California Water – Energy Issues

Martha Krebs, Ph.D.
Deputy Director for R&D

Western Region Energy-Water Needs Assessment Workshop
Salt Lake City, Utah
January 10, 2006

Public Interest Energy Research (PIER) Program
California Energy Commission

The California Energy Commission

Charged with

- Licensing thermal power plants 50 MWs and larger
- Adopting appliance and building energy efficiency standards
- Forecasting state energy use
- Conducting public interest energy research of benefit to electricity and natural gas ratepayers
- Maintaining energy information and performing analysis
- Proposing to the Governor integrated state energy policies

California - Energy Overview

- Population: *34 million,*

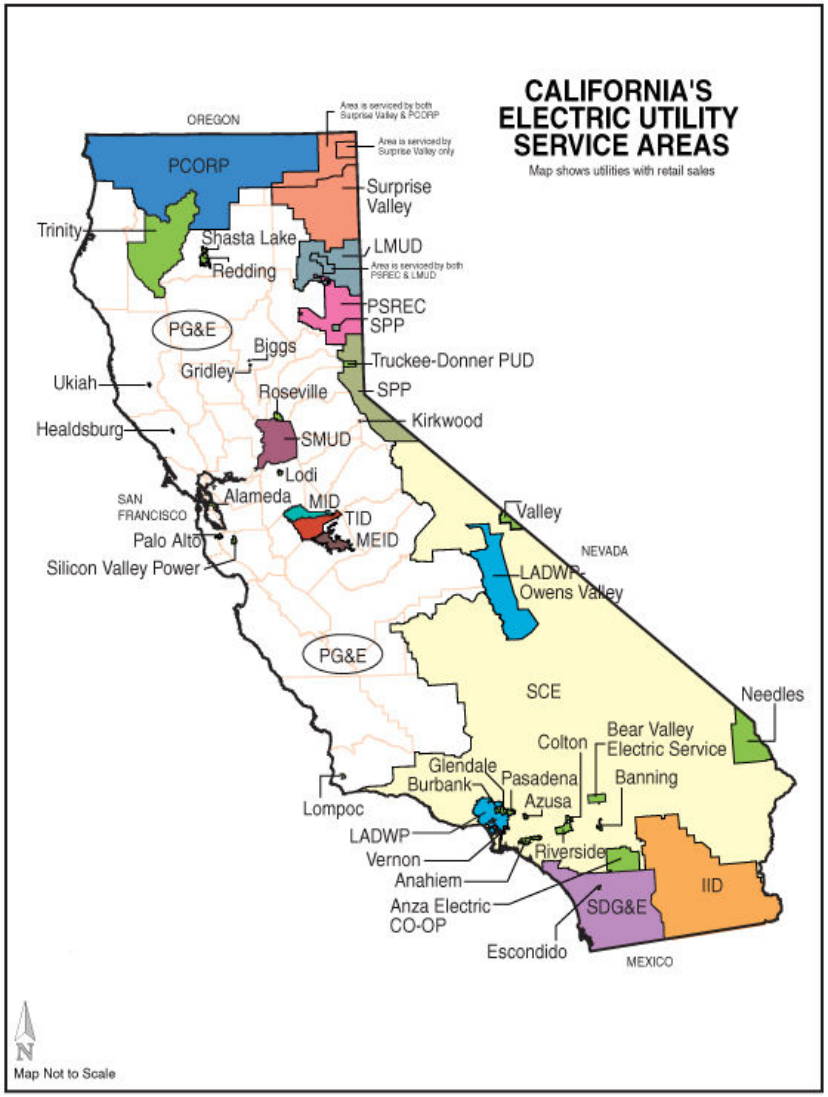
  1.1% per year growth
- Multiple Utility Service Territories
- 2004 Electricity Use:

  262,000 GWH
- 2004 Peak Demand:

  54,500 MW
- Annual growth:

  Consumption - 1.4%

  Peak - 1.65%



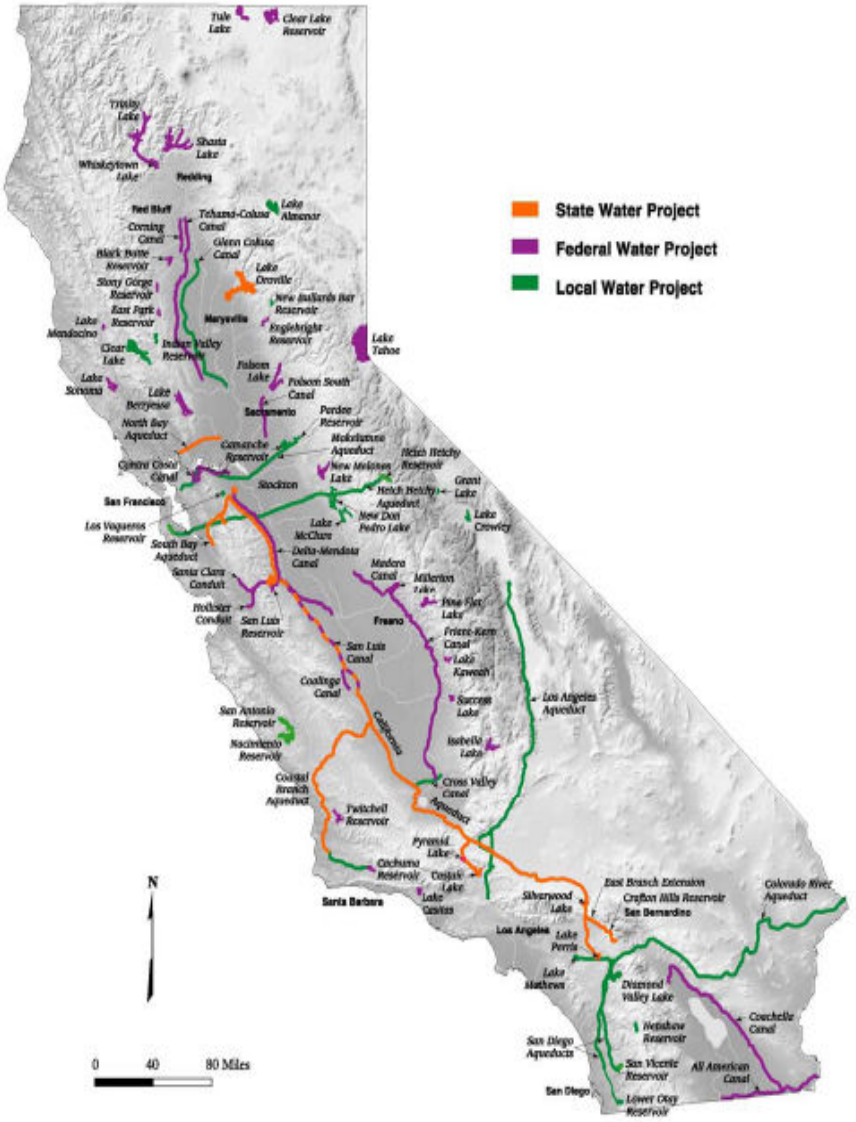
California- Water Overview

- 2/3 of Precipitation in North
- 2/3 Demand in the South
- Water Demand: *43 maf*
- *9 maf Urban*
- *34 maf Agricultural*
- Energy Use:

  48,000 GWh; 4,300 MTh
- Population by 2030:

  48 million
- 2030 Water Demand:

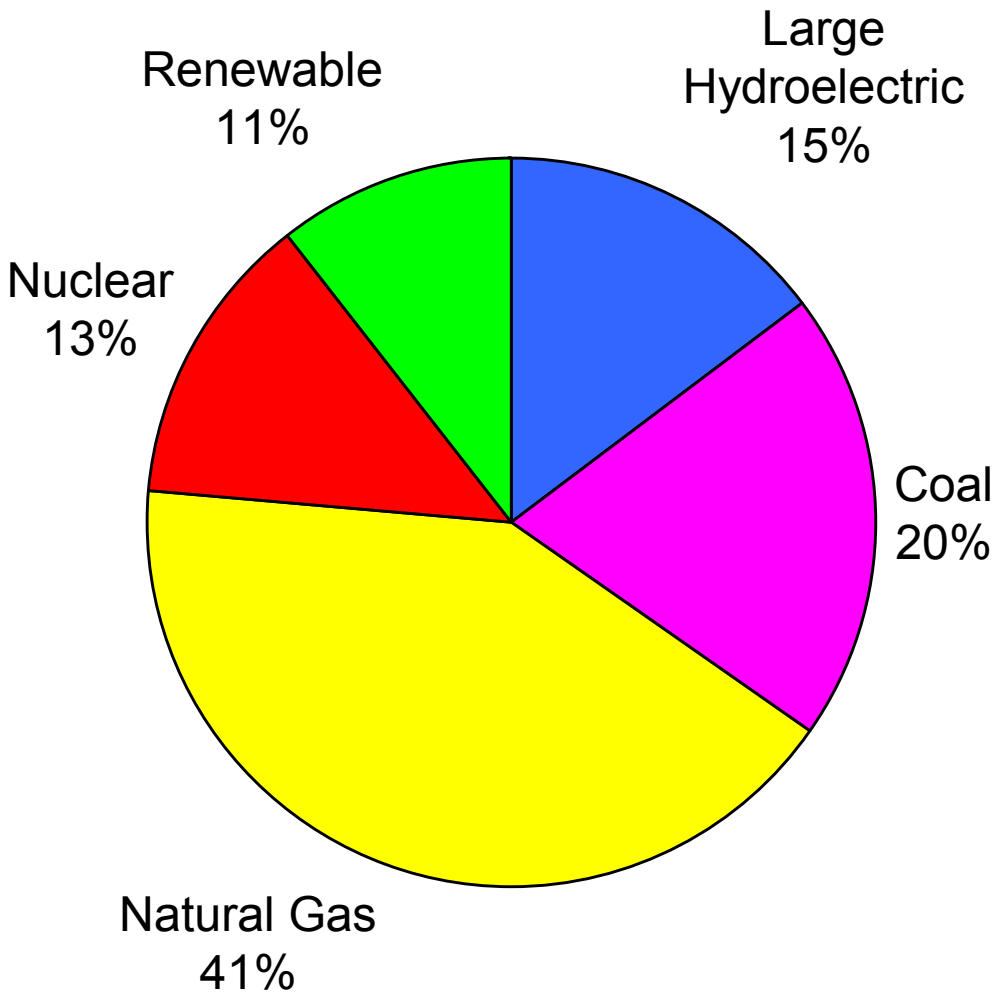
  43-50 maf



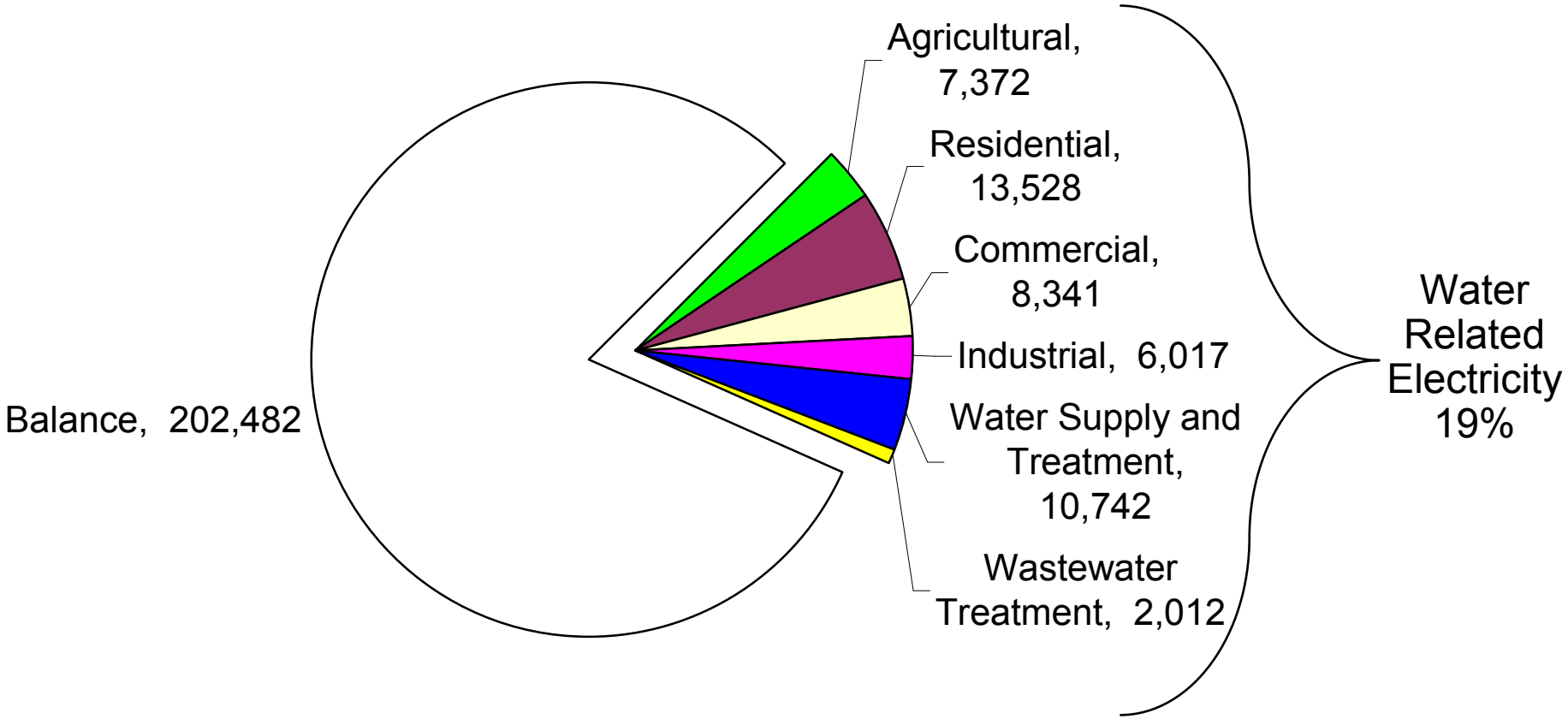
Parallel Concerns

- Growing Demand
- Infrastructure
- Resource Adequacy
- Cost
- Source Quality/Diversity
- Reliable Supplies
- Environmental Protection
- Long-term Uncertainty

