

*completing the energy sustainability puzzle*



# **ENERGY** *and* **WATER**

*Science & Technology at the Energy~Water Nexus*

Presented to the Sustainable Water Resources Roundtable

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# US Energy Sustainability

A critical piece is missing





# Overview

- Energy-Water Nexus Issues Summary
- Energy-Water Science and Technology Related Actions

# Energy and water are ... inextricably linked



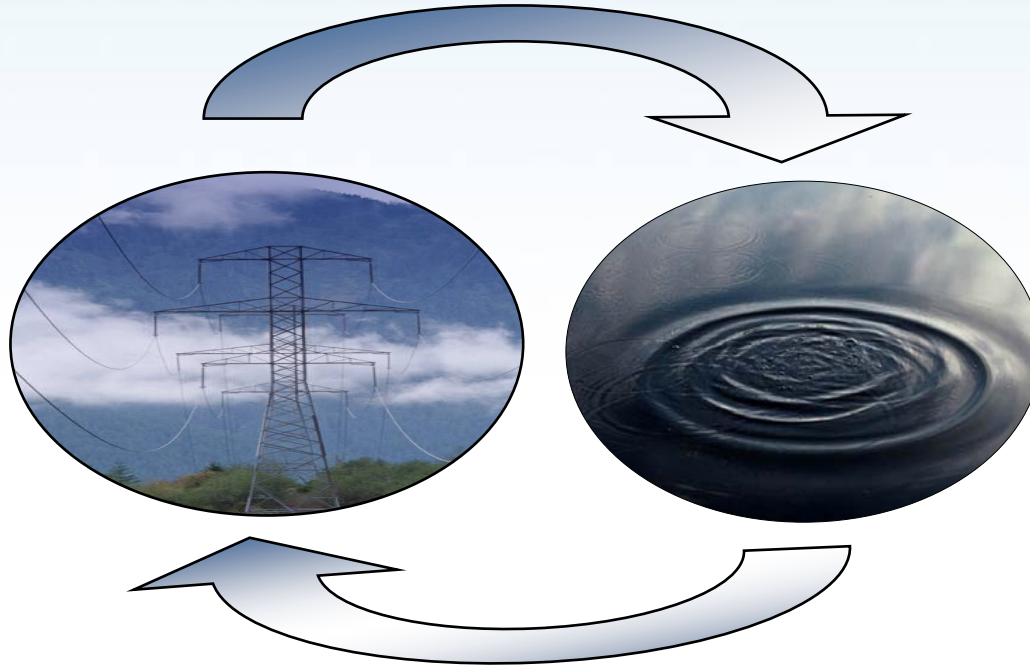
Water for Energy

and

Energy for Water

**Energy and power production requires water:**

- Thermolectric cooling
- Hydropower
- Energy minerals extraction / mining
- Fuel Production (fossil fuels, H<sub>2</sub>, biofuels/ethanol)
- Emission controls



