commission[18]. There are three studies and an evaluation being done.

Study 1: Statewide and Regional Water-Energy Relationship

• The goal of Study 1 is to develop a predictive model of the functional relationship between wholesale water deliveries in California and the energy used to deliver that water. Essential model inputs are the primary determinants of the energy intensity of the state's largest wholesale water systems.

Study 2: Water Agency and Function Component Study and Embedded Energy-Water Load Profiles

• The goal of Study 2 is to characterize and quantify the relationships between water and energy use by water and wastewater agencies, and to determine the range of magnitudes and key drivers of embedded energy in water.

Study 3: End-Use Water Demand Profile Study

• Study 3 is designed to provide accurate hourly water use profiles. End-use Water Demand Profile study measures cold water demands of six end-use (customer) categories:

1. Residential (Normal and Low-income, Single-family)
2. Residential (Low-income, Multi-family)
3. Commercial
4. Industrial
5. Public Buildings
6. Agriculture

The final analysis is the Embedded Energy in Water Pilot Programs measurement and verification. The focus is on verifying and quantifying the water and energy saved as a result of water-use reduction measures. There are a host of measures being tested, ranging from pH controllers to laundry ozone retrofits to high efficiency toilets to recycled water use to leak detection. These studies/programs are underway, and results expected in 2010.

7. How can we encourage coordination and collaboration of research, development and policy efforts in the energy-water domain, with a view to cross-cutting learning?

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[18] Rulemaking (R.) 06-04-010.

Federal responsibility for water (primarily with the Environmental Protection Agency) and for energy (primarily with the Department of Energy) reside in different federal agencies (the Department of Interior is heavily involved with water supply and energy in the western states).

- Joint studies and research on the water and energy can be initiated

- These agencies should be required to address both water and energy as part of their on-going mandate (the EPA should evaluate energy impacts when developing water policy and regulations and the DoE should address water impacts of energy policy and regulations).

There is considerable value associated with developing the science, research, and monitoring techniques to address new generation products, and associated water pollution before the fact, as opposed to investing in costly remedial work after the water has become contaminated. California has initiated a Green Chemistry Initiative which seeks to eliminate or reduce the use of toxic substances in products and manufacturing processes rather than managing wastes at the end of a product's lifecycle[19] that could be followed on a national level.

8. Please describe the linkages between energy and water consumption, as a society becomes more affluent. How do measures to improve water use efficiency and energy efficiency correlate, as societies become more affluent?

Energy use tends to increase with increasing affluence. Water use tends to increase initially with a rise in affluence, and then stabilize. It is axiomatic that water consumes energy and energy consumes water. Saving water will save energy, but saving energy does not necessarily save water. These two resources have fundamentally different characteristics that influence policy decisions.

- **There are very limited sources of additional fresh water available (primarily desalinization of sea water) but there are a host of options available for the creation of electricity.**
- **As stated in my previous testimony, water conservation tends to result in more consistent and stable savings as compared to energy conservation, primarily because new technologies are constantly being developed to use electricity. The energy use in California has tracked the population growth, while water use has remained flat for the last 30 years.**
- **Water issues tend to be localized (or regionalized) while energy concerns tend to be more national (the price and availability of oil has national implications while the price and availability of water in Los Angeles primarily concerns Los Angelians.**

In my opinion, the water crisis is a more pressing matter than the energy crisis, because there are fewer options available to address it.

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[19] http://www.dtsc.ca.gov/PollutionPrevention/GreenChemistryInitiative/index.cfm.

9. Please describe how water resource constraints can become energy constraints.

Depending on the type of cooling tower, the cooling process for thermal electrical generators can account for up to 90%–95% of total plant water use[20]. However, there are options that can significantly reduce the amount of fresh water used in electricity production. As the following table shows, two states, Florida and California, have the majority of power plants using reclaimed water[21] with Texas close behind.

State in Which Power Plant and Wastewater Treatment Plant Are Located	Number of Power Plants Using Reclaimed Water
AZ	3
CA	13
CO	1
FL	17
IA	1
KS	1
MA	3
MD	2
MS	1
NH	1
NJ	2
NM	1
NV	2
PA	1
TX	7
WI	1

On June 19, 1975, amid concerns about the diminishing availability of fresh water in California, the State Water Resources Control Board (SWRCB) adopted its "Water Quality Control Policy on the Use and Disposal of Inland Waters Used for Powerplant Cooling" (Resolution No.75-58)[22]. Resolution 75-58 states that from a water quantity and quality standpoint, the source of powerplant cooling water should come from the following sources (in order of priority): (1) wastewater being discharged to the ocean, (2) ocean water, (3) brackish water or natural sources of irrigation return flow, (4) inland wastewaters of low total dissolved solids (TDS), and (5) other inland waters. Where the SWRCB has jurisdiction, use of fresh inland waters for power plant cooling will be approved by the Board only when it is demonstrated that the use of other water supply sources or other methods of cooling would be environmentally undesirable or economically unsound. Additionally, California Water Code Section 13550 et seq. requires the use of effluent for industrial purposes, especially for cooling, where it is available. In 1997, the siting agency in the state, the California Energy Commission (CEC), and the SWRCB

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[20] "Comparison of Alternate Cooling Technologies for California Power Plants", California Energy Commission. 2002, CEC500-02-079F

[21] "Use of Reclaimed Water for Powerplant Cooling", Argonne National Laboratory, ANL/EVS/R-07/3, August 2007.

