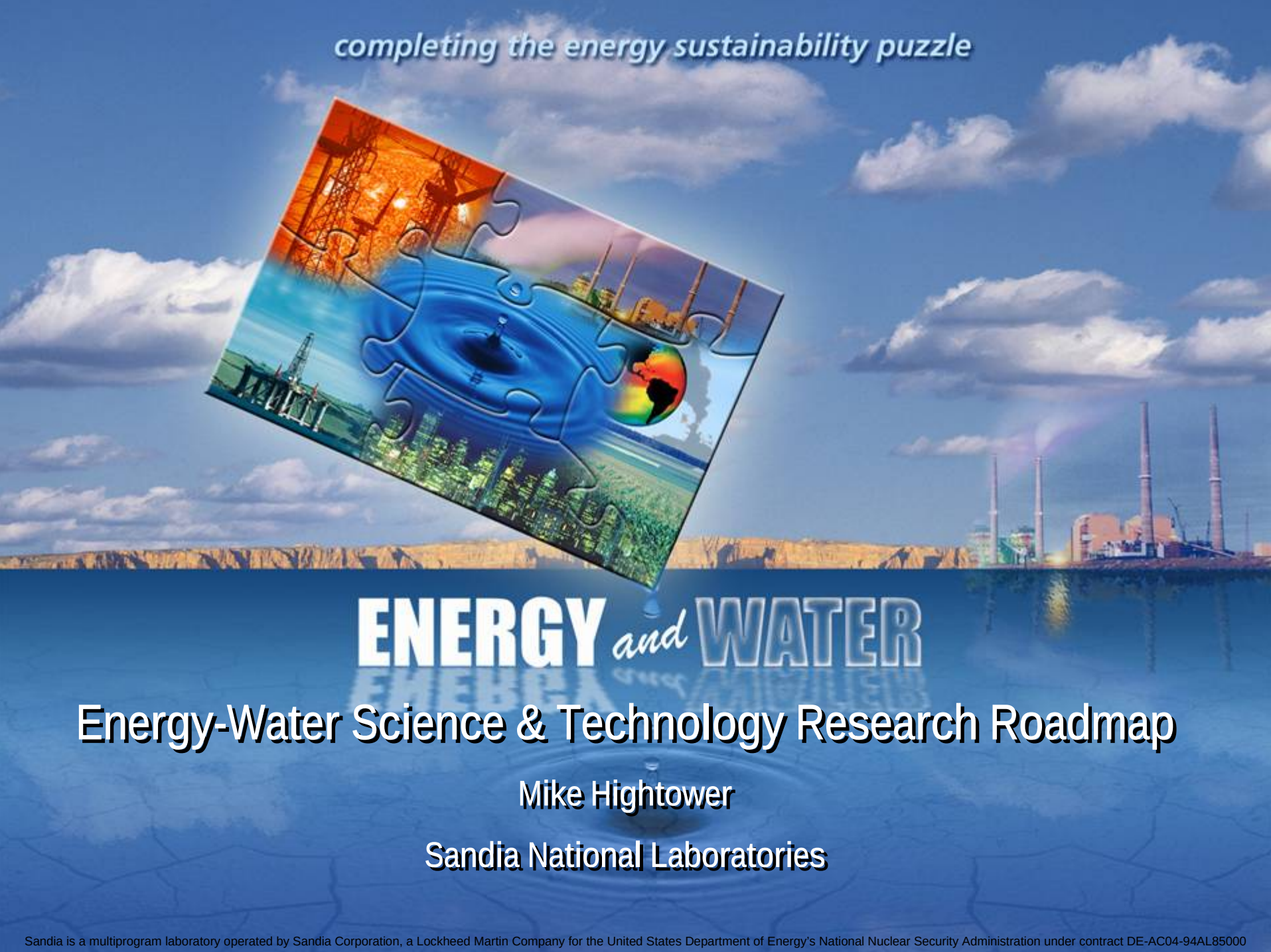


Energy-Water Science & Technology Research Roadmap

Mike Hightower

Sandia National Laboratories

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

- Energy/Water Nexus
  - Issues, Trends, and Concerns
- Overview of DOE Energy-Water Science and Technology Roadmap Process
  - Process, schedule, goals, participants
- Technical Workshops Summary
  - Regional and national issues and challenges identified
  - Some suggested science and technology research and development directions
- www.sandia.gov/energy-water
  - Mike Hightower, 505-844-5499, mmhight@sandia.gov