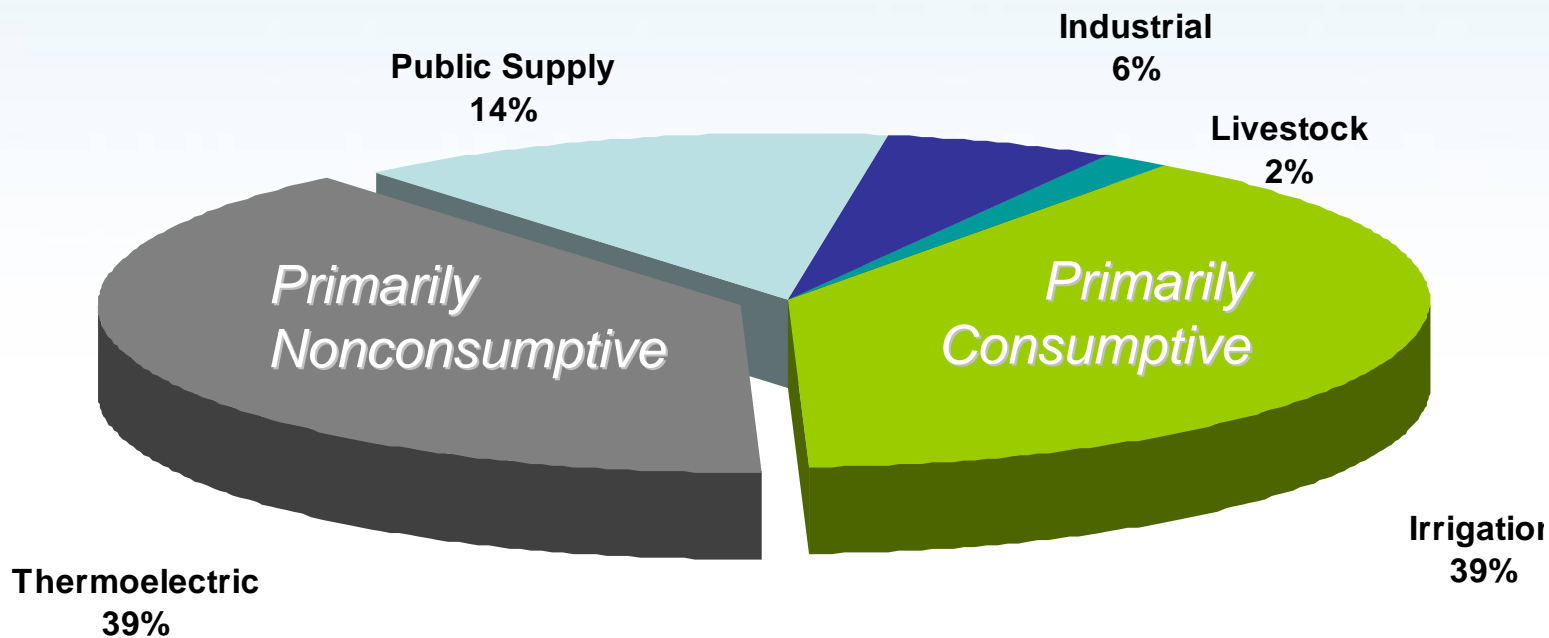
**Water production, processing, distribution, and end-use requires energy:**

- Pumping
- Conveyance and Transport
- Treatment
- Use conditioning
- Surface and Ground water

# Energy and agriculture withdraw the most water in the U.S.



## Estimated Freshwater Withdrawals by Sector, 2000

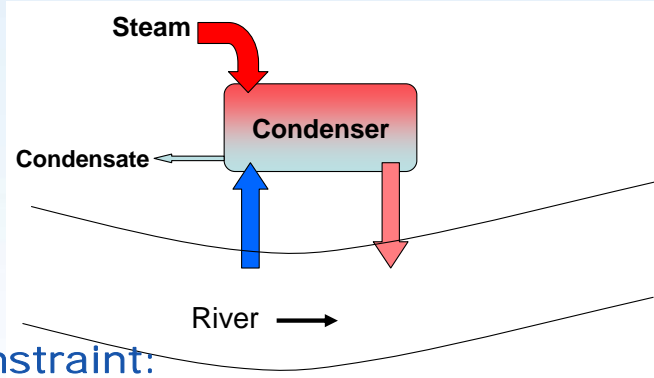


Source: USGS Circular 1268, March, 2004

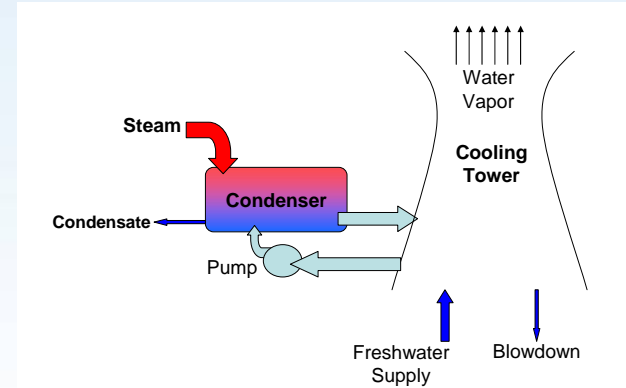
**Note:** Hydropower uses are not included here!