[22] www.swrcb.ca.gov/plnspols/wqplans/pwrplant.doc

entered into a Memorandum of Understanding in order to coordinate the review of projects for which a regional water quality control board or the SWRCB have authority.

The use of dry cooling versus wet cooling for power plant operations has the following impacts:

- **the use of dry cooling reduces plant water requirements by about 90%,**
- **an associated increased plant capital cost of about 5% to 15% of the total plant cost for the dry cooling system,**
- **energy out reductions of 1% to 2%, and**
- **capacity reduction of 4% to 6%.[23]**

10. What percentage of water used in California comes from reused water?

Currently 6% of the water use in California is from reclaimed water, but that percentage is projected to increase to 20% in the next two decades. The following table lists recycled water use in California in 2002.

California State Water Resources Control Board

Office of Water Recycling

RECYCLED WATER USE IN CALIFORNIA

06/2003

Types of Reuse	Volume of Recycled Water Use Within Region, Acre-Feet/Year											
	1	2	3	4	5F	5R	5S	6	7	8	9	Total
Agricultural irrigation	12,694	8,318	22,110	3,752	110,046	1,314	35,349	8,588	2,951	30,795	5,033	240,951
Landscape irrigation and	2,675	10,114	3,152	26,229	80	51	1,431	8,418	6,624	28,135	24,191	111,100
Industrial use	0	4,865	26	22,376	0	61	264	65	0	199	0	27,857
Ground water recharg	0	0	0	46,247	0	0	2,500	0	0	0	286	49,033
Seawater Barrier	0	0	0	10,651	0	0	0	0	0	15,000	0	25,651
Recreational impoundment	0	0	0	24,429	111	0	0	7,347	0	0	1,216	33,103
Wildlife habitat or misc.	1,977	6,198	5	6,437	0	0	1,009	0	172	4,361	41	20,200
Geysers/Energy Production	0	0	0	2,198	0	0	0	0	0	0	0	2,198
Other or mixed type	0	25	0	9,997	0	0	0	0	0	5,159	188	15,369
TOTAL	17,346	29,519	25,295	152,316	110,238	1,427	40,552	24,418	9,747	83,650	30,955	525,462

Source: Office of Water Recycling, California State Water Resources Control Board

Recycled water use has increased sharply since 2000, in part due to the increased use by electric power plants.

[23] "Cost and Value of Water Use at Combined-Cycle Power Plants", California Energy Commission, CEC-500-2006-034, April 2006