US Energy Sustainability

ENERGY and WATER

FY05 appropriations are now supporting two Energy-Water efforts

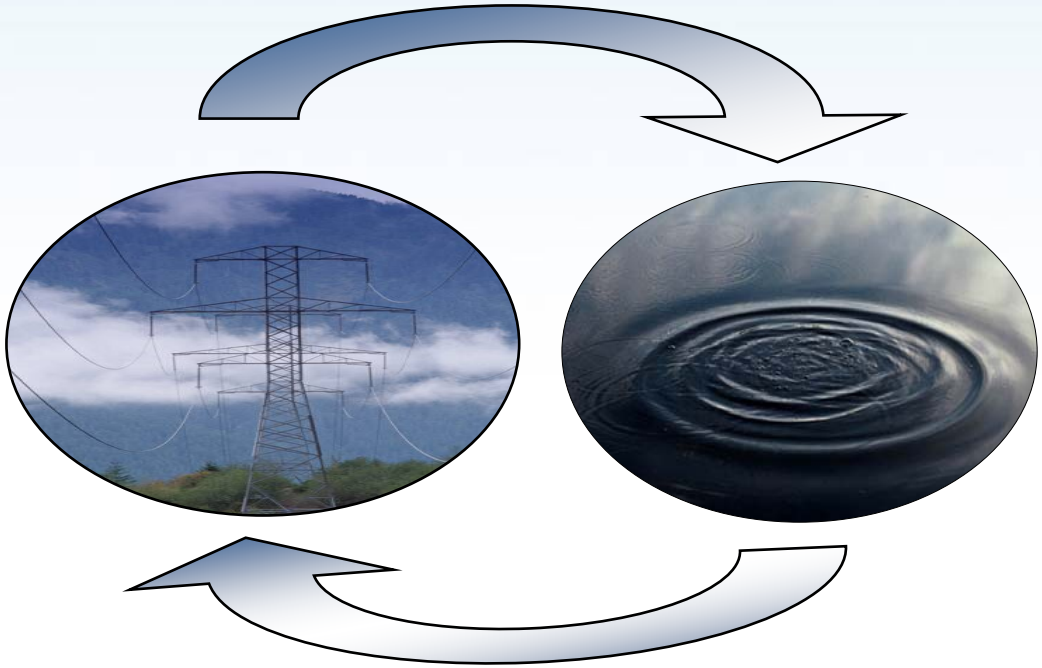
- Report to Congress
  - Consider energy and water interdependencies, trends in energy and water supplies, threats and concerns to energy production
  - Coordinated by Sandia, Los Alamos, NETL, and EPRI
  - Due to Congress March 2006
- Energy-Water Roadmap for DOE
  - Assess emerging energy and water resource issues based on user and stakeholder needs
  - Develop energy and water science and technology priorities
  - Due to DOE by September 2006

Energy and Water are ... Inextricably linked

Energy for Water **and** ***Water for Energy***

Energy and power production requires water:

- Thermoelectric cooling
- Hydropower
- Energy minerals extraction / mining
- Fuel Production (fossil fuels, H_2, biofuels/ethanol)
- Emission controls