# Energy accounts for a growing portion of water consumption

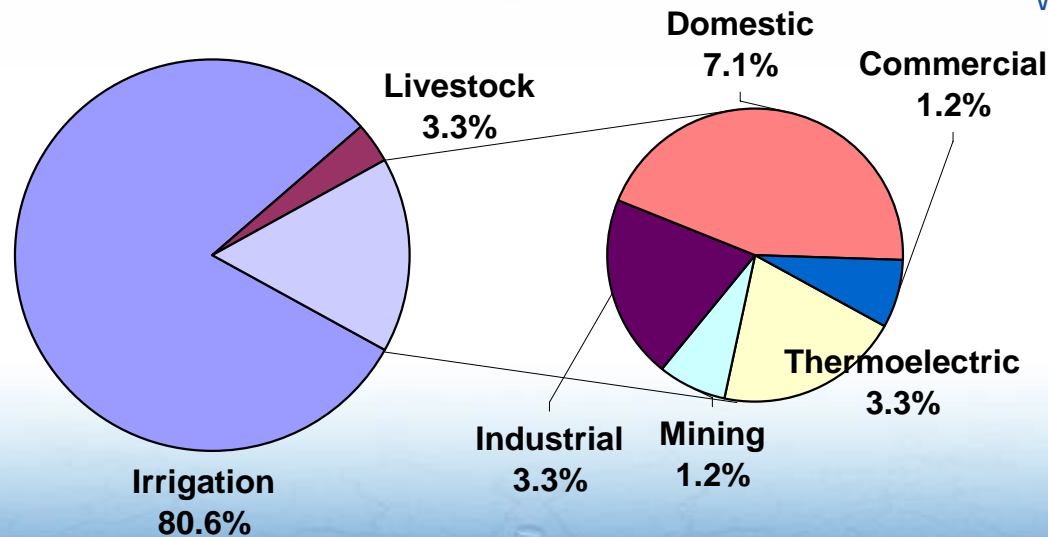


Constraint:  
Thermal  
Discharge  
Limits

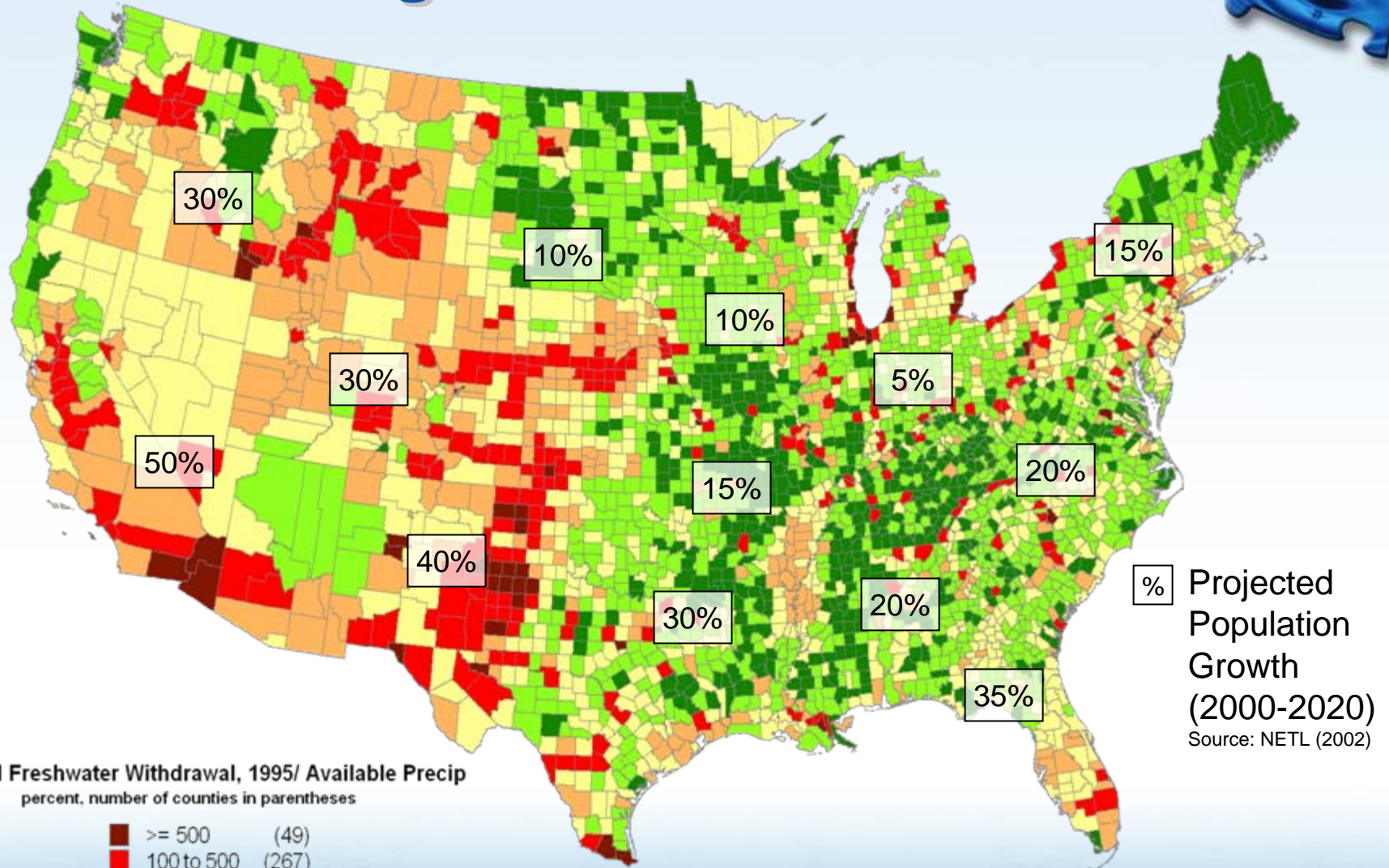


Constraint: Absolute  
Water Consumption

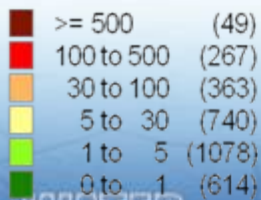