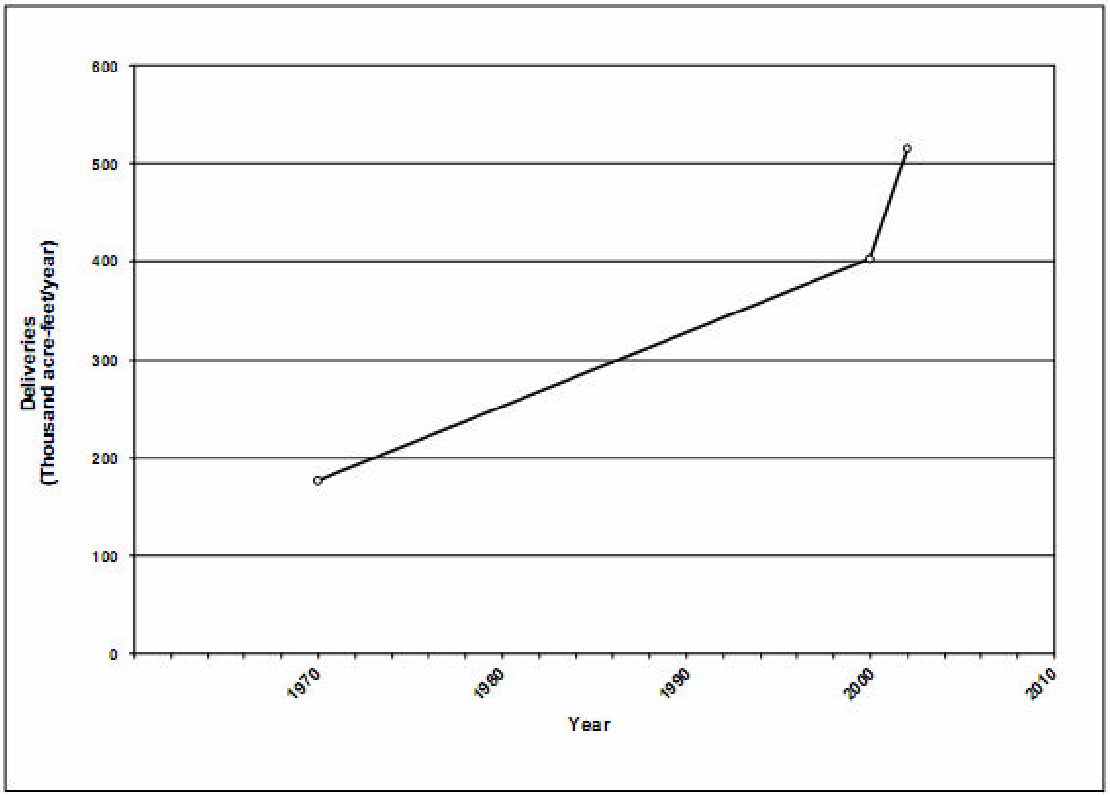


Figure 1. Recycled Water Use in California for 1970 to 2002.

The state water plan developed by the Department of Water Resources, the California Water Plan[24], lists 1,670 acre-ft per year of recycled water in its future portfolio of available water for consumption.

11. Please explain the energy requirements of reused water compared to freshwater use in California, particularly in southern California.

While there is a considerable range in the energy requirements of fresh water, recycled water tends to have a much narrower spread, as the following table illustrates[25].

[24] http://www.waterplan.water.ca.gov/

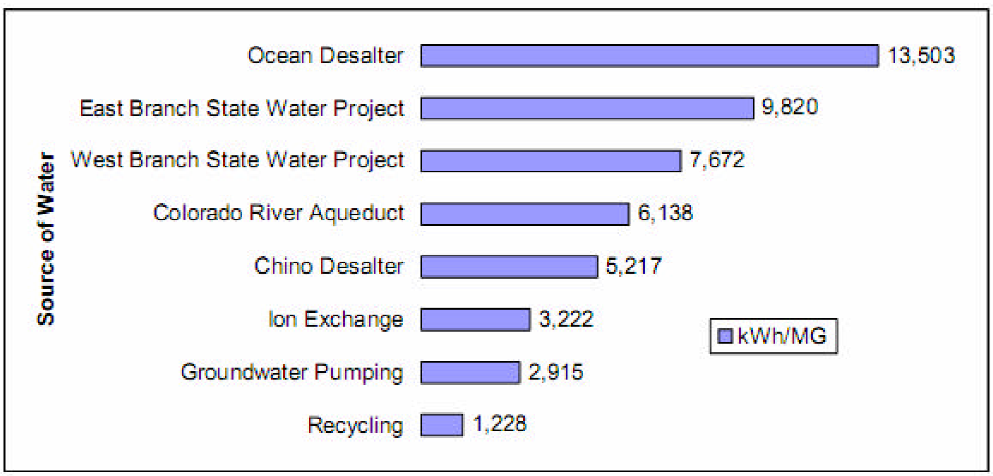
[25] "California's Water – Energy Relationship", California Energy Commission, CEC-700-2005-011-SF, November 2005.

Table 1-2: Range of Energy Intensities for Water Use Cycle Segments

	Range of Energy Intensity kWh/MG	
Water-Use Cycle Segments	**Low**	**High**
Water Supply and Conveyance	0	14,000
Water Treatment	100	16,000
Water Distribution	700	1,200
Wastewater Collection and Treatment	1,100	4,600
Wastewater Discharge	0	400
Recycled Water Treatment and Distribution	400	1,200

As the following table[26] shows, for the Inland Empire Utilities Agency, recycled water has the lowest energy intensity of any of the water sources available. This relationship is typical for water agencies in Southern California.

Figure 2-2 Energy Intensity of IEUA Water Supply Options



12. How do the figures for water reuse compare to other states, and or nations with limited water supplies?

The majority of water reuse in the U.S. occurs in four southern and western states. As the response to Question 9 states, the water reuse in these states is driven not only by a shortage of fresh water, but also by the extensive use of reclaimed water for power plant use.

