completing the energy sustainability puzzle

SAND2005-7433P

ENERGY and WATER

Central Region Needs-Assessment Workshop

Kansas City, MO

November 14-16, 2005

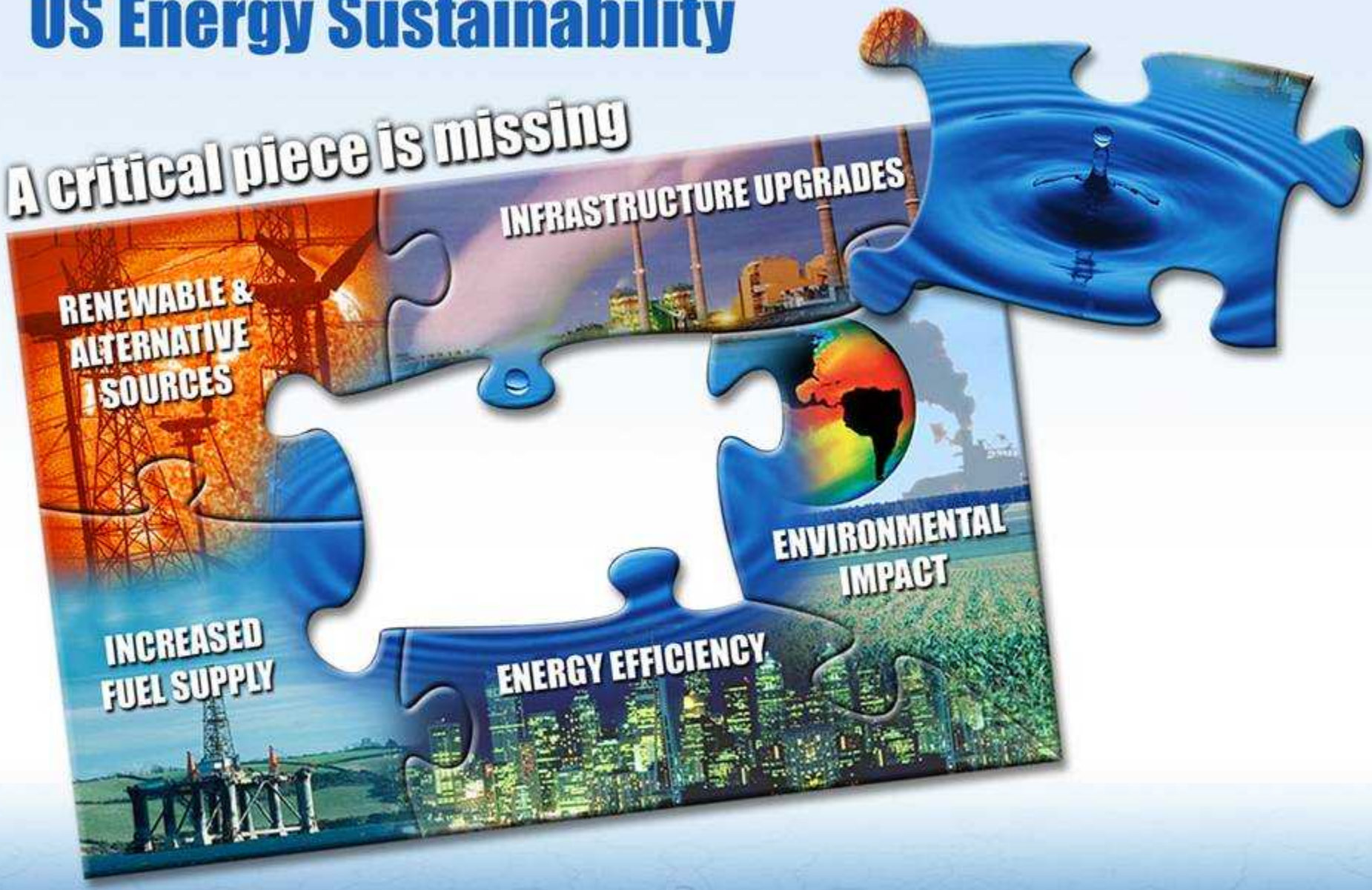
Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company for the United States Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000

Overview

- **Setting the stage**
  - Energy/Water Nexus issues and concerns
  - Discussion of emerging needs and time horizons
- **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?**
  - Workshop goals and objectives
  - Ultimate goal and benefit to the U.S.