## U.S. Freshwater Consumption, 100 Bgal/day



# Water challenges are nationwide



**Total Freshwater Withdrawal, 1995/ Available Precip**  
percent, number of counties in parentheses



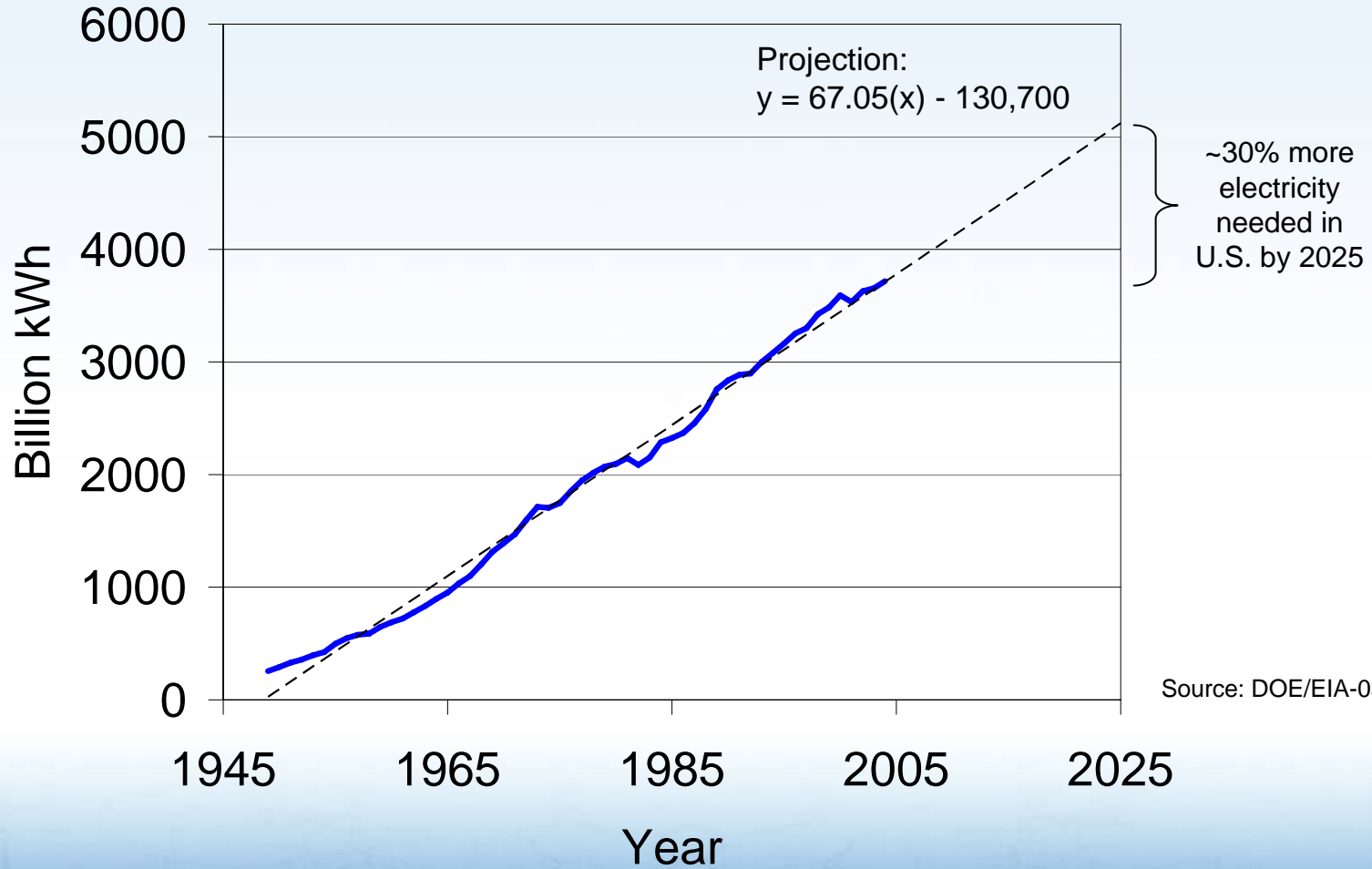
Source: USGS Circular 1200 (Year 1995), EPRI 2003

