completing the energy sustainability puzzle

ENERGY and WATER

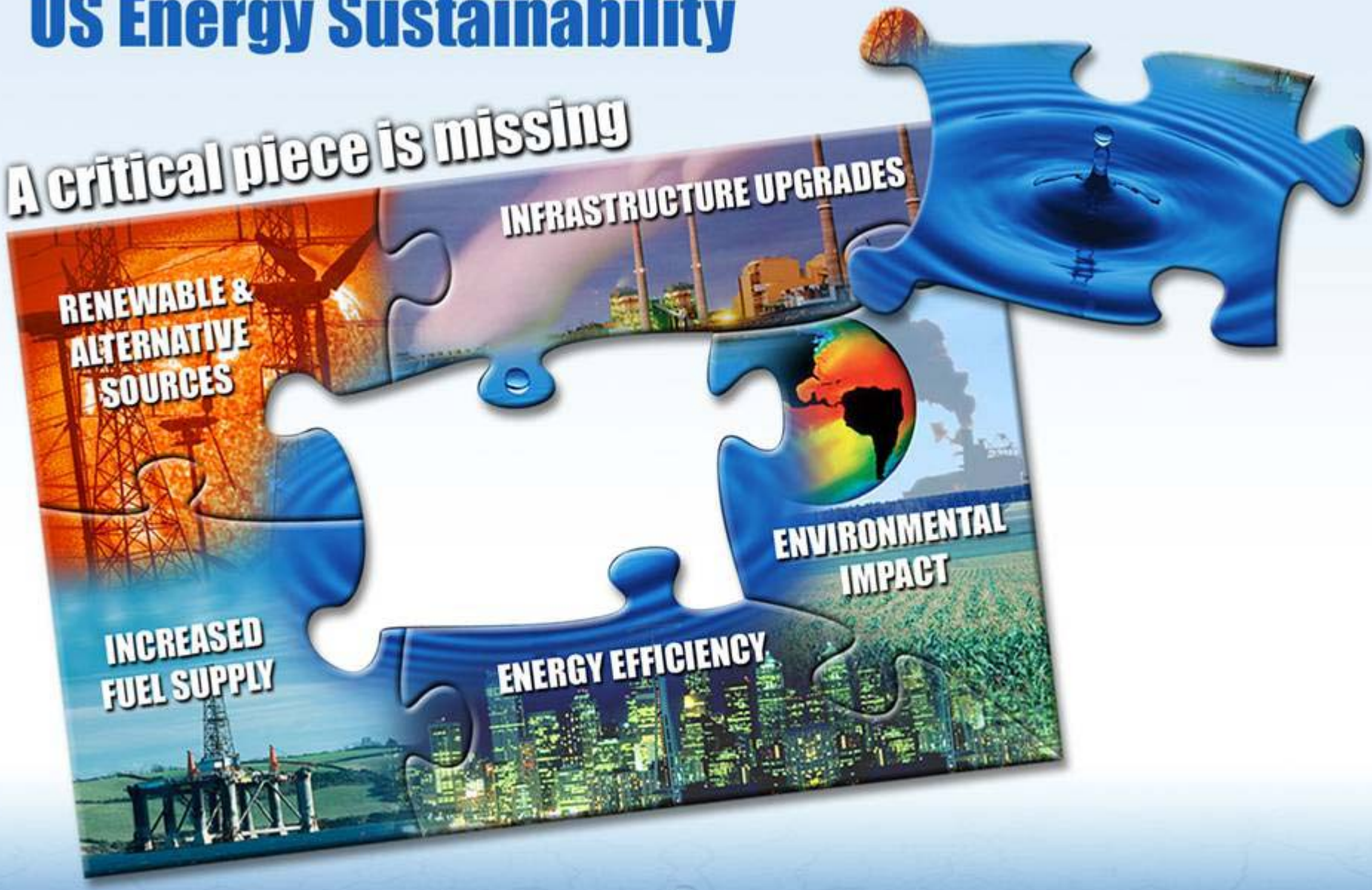
Gaps Analysis Workshop

Albuquerque, NM
March 1-2, 2006

Overview

- **Setting the stage**
  - Energy/Water Nexus issues and concerns
- **Developing national and regional solutions**
  - DOE Energy-Water Science and Technology Roadmap overview - defining future research to solve the energy-water interdependencies problems
- **Why are we here?**
  - Review of Regional Needs Workshops results
  - Gaps Analysis Workshop goals and objectives
  - How this fits into the Roadmap process