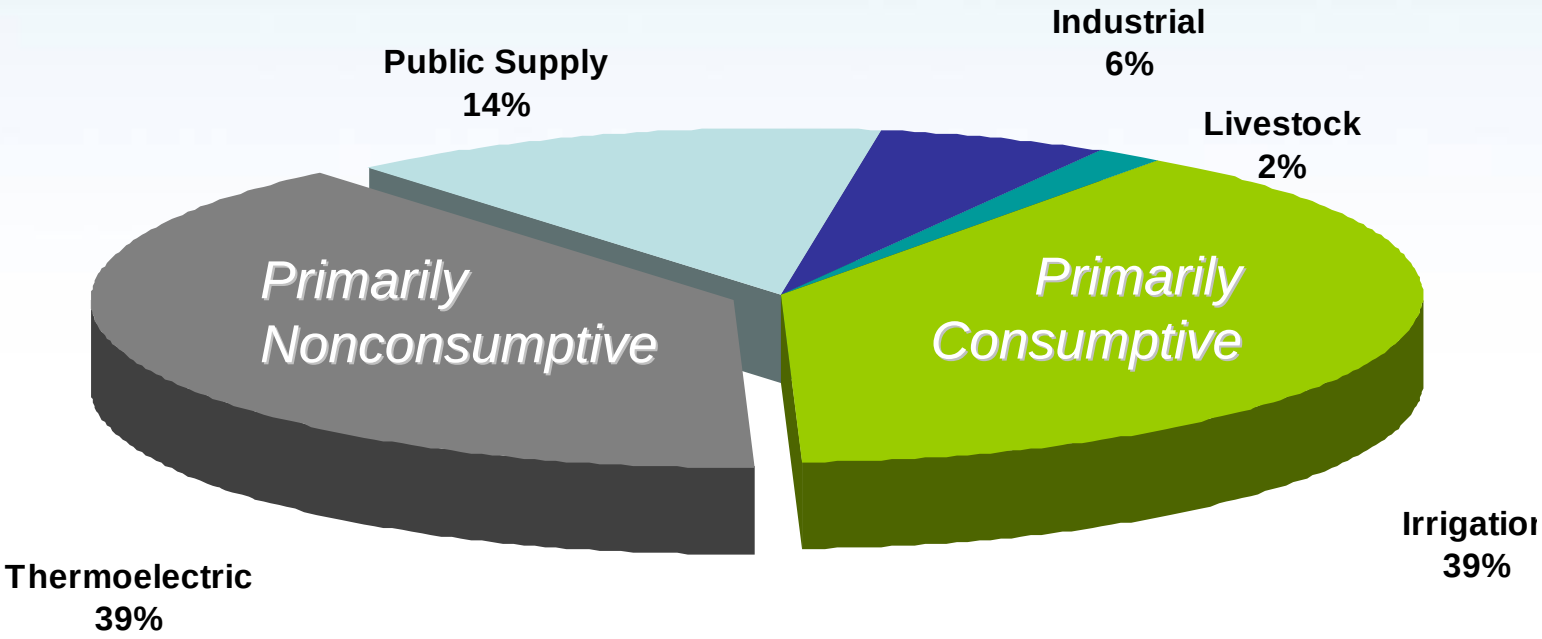
Water production, processing, distribution, and end-use requires energy:

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

ENERGY and WATER

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

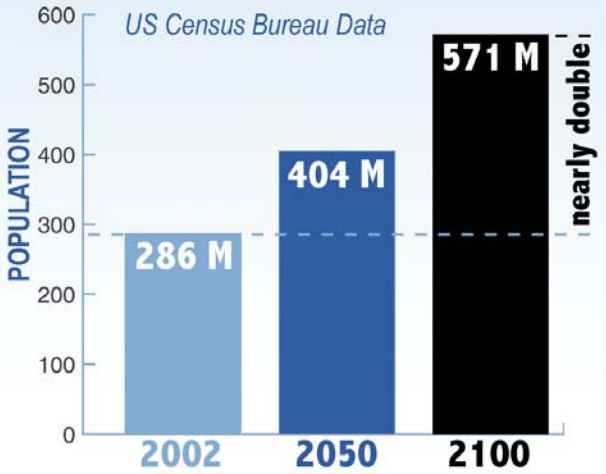
Estimated Freshwater Withdrawals by Sector, 2000



Source: USGS Circular 1268, March, 2004

Note: Hydropower uses are not included here!