Setting the Stage

US Energy Sustainability

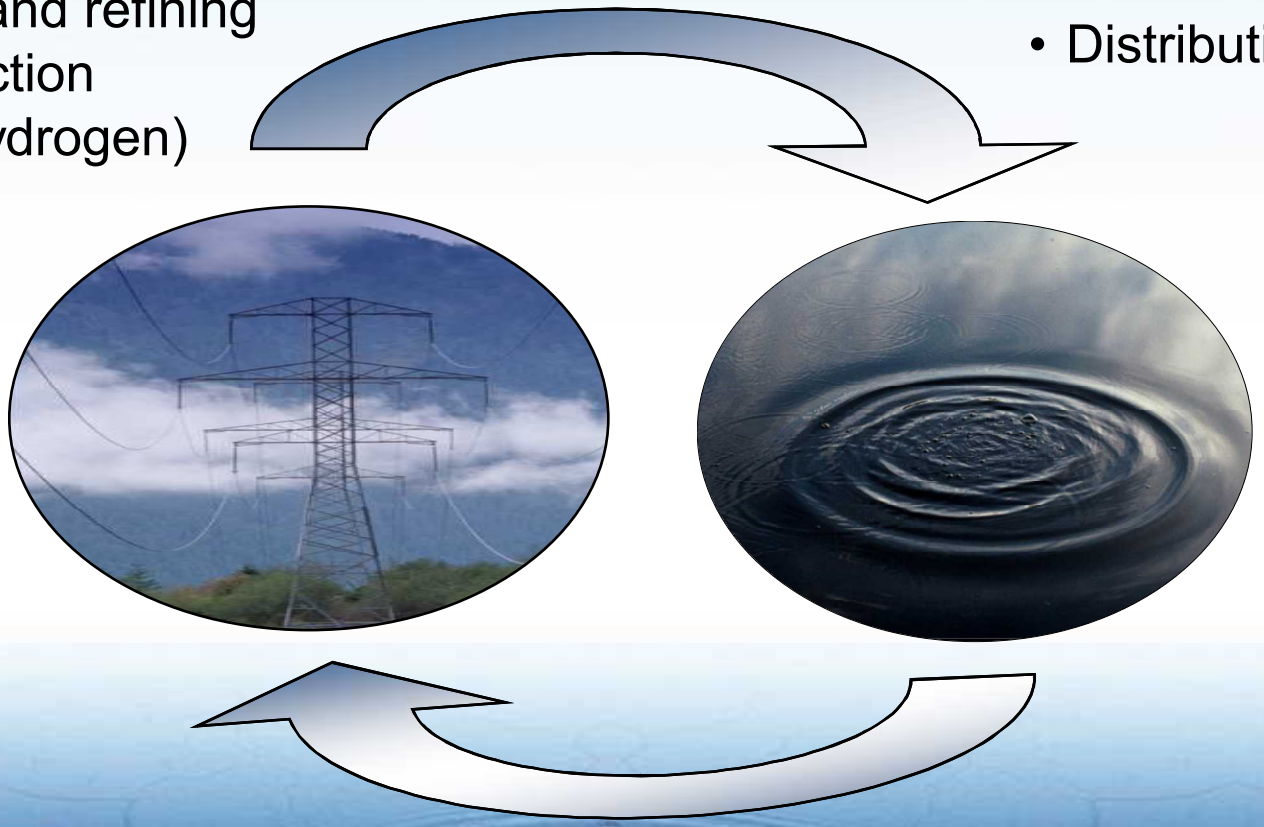


ENERGY and WATER

Energy and Water are Inextricably Linked

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