US Energy Sustainability

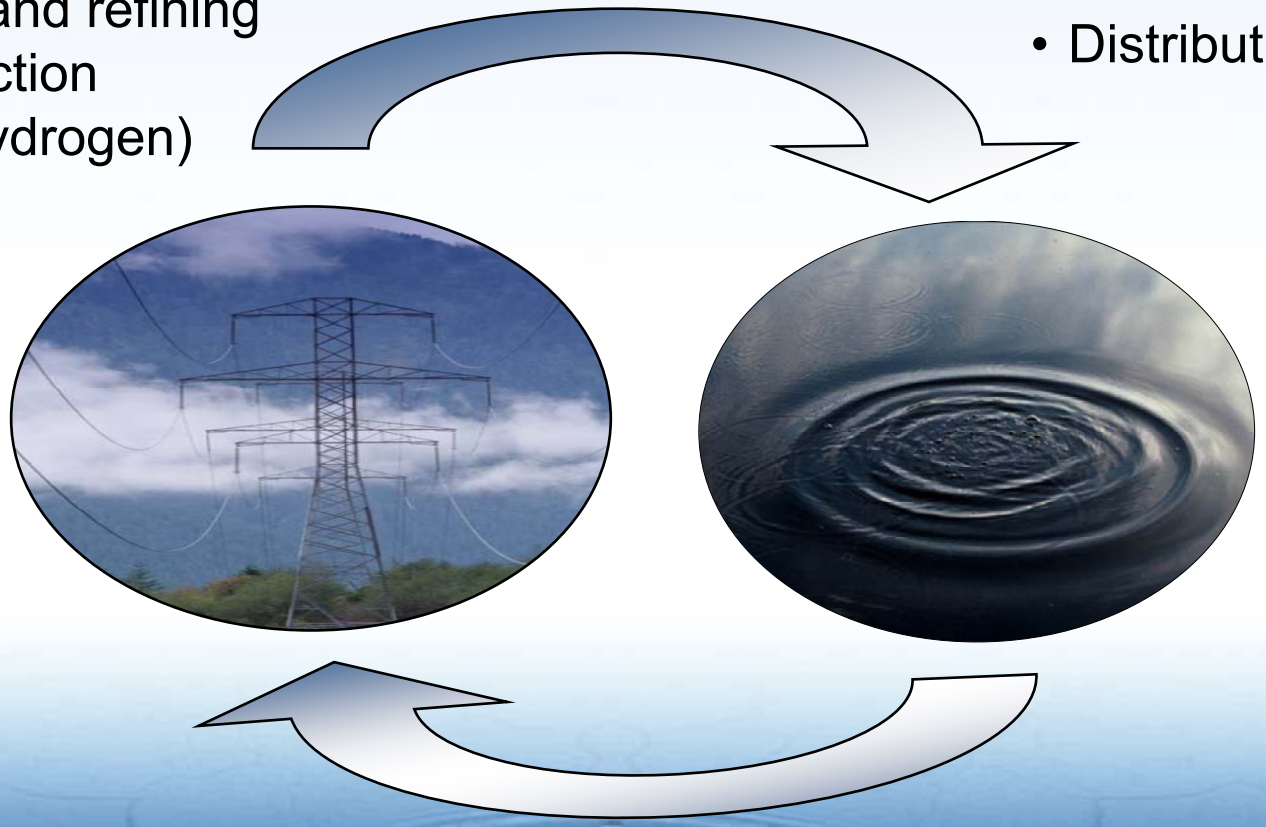


ENERGY and WATER

Energy and Water are Inextricably Linked

Water for Energy
- Thermoelectric cooling
- Hydropower
- Extraction and refining
- Fuel production (ethanol, hydrogen)