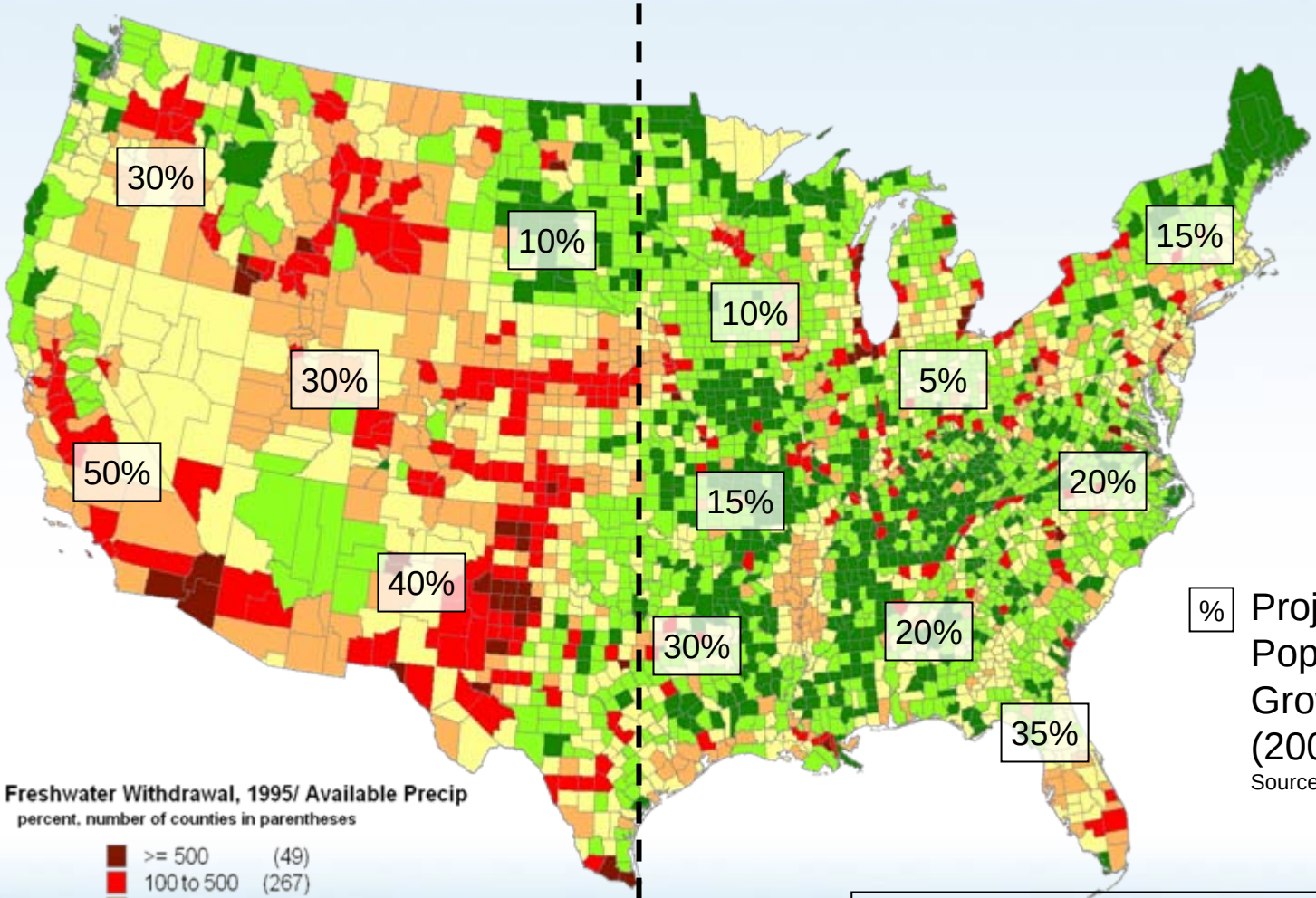
Will water supplies be sufficient to meet US energy demands in 20 years?