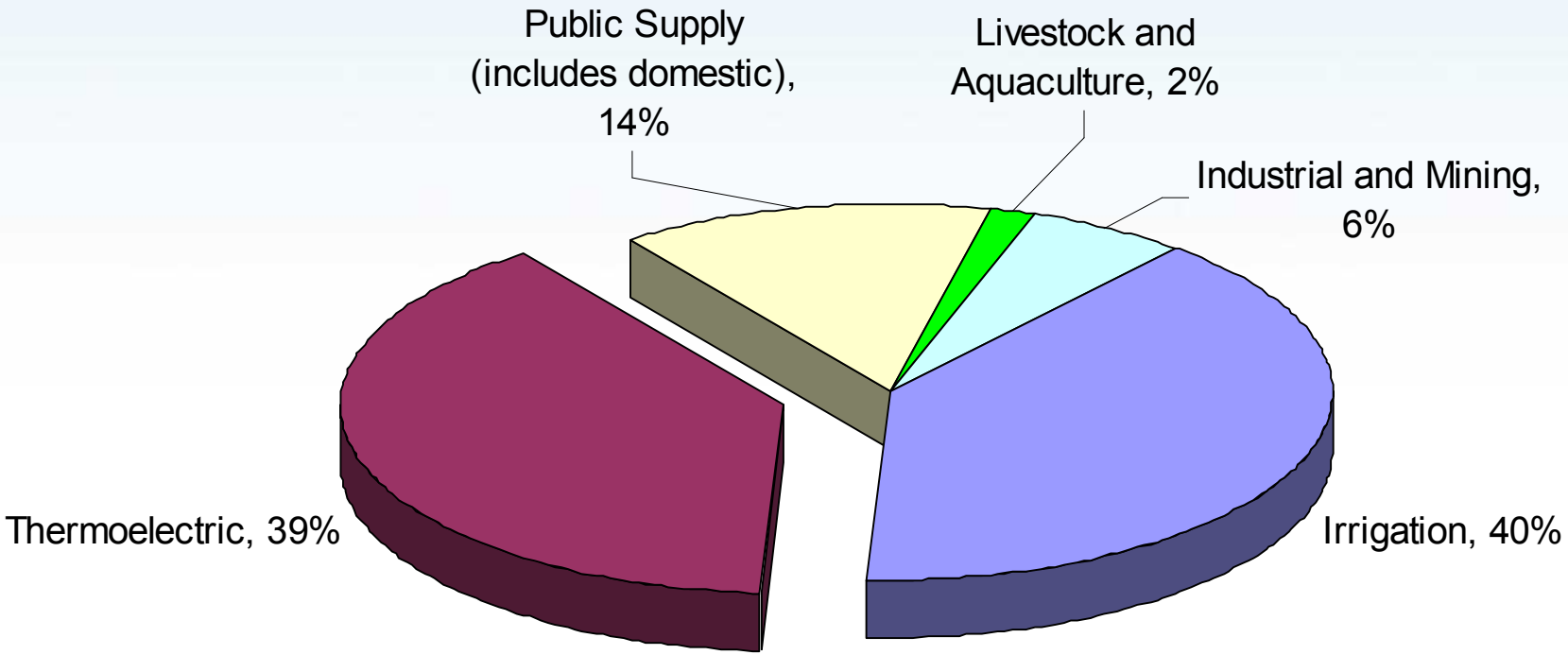
Energy for Water
- Pumping
- Treatment
- Distribution



ENERGY and WATER

Water for Energy

Estimated Freshwater Withdrawals in the U.S. by Sector (2000)