California Electricity Production 2004

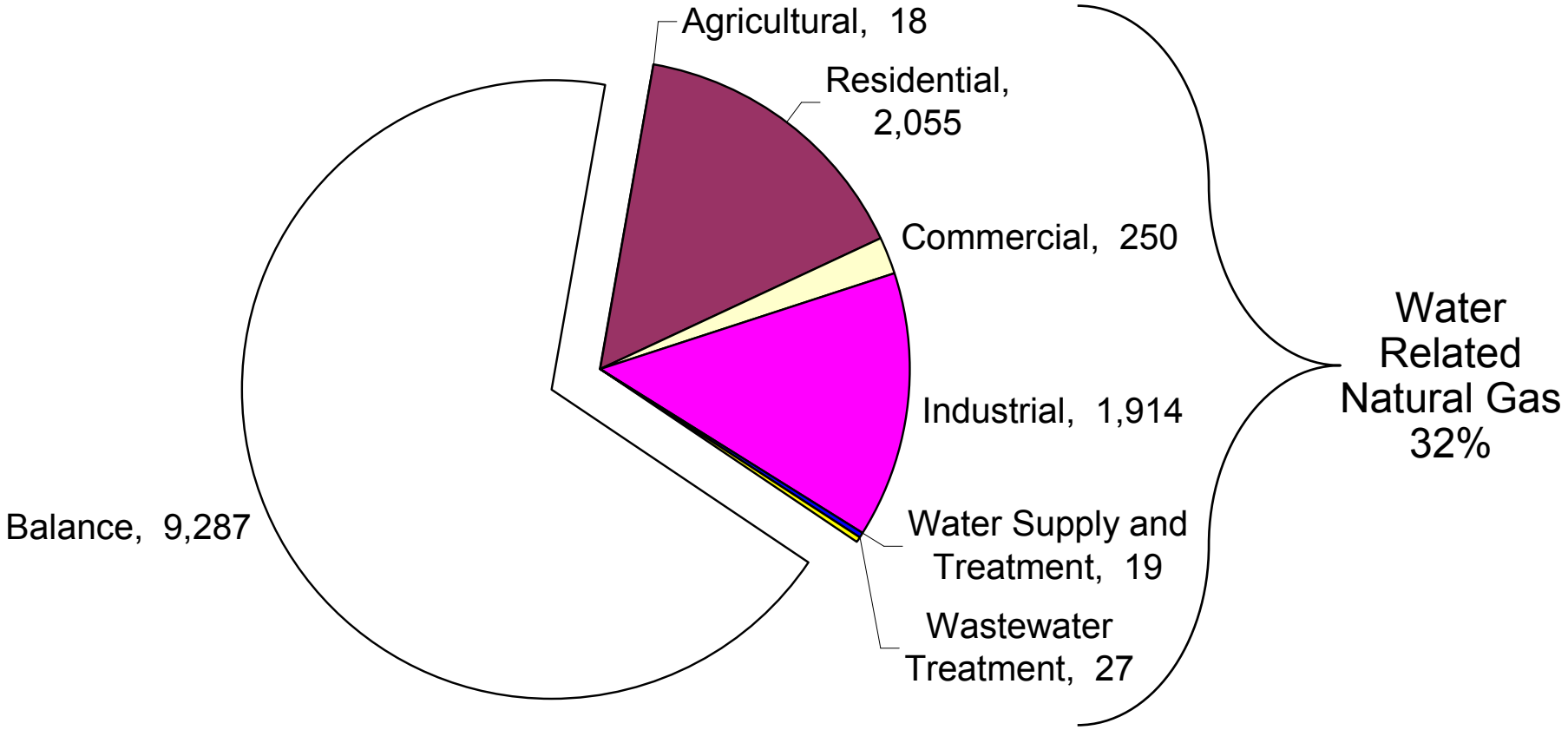


Electricity Demand for California's Water System in 2001



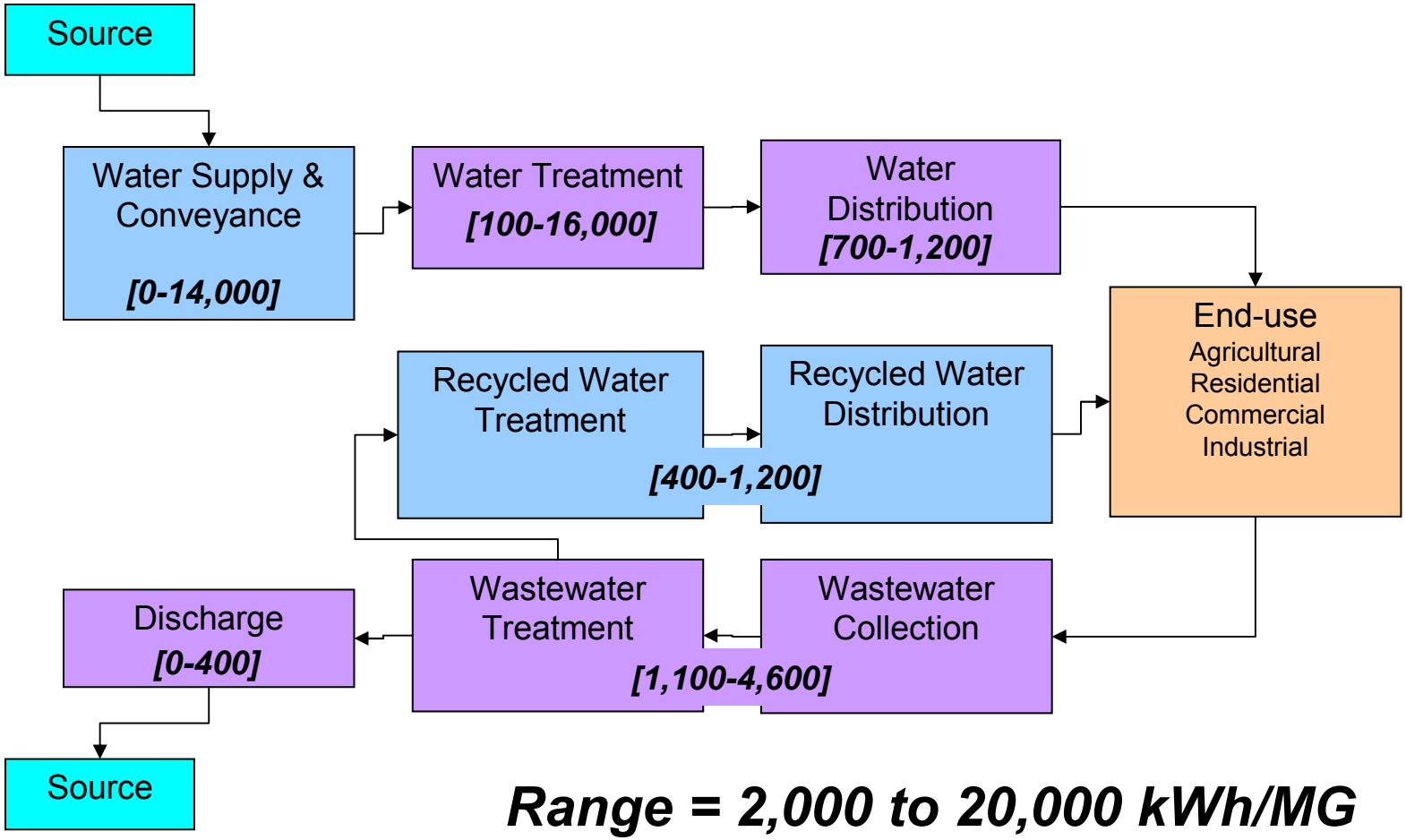
Total Electricity Demand in 2001 = 250,454 GWh

Natural Gas Demand for California's Water System in 2001



Total Natural Gas Demand in 2001 = 13,571 therms

Water Use Cycle Energy Intensities (kWh/MG)