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

- Diminished supplies of surface and ground water
- 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 challenges are nationwide



% Projected Population Growth (2000-2020)

Source: NETL (2002)

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

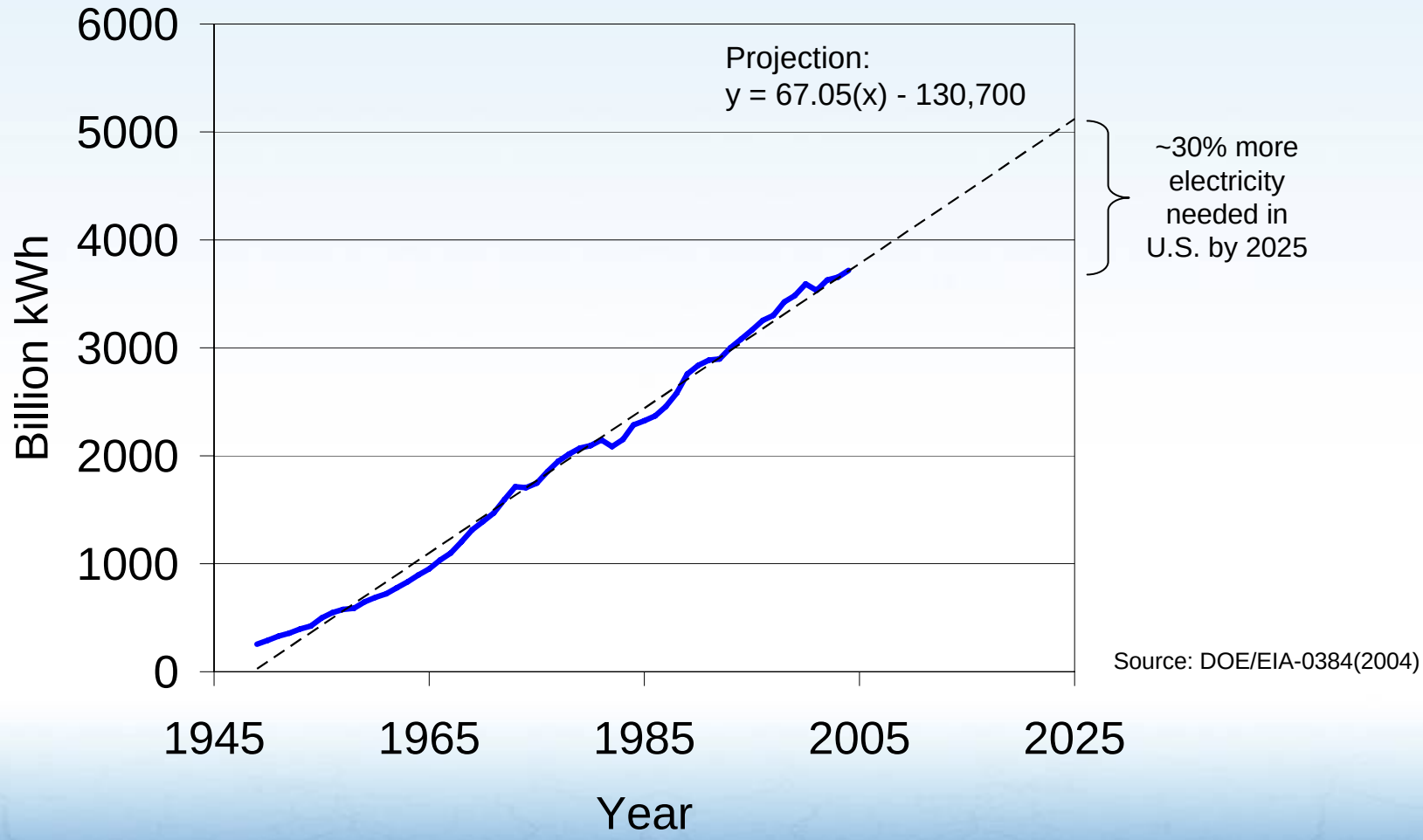
Heavy reliance on irrigation in agriculture