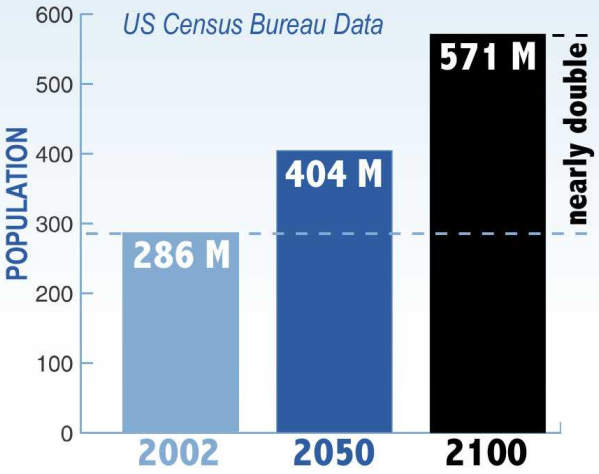
Source: USGS Circular 1268, March, 2004

Withdrawal vs. Consumption

- **Power Plants**
  - 136,000 Mgal/day withdrawn
  - 4,000 Mgal/day (~3%) consumed
    (EPA ruling 316A/B may increase consumption)
- **Irrigation**
  - 137,000 Mgal/day withdrawn
  - 84,000 Mgal/day (~61%) consumed

Source: USGS Circular 1200 (Year 1995) and 1268 (Year 2000)

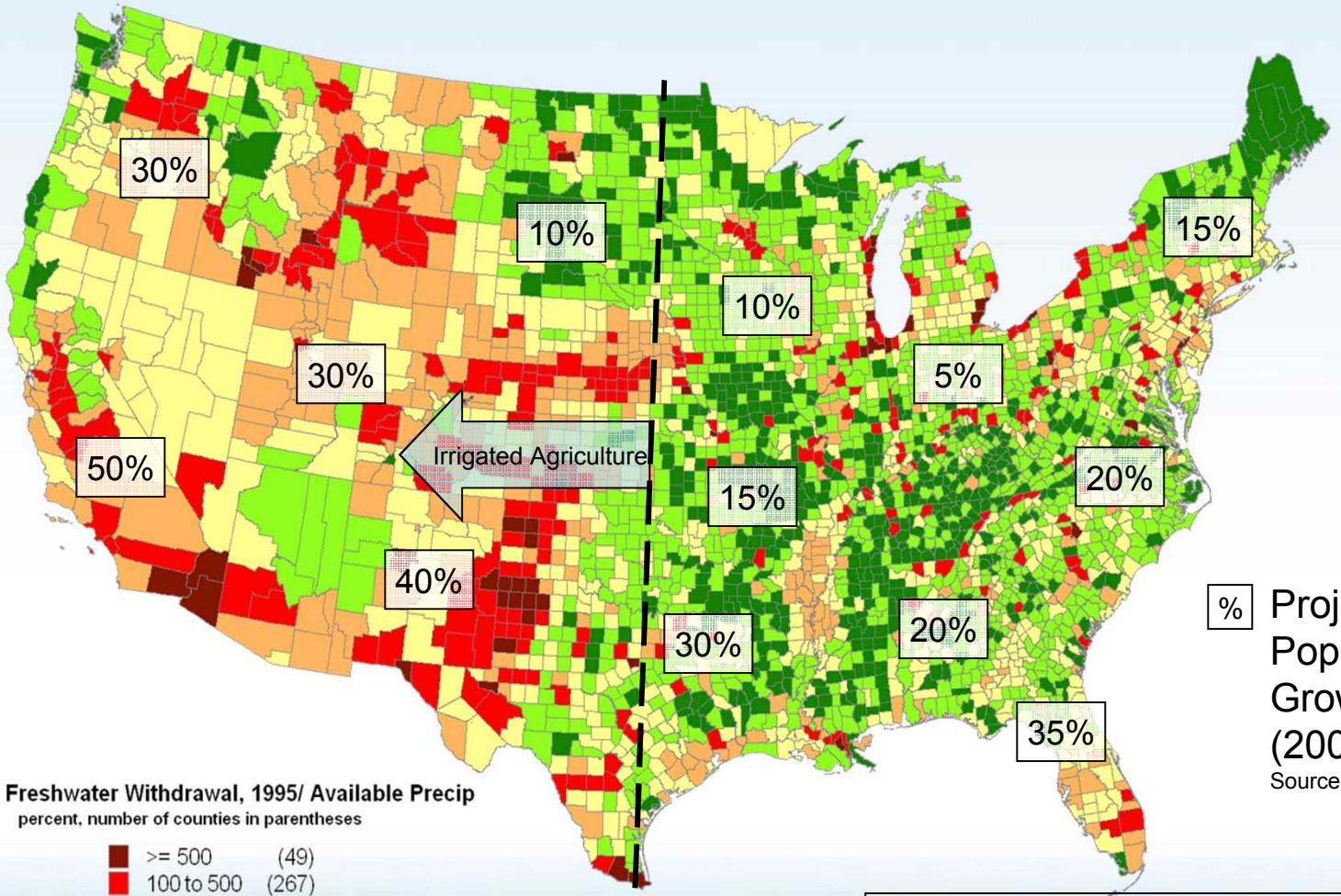
Will water supplies be sufficient to meet US energy demands in 20 years?