Range = 2,000 to 20,000 kWh/MG

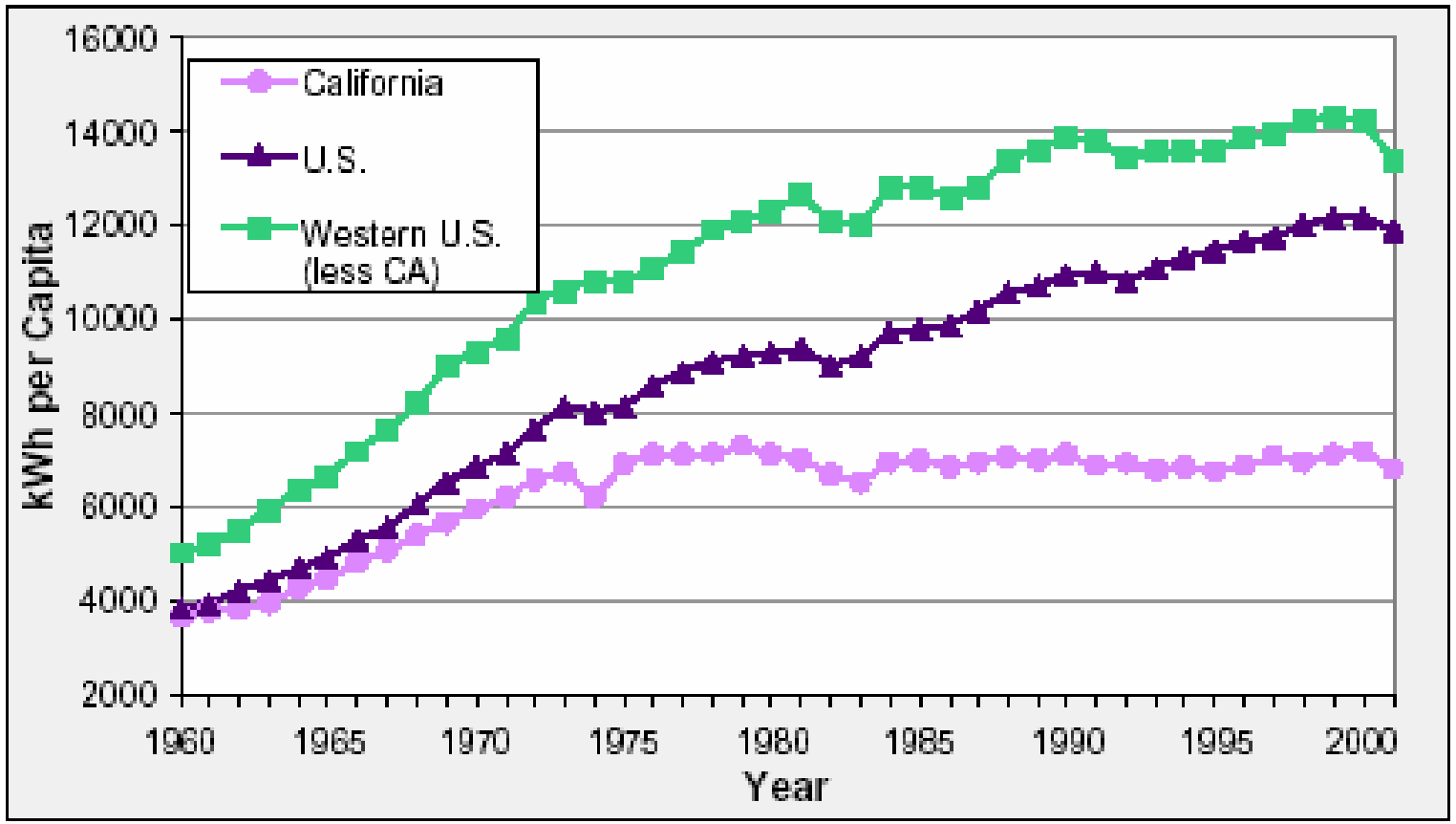
Source: California Energy Commission, 2005 Integrated Energy Policy Report

Regional Differences

	Northern California	Southern California
	kWh/MG	kWh/MG
Supply & Conveyance	150	8,900
Water Treatment	100	100
Distribution	1,200	1,200
Wastewater Treatment	2,500	2,500
Regional Total	3,950	12,700