Energy for Water
- Pumping
- Treatment
- Distribution



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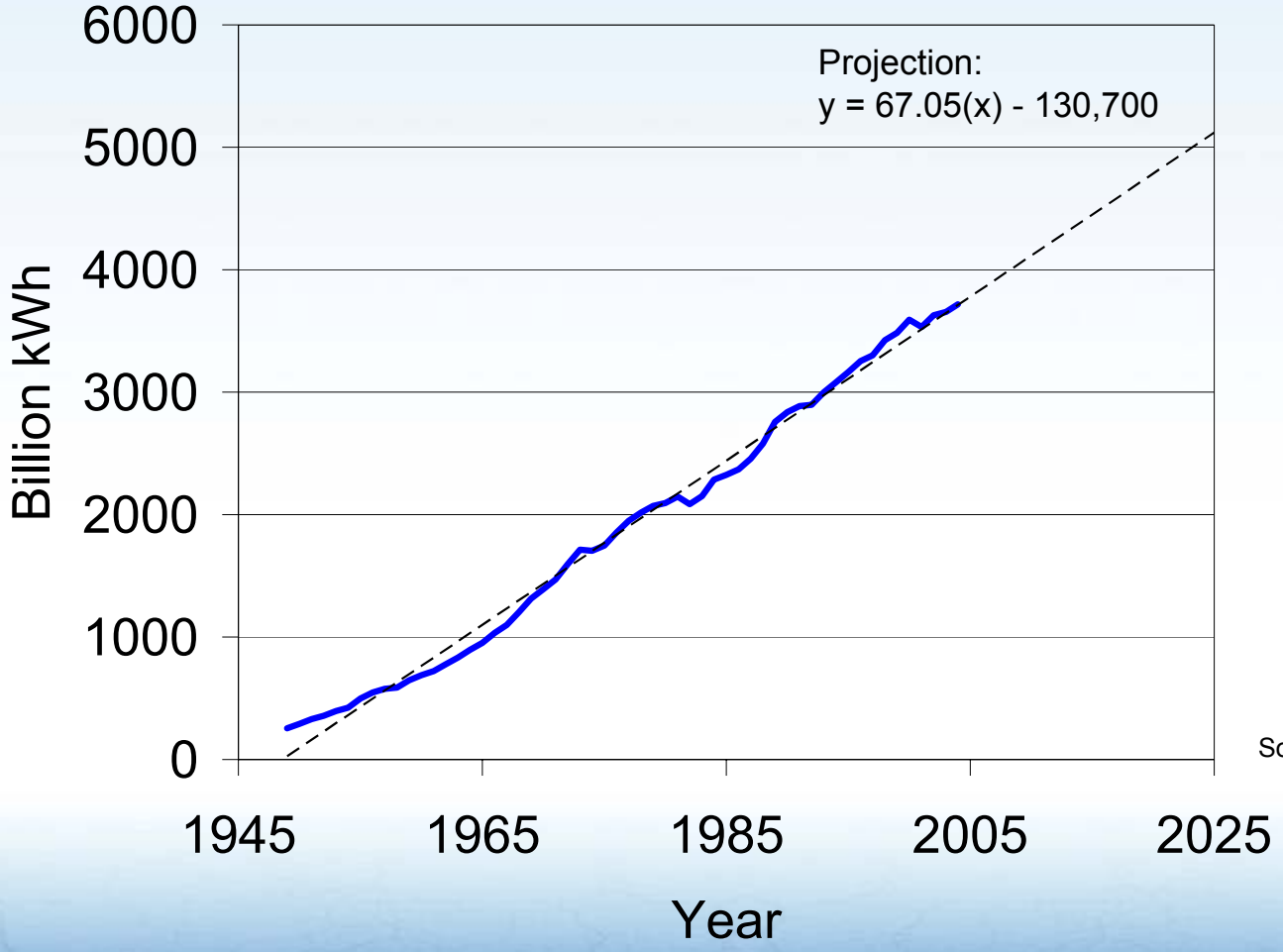
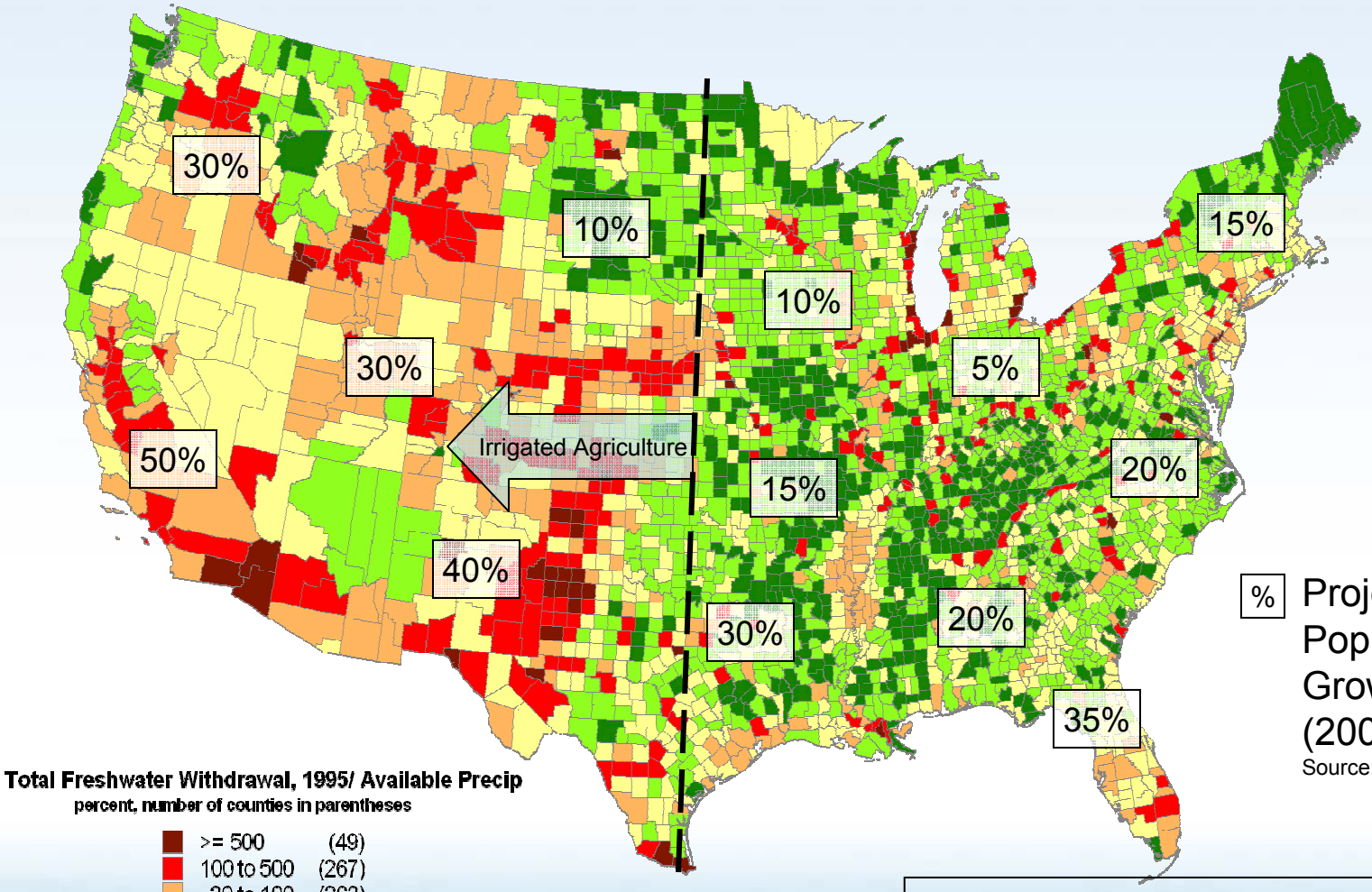
The U.S. will need 30% more electricity by 2025