- 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

Water Availability is a Nationwide Problem



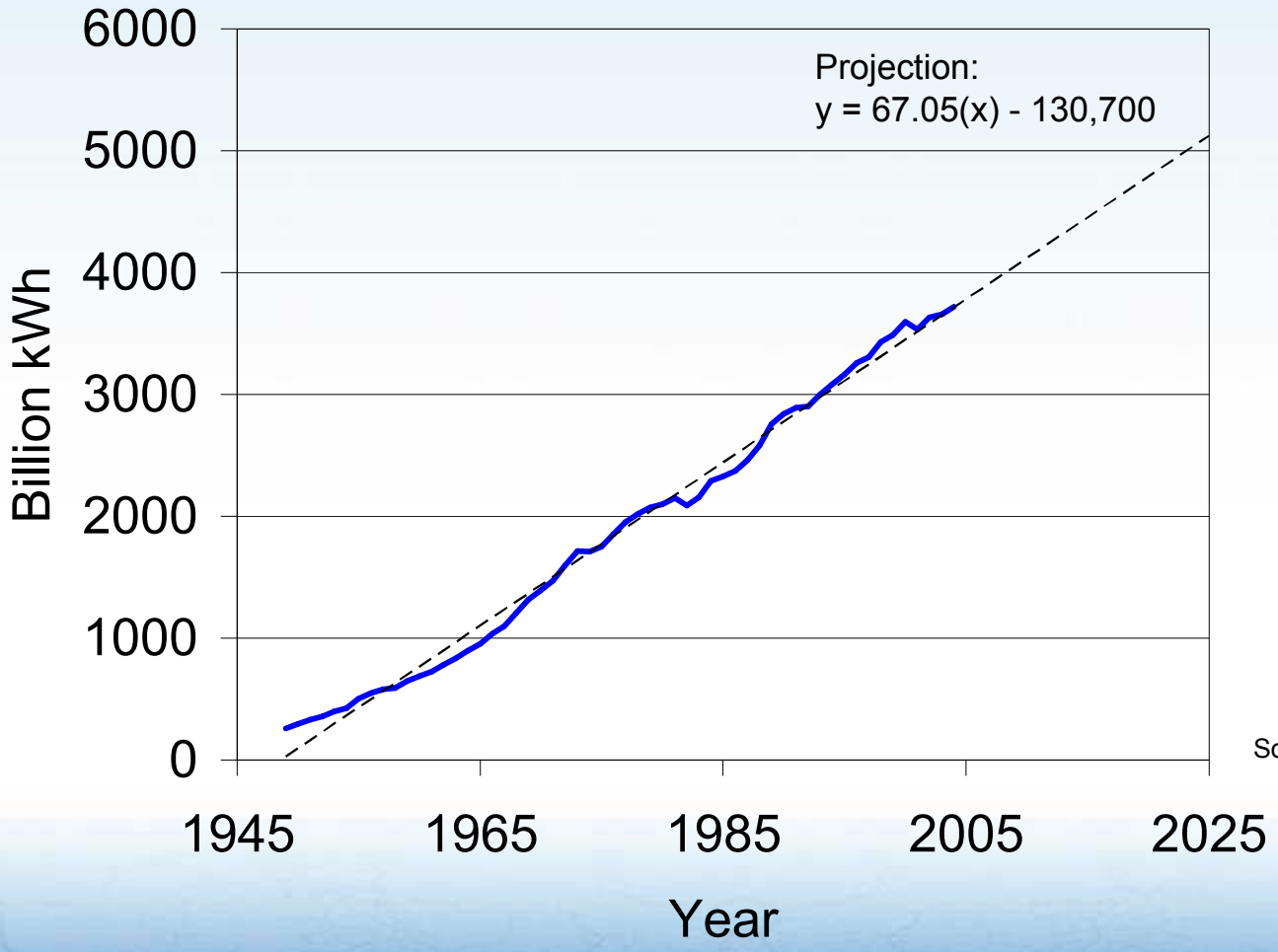
% Projected Population Growth (2000-2020)
Source: NETL (2002)