Source: California Energy Commission, 2005 Integrated Energy Policy Report

Total Electricity Use Per Capita 1960- 2001

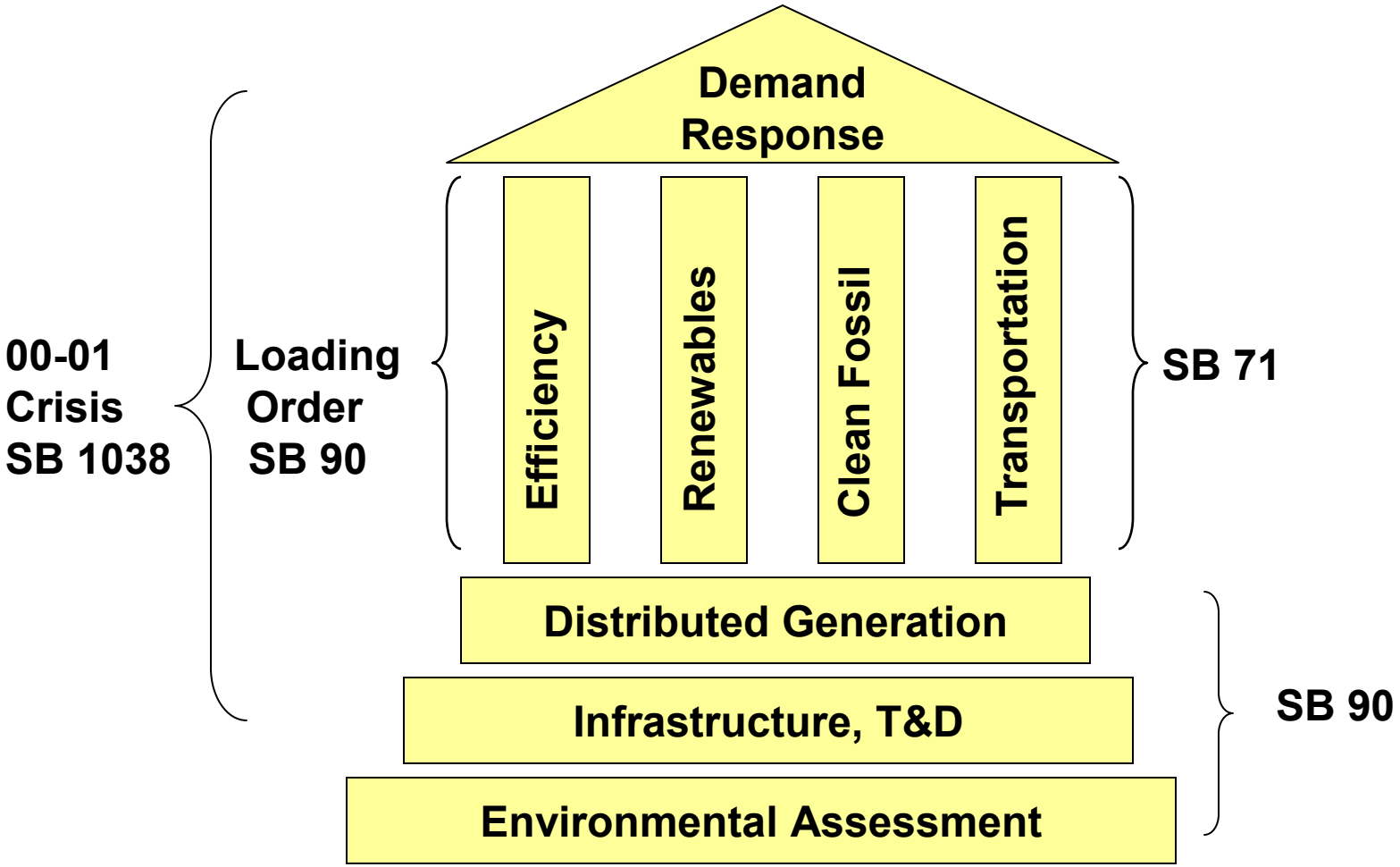


Californians use almost 50 percent less electricity than the U.S. average
Source: Energy Information Agency and California Energy Commission

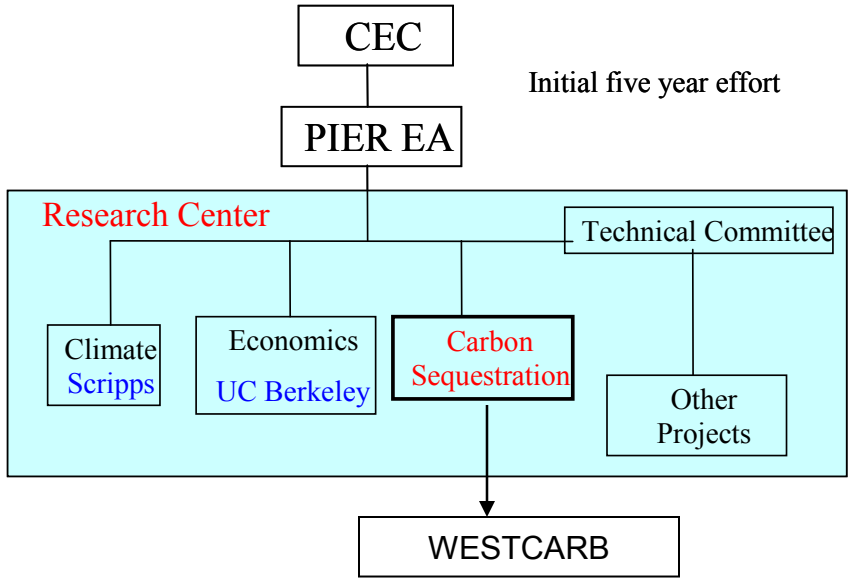
Water-Energy Relationship Synergies

- ✓End-User Water and Energy Conservation
  - ✓ Saving water can save energy
  - ✓ Saving energy can save water
- ✓Improve Price Signals
  - ✓ Time of use water rates and meters
  - ✓ Time of use electric rates and meters
- ✓Water and Wastewater Utility Operational Efficiency
  - ✓ Increasing water and wastewater system efficiency reduces energy in the water use cycle
- ✓Water Storage
  - ✓ Increased water storage and more flexible water storage shifts peak energy requirements
  - ✓ Pumped storage increases peak electric generation and improves electric system efficiency
- ✓Renewable Generation by Water and Wastewater Utilities
  - ✓ Increase generation from in-conduit hydro and biogas. Add generation from solar and wind.
  - ✓ Assist in meeting California's renewable generation goals

PIER's programmatic structure is determined by law and CEC policy guidance



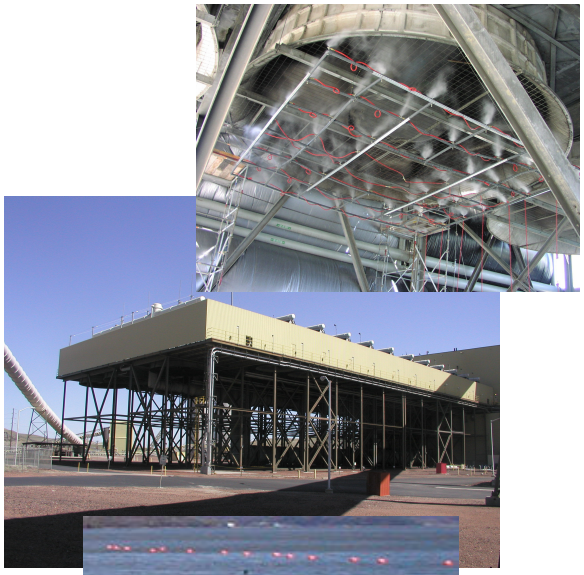
Climate Change – Consequence evaluation of climate change and adaptation and mitigation strategies for California



California Climate Change Center

- This center is the first state-sponsored climate change research program in the U.S.
- The goal is to produce policy relevant research products relative to impacts, mitigation and adaptation
- Primary responsibility for ’06 assessment of impacts and adaptation options for the Governor Initiative
- $20 Million initial investment in a five year program
- Understand climate change impacts in California and the northwestern United States
- Examine alternative mitigation/adaptation options

Cost-effective dry cooling technologies and minimization of once-through cooling practices



Dry Cooling

- Dry cooling can reduce power plant water use by up to 95% but with a nearly 5% performance penalty during the hottest hours of the year.
- PIER research at two dry cooled power plants has demonstrated the penalty can be reduced by a factor of 4 by introducing just a small spray of water into the air passing through the dry cooling towers.
- This research has been a collaborative effort with Crockett Cogeneration, Reliant and EPRI. A full scale demonstration is being planned
- Other on-going efforts include modeling the effects of high wind speed and evaluating measures to reduce wind effects.