Source: DOE/EIA-0384(2004)

Water Availability is a Nationwide Problem



% Projected Population Growth (2000-2020)
Source: NETL (2002)

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

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Energy and Water Interdependency Issues Are Appearing Now

- Water rates in the Las Vegas Valley will go up . . . because of increased electricity costs (Las Vegas SUN, 2002)
- Utility regulators put ecology ahead of electricity in rejecting a major power plant . . . . that would use 2,500 gallons per minute to cool its steam turbines (Arizona Daily Sun 2002)
- Georgia Power Loses Bid to Draw Water from Chattahooche (Miami Herald, February 2002)
- EPA Orders Mass. Power Plant to Reduce Water Withdrawals (Providence Journal, RI, July 2002)
- Idaho Denies Water Rights Request for Power Plants (U.S. Water News Online, August 2002)
- Pennsylvania Nuclear Power Plant to Use Wastewater from Coal Mines (The Philadelphia Inquirer, July 2003)
- Utilities Warn of Power Crunch if Flows Are Cut (Greenwire, July 2003)
- Governor Mike Rounds of South Dakota called for a summit to discuss drought-induced low flows on the Missouri River and the impacts on irrigation, drinking-water systems, and power plants (News Release, February 2005)

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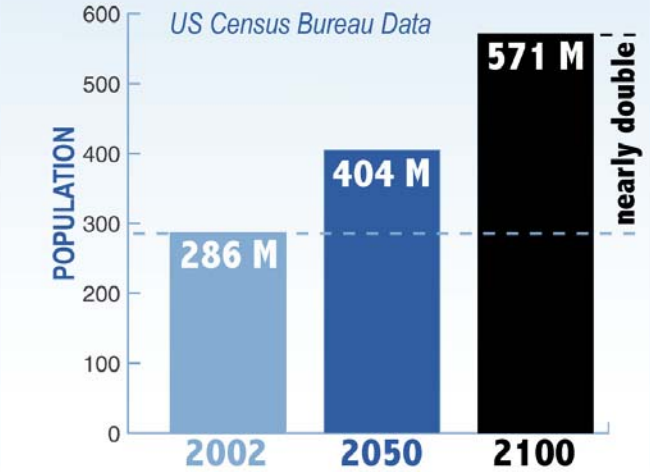
Will water supplies be sufficient to meet US energy demands in 20 years?



- Population could increase significantly; fresh water will not
  - Population increases will not necessarily be in water-rich regions

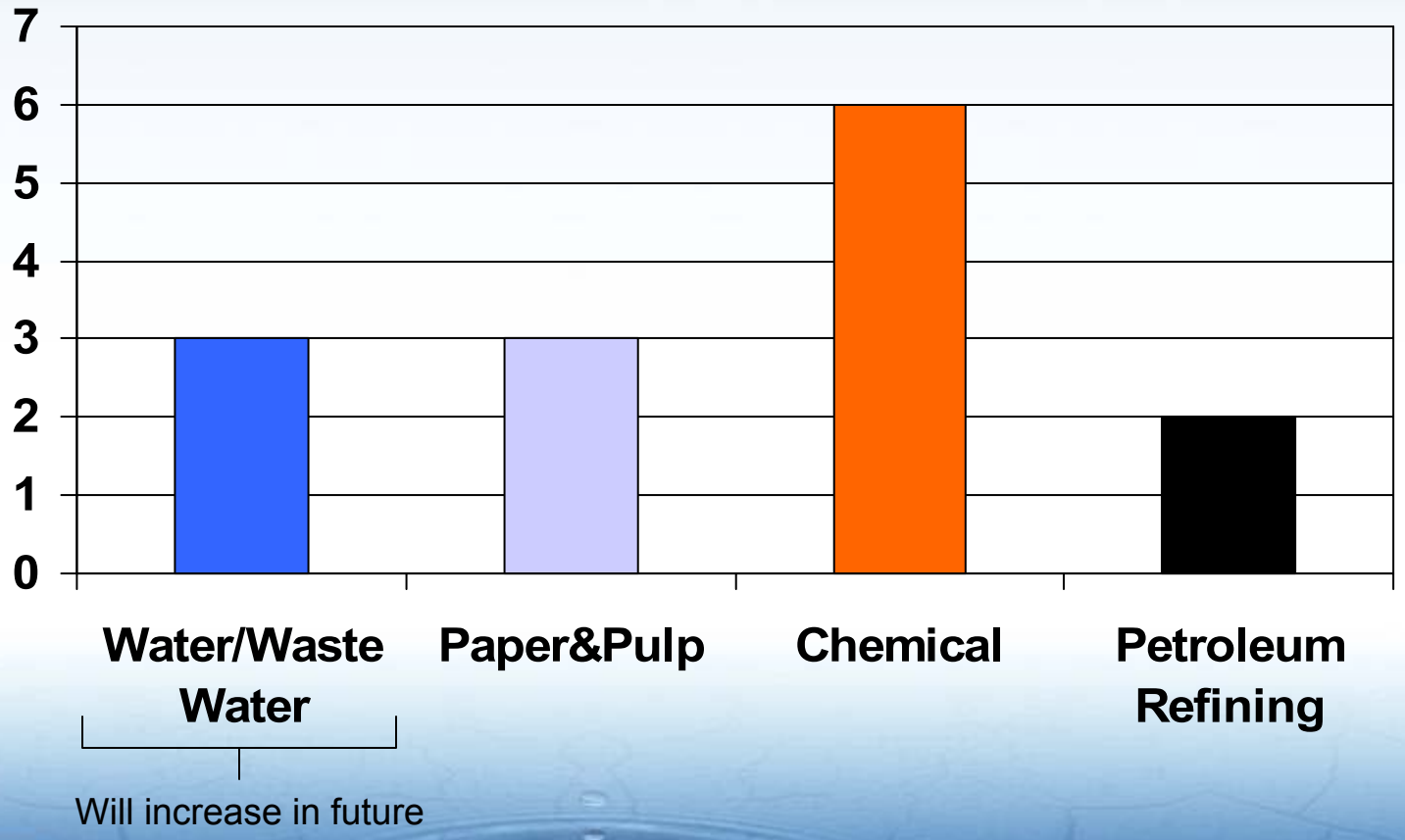
- Energy industry must compete for water with agriculture, other industries, and domestic use
- Climate change and energy-industry operations could impact water supplies, quality, and energy demand