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

ENERGY and WATER

Energy Needs

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



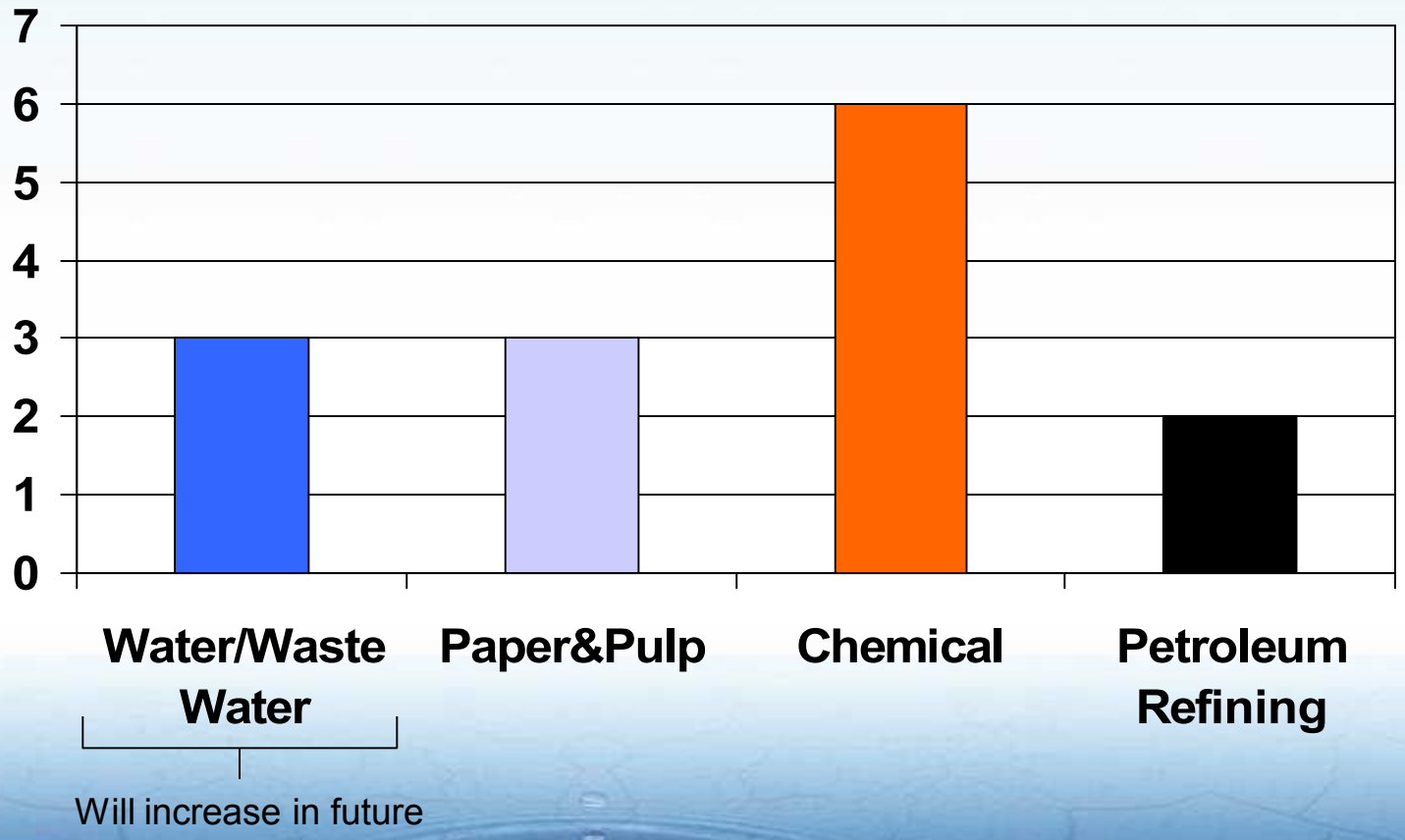
Source: DOE/EIA-0384(2004)