# Energy and water conflicts are appearing now





# The U.S. will need 30% more electricity by 2025

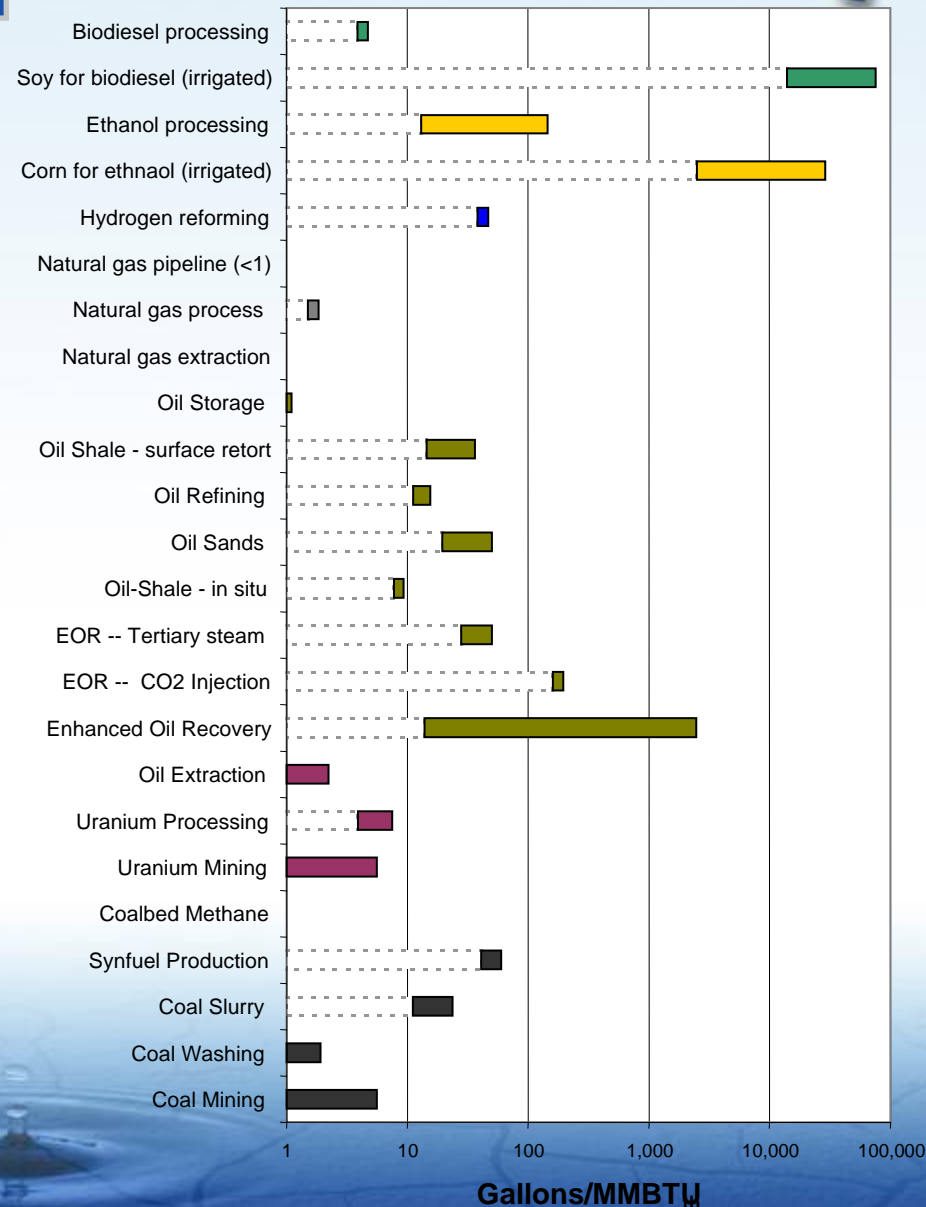


# Future energy development will put new demands on water

Water Use for Energy Extraction, Processing, Storage, and Transport



- Many newer technologies will be more water intensive
- Biofuels and hydrogen economy would require significantly more water than fossil transportation fuels
- Constraints will grow for power plant siting because of water for cooling needs, advanced scrubbing, and CO<sub>2</sub> removal