Energy for Water

Currently the Water/Wastewater Sector is a Major User of Electricity

Percent of U.S. Electricity Generation Used by Industry

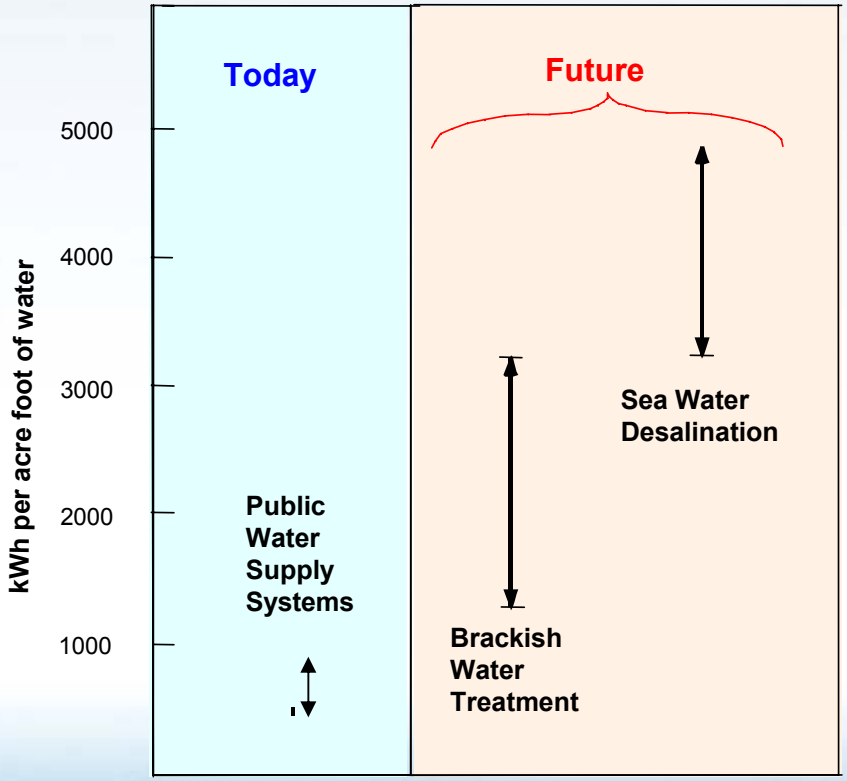
Source: DOE:2004



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
  - Increased energy for pumping at deeper depths and longer conveyance
- 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



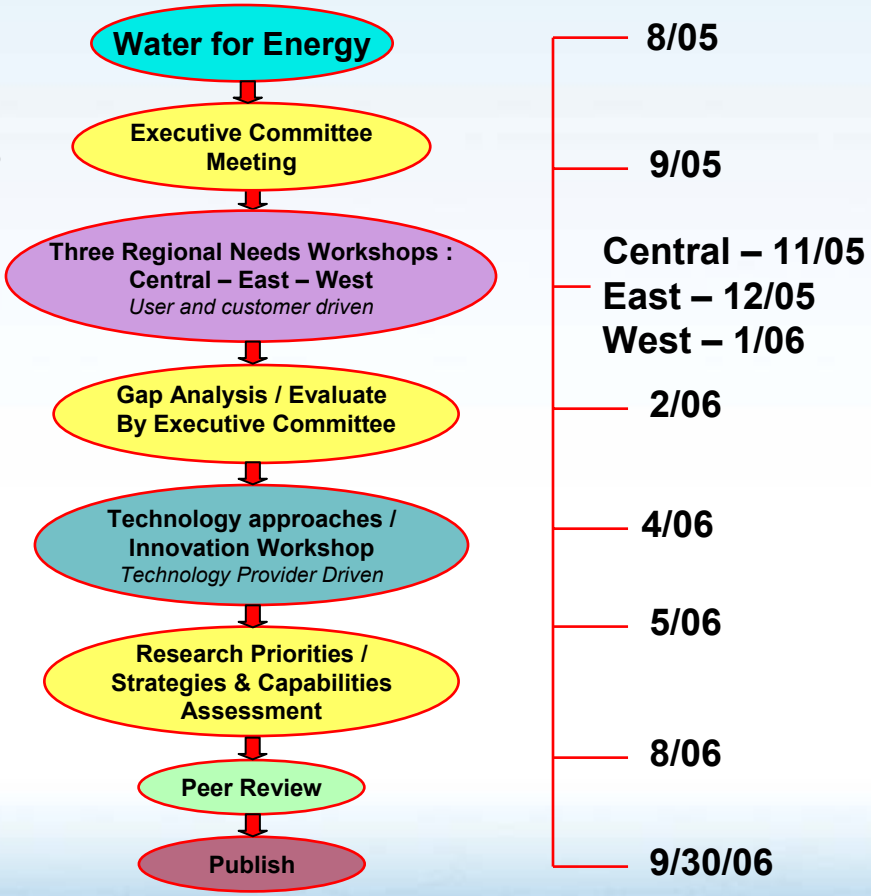
Source: EPRI (2000), Water Desalination Task Force (2003)