Once Through Cooling

- Moss Landing Marine Laboratory to evaluate the ecological effects of power plants using once-through cooling technology on California's oceans and bays.
- This research program will improve current and develop new sampling and analytical methods to detect and predict potential effects and examine the suitability of current and potential mitigation measures to address the negative effects of once-through cooling technology on aquatic species and communities.
- High priority research has been identified with representatives from industry, state and federal agencies, universities and environmental group. A request for proposals has been released with proposals due by November 30, 2005.

PIER Water-Energy Research Priorities

Excerpt from 2005 IEPR, p.145: "California can implement strategies now to increase water use efficiency, energy efficiency, peak operational flexibility, and renewable generation potential to serve the state's water and wastewater infrastructure.

The 2005 IEPR identified 5 types of water & energy priorities which suggest PIER R&D focus areas.

- ***Increasing Energy Production from Water***
  - Increase cost-effective, environmentally preferred self-generation by water and wastewater agencies
  - Develop/enhance tools for better environmental protection while optimizing hydropower operations
- ***Energy Savings by End Users***
  - Increase efficiency of water-related energy use throughout the water use cycle
  - Maximize energy and water savings through efficiency improvements, appliances and other viable options
- ***Electricity Storage***
  - Maximize use of [water] storage to shift loads off peak and integrate intermittent renewable generation
- ***Once-Through Cooling***
  - Develop a consistent regulatory approach, including protocols & guidelines for assessing ecological effects of once-through cooling
  - Update current data adequacy regulations for state's coastal power plants
- ***Energy Savings through Water Efficiency***
  - Increase understanding of water-energy interdependencies
  - Identify new and innovative technologies & measures for achieving energy and water efficiency savings
  - Identify potential savings throughout the water cycle, especially in Southern California
  - Identify & implement cost-effective water system retrofits that reduce energy and peak demand
  - Increase savings through development of TOU water tariffs and meters
  - Increase flexibility in water deliveries

PIER Water-Energy Research Priorities

Excerpt from 2005 IEPR, p.145: "California can implement strategies now to increase water use efficiency, energy efficiency, peak operational flexibility, and renewable generation potential to serve the state's water and wastewater infrastructure.

The 2005 IEPR identified 5 types of water & energy priorities which suggest PIER R&D focus areas.

- ***Increasing Energy Production from Water***
  - Increase cost-effective, environmentally preferred self-generation by water and wastewater agencies
  - Develop/enhance tools for better environmental protection while optimizing hydropower operations
- ***Energy Savings by End Users***
  - Increase efficiency of water-related energy use throughout the water use cycle
  - Maximize energy and water savings through efficiency improvements, appliances and other viable options
- ***Electricity Storage***
  - Maximize use of [water] storage to shift loads off peak and integrate intermittent renewable generation
- ***Once-Through Cooling***
  - Develop a consistent regulatory approach, including protocols & guidelines for assessing ecological effects of once-through cooling
  - Update current data adequacy regulations for state's coastal power plants
- ***Energy Savings through Water Efficiency***
  - Increase understanding of water-energy interdependencies
  - Identify new and innovative technologies & measures for achieving energy and water efficiency savings
  - Identify potential savings throughout the water cycle, especially in Southern California
  - Identify & implement cost-effective water system retrofits that reduce energy and peak demand
  - Increase savings through development of TOU water tariffs and meters
  - Increase flexibility in water deliveries

PIER Development of a Water-Energy Roadmap

- ***Integrated water and energy planning and management is a new area of focus, both for California and the nation***
  - The IEPR workshops and working groups demonstrated that while there is substantial literature about energy efficiency opportunities for water and wastewater agencies, little is yet known about how to optimize the state's water and energy resources on a joint basis
- ***California's distinctive water-energy profile provides opportunity for significant benefits through fully integrated water and energy resource management***
  - Water (hydropower) accounts for 25% of the state's generation capacity
  - Northern California receives 2/3 of the state's precipitation while 2/3 of the state's population lives in Southern California
- ***PIER is embarking upon a 2 phase process to allow quick identification of near-term opportunities***
  - Phase 1: Identify R&D opportunities with potential for significant water-related energy efficiency and/or demand reduction benefits that require near-term actions
  - Phase 2: Develop Water-Energy roadmap
    - Strategic Water-Energy R&D Plan
    - Long-term Water-Energy R&D Portfolio (five years)

For purposes of Phase 1, "near-term" includes those R&D measures that are expected to either produce near-term results (e.g., within 3 years) OR that are needed to preserve an important future opportunity.

Initial Inventory Development

The Phase 1 Water+Energy R&D Inventory is being assembled from multiple sources

Baseline	IEPR, WER Paper and stakeholder input to IEPR/WER Working Group
Primary Water-Energy R&D Activities	• Awwa-RF/CEC PIER "Water and Wastewater Industry Energy Efficiency Roadmap" • EPRI Municipal Water & Wastewater Program • Irrigation Technology Research Center studies of agricultural water and energy use • Pacific Institute Water Efficiency Research (miscellaneous publications) • U.S. DOE National Laboratories & EPRI "Energy-Water Nexus" report to Congress

Other concurrent water-energy R&D planning activities

• ACEEE "Water and Wastewater Energy Roadmap" (WWER)
• Alliance to Save Energy & USAID: "Watergy: Taking Advantage of Untapped Energy and Water Efficiency Opportunities in Municipal Water Systems"
• California Urban Water Conservation Council "Best Management Practices"
• Consortium for Energy Efficiency "National Municipal Water and Wastewater Facility Initiative"
• National Research Council of the National Academies, Desalination and Water Purification Technology Roadmap
• Northwest Energy Efficiency Alliance "Pacific Northwest Water and Wastewater Market Assessment"
• U.S. EPA "Water Use Efficiency Program"
• U.S. House of Representatives "Subcommittee on Water Availability and Quality (SWAQ)"
• WaterReuse Association "Energy-Water Roadmap"