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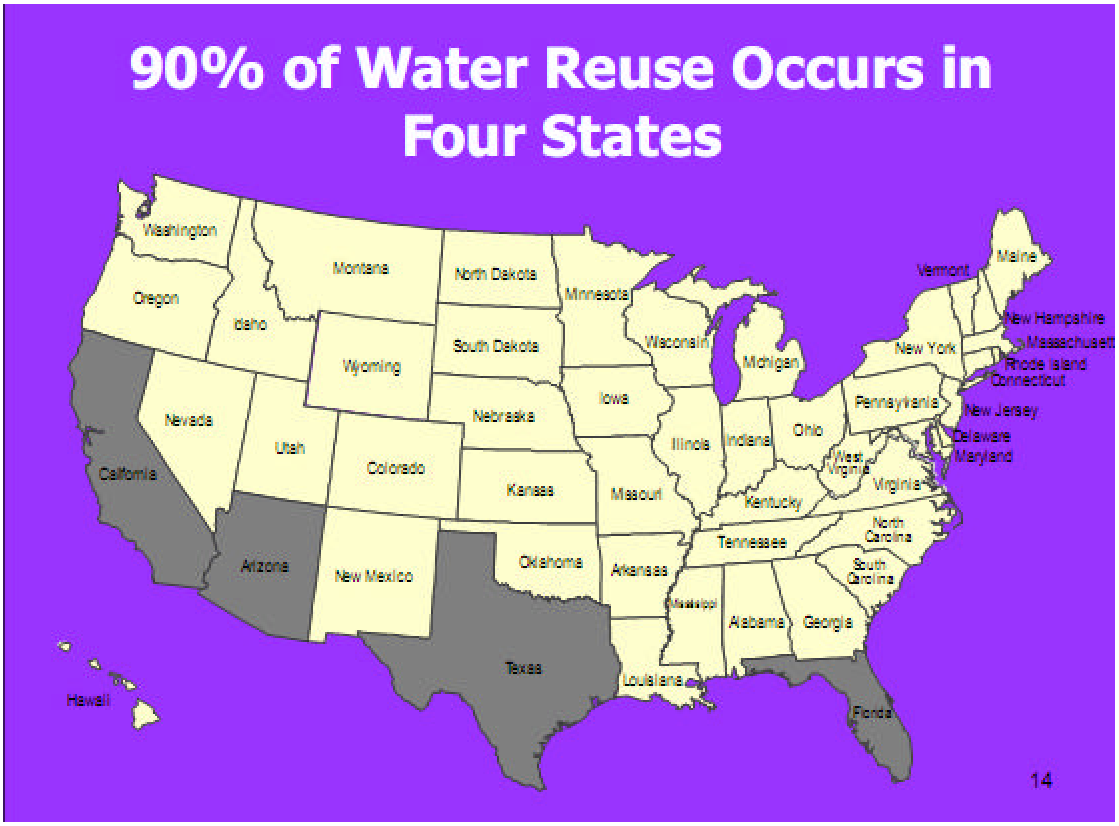
[26] Ibid.



13. How do you weigh the ecological impacts of seawater use for energy production verses inland facilities, that likely use fresh water?

For humans, fresh water is more valuable that salt water. As stated in response to Question 9 above, it is very difficult to site a power facility inland in California that uses fresh water without going to some alternative form of cooling or water. California is also in the midst of evaluating a ban on once through cooling for power plants located on the coast due to its environmental impact.[27]

<u>Questions from Senator Stabenow:</u>

1. *Water scarcity in non-arid regions.* When we talk about water supply, we often think immediately of California and the arid Southwest. Yet the groundwater situation around the Great Lakes is poor and we're facing major groundwater depletion around population centers like Chicago, Milwaukee, and Detroit. Furthermore, those areas have faced additional pressure on supply due to compacts with Canada restricting water extraction from the Great Lakes. I have also been told that in Michigan, a power plant application was denied due to lack

[27] http://www.waterboards.ca.gov/water_issues/programs/npdes/cwa316.shtml

of water availability. Could you expand upon this a bit more, to explain why the Great Lakes region also requires better water efficiency, although one might not realize it?

Clean fresh water is a premium resource. The use of such a valuable resource to carry heat away from a power plant may not be the highest and best use, particularly when there are a number of alternative ways to either produce the power or dispose of the heat.

Even in areas of perceived water abundance such as the Great Lakes area, there is conflict over water policy and use[28]. In 2008, the governments of the eight states in the Great Lakes basin adopted the Great Lakes –St. Lawrence River Basin Water Resources Compact (the Compact)[29], which was recently ratified by the federal government to finalize the agreement[30]. The Compact puts strict limits on water use in an attempt to minimize future threats to the region[31]. One of the major objectives of the Compact is water conservation and efficiency goals and programs. These goals and programs are attempts to minimize water use and create sustainable use of the water within the Great Lakes area.

[28] "The Great Lakes Water Wars", by Peter Annin, Island Press, August 2006.
[29] "The Great Lakes-St Lawrence River Basin Water Resources Compact", Final Report, August 15, 2007.
[30] Signed October 3, 2008, by President Bush. The U.S. House of Representatives voted to approve the Compact by a 390 to 25 vote on September 23rd. The U.S. Senate approved the Compact on August 8, 2008.
[31] The Compact prohibits all new or increased diversions from the Basin