Energy-Water Roadmap Planning and Implementation Team

- **Sandia National Laboratories**
  - Coordinate all workshops – logistics, participants, facilitators
  - Interface with Executive Committee and National Lab Advisory team
  - Coordinate science and technology issues analysis
  - Develop Energy-Water Roadmap
- **UNM Utton Transboundary Center and Lawrence Berkeley National Laboratory**
  - Coordinate policy, regulatory, and economic issues analysis

National Energy-Water Technology Roadmap Process

Executive committee consists of ~ 20 esteemed members from industry, government, and academic institutions to provide external direction and review of process.



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Energy Water Roadmap – How Does This Workshop Fit In?

Problems →Needs →Gaps →Technology Solutions

- **Problems** and **Needs** identified in Regional Meetings
  - High-level issues and needs
- **Gaps Workshop** used to quantify needs/guide technology
  - Add more detail and specifics to needs and schedule
- **Technology Solutions Workshop**
  - Later workshop to identify technologies to meet Needs or close Gaps, and thus solve Problems

Needs Assessment Workshop Overview

- Three regional workshops: Nov 2005 through mid-January 2006
  - Almost 350 participants from 45 states involved
- 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 relatively high-level issues, needs, and recommendations identified in each workshop

Summary of Major Regional Needs and Issues Identified

1. Improved water supply characterization/monitoring
2. Integrated resource planning and decision support
3. Oil and gas produced water treatment for use
4. Emerging/Re-emerging energy resources
5. Biofuels production and water use
6. Thermoelectric power generation water use
7. Energy efficiency for impaired water treatment and use
8. Infrastructure changes for improved energy/water efficiency

What we want to achieve …

1. Validation of Needs … have we missed anything?
2. Identification of sub-Needs
3. Identification/evaluation of current performance
4. Quantification of out-year performance goals … what level of improvements do we need, who should be involved, how is it done, by when?
5. The focus is on identifying needs and defining goals that will support improvements in water efficiency in energy production and generation and energy consumption in water treatment/ distribution.

Elements to Consider and Include in Gaps Analysis

- **Schedule and Time Frames**
  - **Near-term** (0-5 years) **Mid-term** (5-10 years) **Long-term** (10+ years)
- **Efforts needed to support implementation**
  - Research, development, demonstration, test and evaluation, Implementation
- **Partners, collaborators, and lead agencies**
- **All crosscutting science and technical elements**
  - Improved technologies, new materials and processes,
  - Advanced modeling and decision support tools
  - Advanced monitoring systems and sensors
  - Infrastructure improvements
- **Policies/Regulations/Economics**
  - Science and technology studies or improvements that support solution implementation

Gaps Analysis Process

1. Examination and discussion of general needs and issues, current performance, and potential goals (30 minutes)
2. Brainstorming of top-priority goals (15 minutes, individually or in small groups)
3. Round-robin identification and discussion of quantified science and technology goals (60 minutes)
4. On to the next topic!

Assumptions/Projections

Fresh water supply (relatively) fixed?