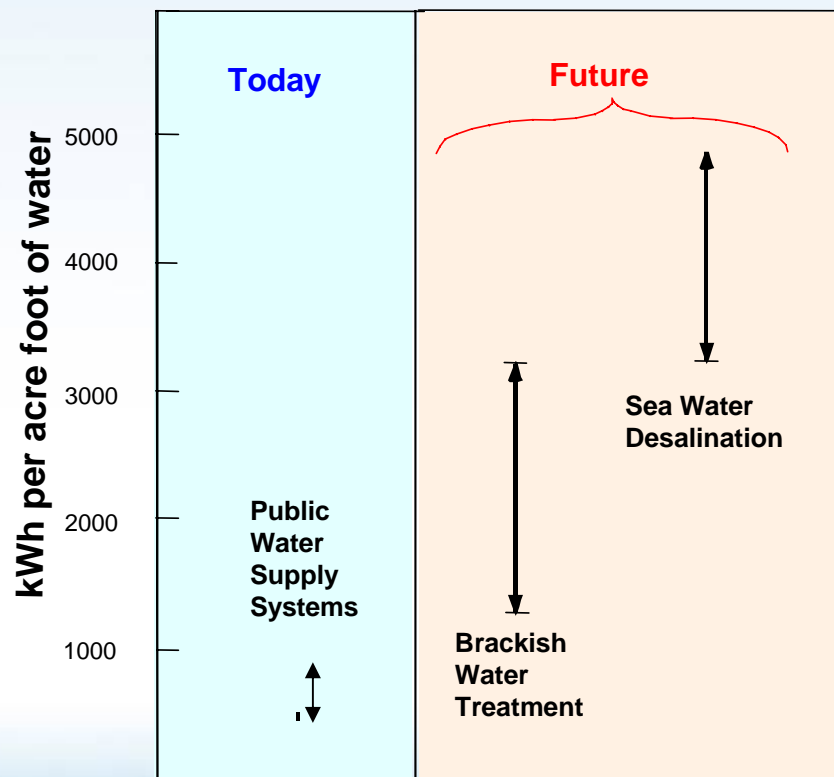


# Future water supplies and treatment will be more energy intensive



- Readily accessible fresh water supplies are limited and have been fully allocated in some areas
  - Pumping at deeper depths and longer conveyance distance require more energy
- New technologies to access and/or treat non-traditional water resources will require more energy per gallon of water
  - Impaired water, produced water, brackish water, and sea water