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

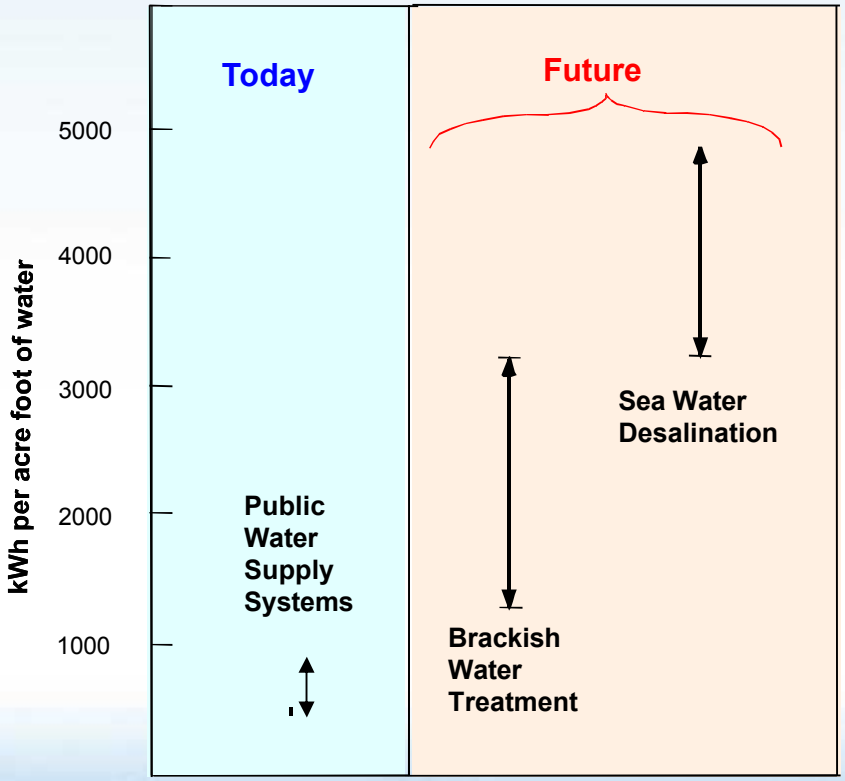


ENERGY and WATER

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 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)

ENERGY and WATER

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Recent Energy and Water Forums