Increasing climate variability
Decreasing groundwater tables
No new surface water reservoirs

Water demand increasing

- Electricity water consumption today: 3.3 billion g/d
- Electricity water consumption 2030: 7.3+ billion g/d

- Ethanol water consumption today: 46.6 million g/d
- Ethanol water consumption 2012: 96.6 million g/d

- Biofuels water consumption 2030: 1 billion g/d

- Water for an additional 50-75 million new people

- Water demand for ecological needs

Energy demand increasing

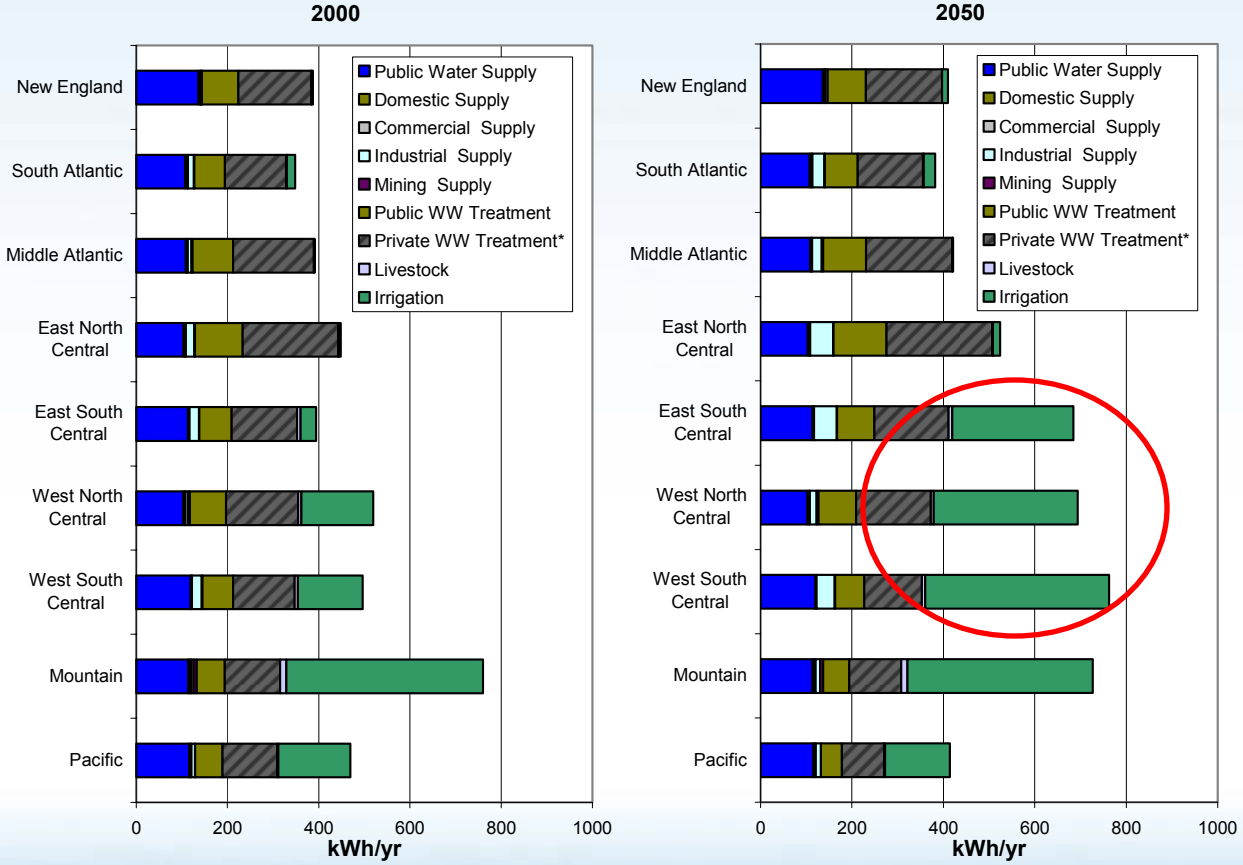
- Electricity capacity today: 560GW
- Electricity capacity 2030: 700GW

- Ethanol production today: 3.4 billion gallons
- Ethanol production 2012: 7.5 billion gallons

- Biofuels production 2030: 40-50 billion gallons

- Water treatment/supply today: x GWh
- Water treatment/supply 2050: 2-3x GWh

Increasing Competing Demands



East South Central Division: AL KY MS TN
West North Central Division: IA KS MN MO NE ND SD
West South Central Division AR LA OK TX