Power requirements for current and future water supply



Source: EPRI, 2000; Water Desalination Task Force, 2003

# Growing Congressional awareness and action at the Energy Water Nexus



- Energy Policy Act of 2005 gives DOE new Authorization for EWN-related R&D
  - Sect. 979: Energy-Water Supply Technologies Program
    - **Water and Energy Sustainability Program**
      - **Assessments**
      - **Tools development for long-term planning**
      - **Report to Congress**
  - \$30M authorization starting in FY07
- Proposed Energy-Water Technology bills
  - 2004 introductions in Senate (S. 2658) and House (H.R. 4835)
    - National Laboratory/University-led, technology-focused program to increase water supply
  - 2005 introductions in House (H.R. 3182) and Senate (S. 1860)
    - **Re-scaled proposals (\$6M for first year, out year funding “as appropriate”)**



# U.S. Department of Energy appropriations are now supporting Energy-Water Nexus efforts

- Report to Congress
  - Consider energy and water interdependencies, trends in energy and water supplies, threats and concerns to energy production
- Energy-Water Roadmap
  - Assess emerging energy and water resource issues based on user and stakeholder needs
  - Develop energy and water science and technology priorities
- Energy-Water Studies
  - Address concerns identified by Roadmap participants

# Report to Congress on the Interdependency of Energy and Water: Energy Demands on Water Resources



- Issues Addressed Include:
  - Natural Resources R&D
  - Interagency collaboration on critical resource planning
  - Science and system-based natural resources and policies and regulation
  - Energy Water Infrastructure
- Prepared by DOE National Laboratories and EPRI
- Report sent by DOE to Congress 1/12/07
  - Expected publication – January 2007

# Energy-Water Roadmap



- Energy-Water Roadmap for DOE
  - Assess emerging energy and water resource issues based on user and stakeholder needs
  - Develop energy and water science and technology priorities
- National Scope
  - Regional workshops: Needs Assessment Gaps Analysis, Science and Technology Recommendations
  - Almost 350 participants from 45 states involved overall
- Focus on emerging user and stakeholder problems, issues, and needs and science and technology role in developing effective solutions
- Broad spectrum of regional, state, and local participation and input
  - Representatives from energy companies, electric utilities, water utilities, water managers, economic development groups, energy regulators, environmental groups, tribal nations, other water-use sectors
- Captured high-level issues, needs, and recommendations identified in each workshop

# Examples of national needs, science-technology responses identified through roadmap process



## Improved data on regional water availability and sustainability

- Statistical determination of monitoring needed, improved water data collection and frequency
- Improved sensors and data management systems

## Coordinated regional natural resources planning

- Modeling and decision support tools for improved resource management and utilization
- Climate, hydrology, meteorology variability and uncertainty modeling
- Assessment of ecological water needs and demands

## Improved materials, processes, and technologies to enhance water use efficiency and energy use efficiency

- Basic research in chemical and biological processes to improve energy and water use efficiency
- Applied research and more joint industry-government field demonstrations of emerging technologies
- Implementation of energy technologies with high water use efficiency

## System-level consideration of energy-water solutions

- Energy and water transmission infrastructure improvements to enhance efficiency
- Co-location of energy and water production facilities to improve overall resource efficiency



# Ongoing DOE Energy-Water Studies address concerns identified by Roadmap participants



- Establish pilot regional working groups for energy-water planning.
- Evaluate data and analytical tools needed for integrated energy-water planning
- Analyze potential to reduce future water demands for electric power generation through electric transmission grid improvements.

# Science and Technology at the Energy-Water Nexus



- Report to Congress
  - Final Report sent to Congress 1/12/07
  - Expected publication January 2007
- Energy-Water Roadmap
  - Expected publication Spring 2007
- Energy-Water Studies
  - Expected publication Fall 2007
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