ILLUSTRATIVE Mapping of R&D Measures

Water Use Cycle	Primary Types of Energy Use	R&D Opportunities	Examples of R&D Activities
Supply & Conveyance	• Regional Conveyance • Groundwater Recharge & Pumping	• Change operations • Change system • Increase storage • Energy development (in-conduit, other renewables)	• Identify opportunities to change operations &/or systems to reduce energy &/or peak • Study groundwater capacity & operations • Assess renewable energy potential of water & wastewater agencies
Treatment	• Pumping • Filtering • Disinfection • Digesters • Wet weather loads	• Optimize pumping, filtration, disinfection • Optimize system design & operations • Increase biogas production & utilization • Reduce wet weather loads	• Develop optimization models & tools • Investigate lower energy intensity filtration & disinfection technologies • System optimization models & tools • Connect treatment plants with pipelines to allow effluent detention for peak reduction • Apply bacgen technologies to increase biogas • Evaluate potential to reduce energy and demand through storm water management
Distribution	• Pumping	• Optimize pumping	• Pumping optimization models & tools
End-Use	• Residential • Commercial • Industrial • Agricultural	• Water use efficiency (cold & hot) • Reduce use of potable water for non-potable uses	• Evaluate/quantify water+energy interdependencies; develop models & tools • Explore efficient irrigation options • Assess alternate advanced hot water systems • Identify cost-effective cold water efficiency appliances, tools & techniques • Assess benefits of TOU water meters • Alternate (waterless) cooling systems

Examples of R&D Measures (1 of 3)

Work in Progress …

Water Use Cycle	Type of Measure	Sector Impacted	Measure	Source(s)
Supply & Conveyance	Studies, Models & Tool	Regional water conveyance	Evaluate potential to shift summer peak by increasing groundwater capacity &/or deferring recharge to non-summer months	DWR, SWP, SWC, MWD
			Project changes in energy requirements attributable to water transfers	WER
		Wholesale water supply	Identify strategies to reduce the energy intensity of water supply portfolios in Southern California	IEPR, WER, DWR, MWD
	Practice Improvement		Identify energy best practices for desalination facilities	Awwa-RF
Treatment	Technology Demonstration	Water & wastewater	Demonstrate ability to shift loads by connecting treatment plants with pipelines	IEUA
		Wastewater treatment	Demonstrate energy benefits attainable from membrane treatment of biosolids	Awwa-RF
	Studies	Water & wastewater	Evaluate relative energy intensity of alternative disinfection systems, processes and technologies	Awwa-RF, WER, MWD
		Water treatment	Evaluate energy requirements to produce potable water from varied sources	Awwa-RF
		Water & wastewater	Evaluate statewide energy benefits attainable through optimized systems, processes & pumping	Awwa-RF, WER
		Wastewater treatment	Evaluate energy & demand reductions through improved storm water management (i.e., reduction of wet weather treatment loads)	IEUA, NCI

Examples of R&D Measures (2 of 3)

Work in Progress …

Water Use Cycle	Type of Measure	Sector Impacted	Measure	Source(s)
Distribution	Study, Models, Tools	Water & Wastewater	Evaluate potential of pipelines and tanks to detain water and shift demand to partial or off-peak periods	ACWA, WER
	Technology Demonstration	Water & Wastewater, Agricultural	Demonstrate current and emerging technologies in efficient pumps and motors	ITRC
End Use	Study	Agricultural	Evaluate embedded and end-use energy impacts of drip/micro systems	WER, ITRC
	Hardware		Evaluate energy impact of pumps & motors with soft start & stop capabilities	ITRC
	Technology Solicitation	All Sectors	Partner on innovation grants (new & emerging technologies) for water & energy efficient appliances	MWD
	Technology Demonstration	Urban	Demonstrate & document energy savings attainable by various urban landscape irrigation control technologies	Pacific Institute, DWR, MWD, IEUA
	Studies, models, tools, pilot projects	All Sectors	Identify and document total resource value of an avoided unit of potable water, including avoided upstream & downstream energy benefits, for various types of water end uses	WER

Examples of R&D Measures (3 of 3)

Work in Progress …

Energy Production

Type of Measure	Sector Impacted	Measure	Source
Technology Demonstration	Wastewater	Demonstrate & document increased production of digester gas through thermophilic anaerobic digestion	Awwa-RF, IEUA, SCG
		Evaluate benefits of gasification to anaerobic digestion	IEUA, CIWMB
		Link hydro dispatch tools to renewable production forecasts	IEPR, WER
Analysis	Wastewater	Assess technologies for digester gas clean-up for advanced power generation or production of [near] pipeline quality gas	Awwa-RF, IEUA
	Wastewater	Optimize digester gas storage for peak power management	Awwa-RF
	All Sectors	Potential transmission system modifications to increase market participants' capability to increase demand reductions & energy supply in congested zones	MWD
	Water	Phase 2: Potential increase in pumped storage capacity through development of reservoir pairs identified by LLNL	LLNL
	Water & Wastewater	Identify potential solutions to barriers and hurdles to development of in-conduit hydropower	WER, PIER
		Evaluate developable renewable energy on water & wastewater lands & rights-of-way; develop roadmap for implementation	IEPR, WER
Studies, Model & Tools	Hydropower	Improve ability to determine in-stream flows for better environmental protection while optimizing hydropower production	PIER, IEPR, WER
		Improve runoff forecasting & decision support models to balance conflicting demands for water supplies	PIER, IEPR, WER
	Regional Water Conveyance	Evaluate undeveloped hydropower capacity of interbasin transfer systems and identify potential solutions to barriers & hurdles	WER, DWR, MWD

PUC Utility Energy Efficiency Programs Resource Value vs. Water Use Efficiency

	Investor Owned Utility Energy Efficiency Procurement 2004 – 05	2006 – 08	WUE
GWh (Annualized)	**2,745**	**6,812**	**6,500**
Peak MW	**690**	**1,417**	**850**
Funding ($ Million)	**$762**	**$1,500**	**$826**
$/Annual KWh	**$ 0.28**	**$ 0.22**	**$ 0.13**
WUE Relative Cost	**46%**	**58%**	

Thank You