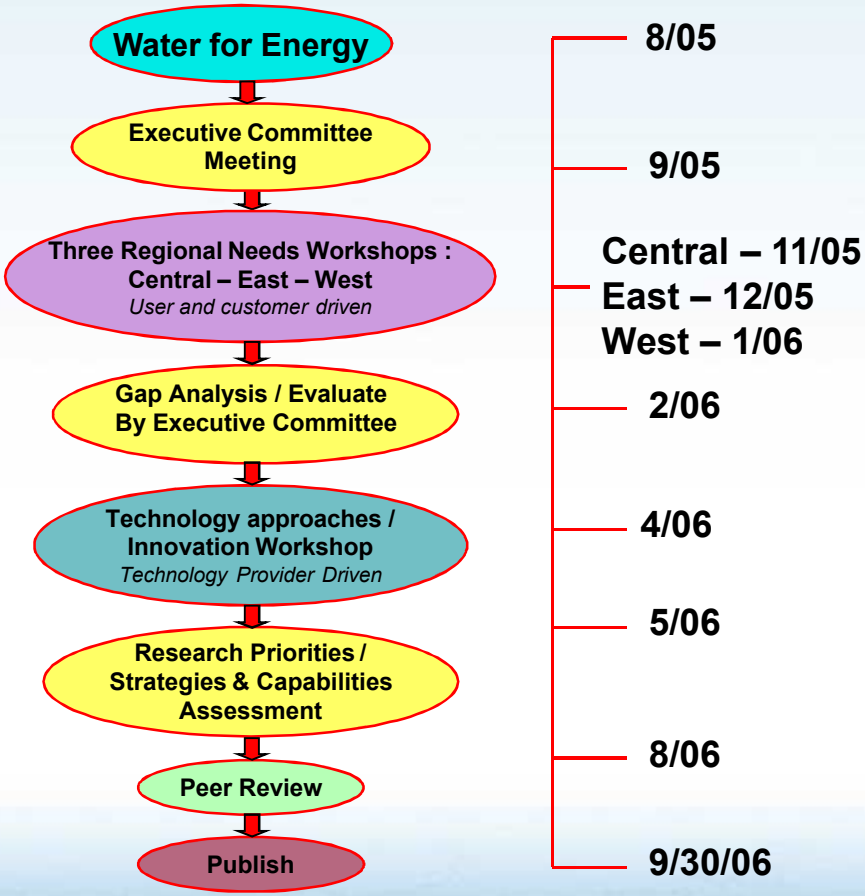
- **Sandia and Los Alamos Water for Energy Forum 2002**
  - Treatment of produced water, need for advanced treatment technologies, and regional approaches to utilize produced water
- **National Energy Technology Lab Water for Energy Forum 2002**
  - Recognized need for improved cooling technologies, non-traditional water sources, pollutant measurement and treatment.
- **National Renewable Energy Laboratory**
  - Use of renewable energy for water supply
- **American Council for an Energy-Efficient Economy**
  - Roadmap for Energy in the Water and Wastewater Industry
- **Sustainable Water Resources Research Workshop**
  - Need better integrated regional planning, better characterization of water supply availability, and advanced technologies and modeling capabilities

Energy-Water Legislation

- **FY05 appropriations bill provided funding for two specific Energy-Water efforts:**
  - **Report to Congress**
    - **Address energy and water interdependencies, current trends in energy and water issues and demands, general gaps between current program direction and emerging concerns, and possible future needs**
    - **Due to Congress by February 2006**
  - **National Energy-Water Roadmap for DOE**
    - **Assess emerging energy and water issues based on user and stakeholder needs and develop energy and water science and technology priorities**
    - **Due to DOE by September 2006**
- **Energy Policy Act of 2005**
  - **Established DOE role in energy and water related issues**

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.



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

Partnerships and integration will be crucial for program success

- Integration of agencies (federal, state, tribal), utilities, and industry responsible for water, energy, economic development, and environmental management
- Universities and labs to perform fundamental research in areas relevant to program
- Industry and utility consortia involvement in testing and evaluation of water and energy technologies

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Needs Assessment Workshops Goals and Objectives

- Three regional workshops: Nov 2005 through mid-January 2006
- Focus on emerging user and stakeholder problems, issues, and needs and science and technology role in developing effective solutions
- Interested in 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
- Will capture all issues, needs, and recommendations identified in each workshop
- Use results to rank regional and national priorities and to focus future science and technology research, development, and implementation

Examples of Science and Technology Problems and Needs for Energy and Water

- Improved materials, processes, or technologies to enhance efficiency or performance of energy production, cooling, water treatment, etc.
- Science-based regulations or policy
- Improved understanding of chemical or biological processes that impact water and energy-use efficiency
- Modeling or decision support tools for improved cooperation of resource management and utilization
- Improved technology transfer and economic evaluations of costs and benefits
- Real-time resource monitoring and sensing
- Better understanding or evaluation of future energy or water alternatives

National Impact of Energy-Water Science and Technology Roadmap

- Understanding the interdependencies of water-reliant systems and their impact on future energy supplies
- Ensuring regional water availability
- Balancing future water demands across all users and stakeholders
- Developing science and technology to reduce water use, loss, and environmental impact in energy systems

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