ENERGY and WATER

Energy and Water Interdependency Issues Are Appearing Now

ENERGY and WATER

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

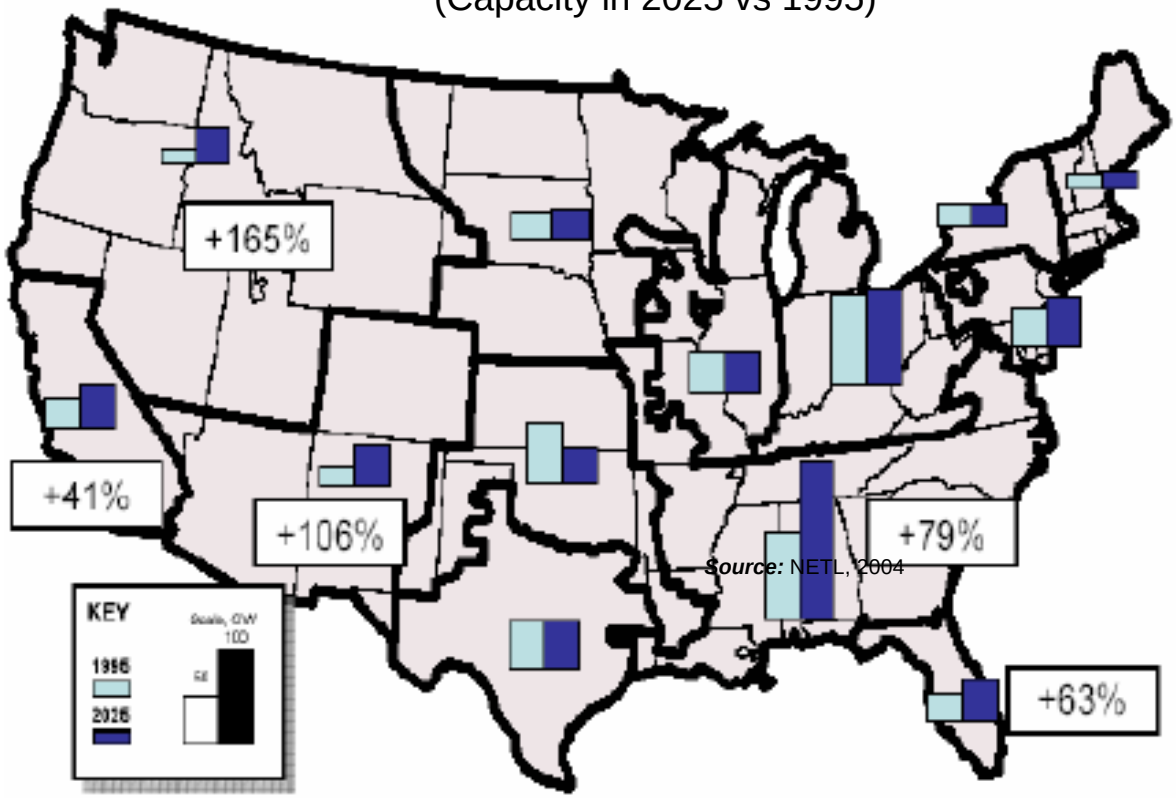


Source: DOE/EIA-0384(2004)

EWN issues align with DOE goals, responsibilities, and capabilities

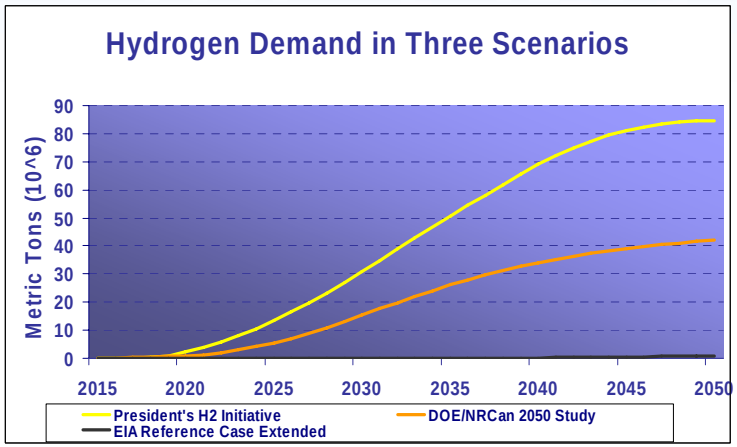
- DOE's Energy Strategic Goal is at risk if water needs are not considered
  - *"promote a diverse supply … of reliable, affordable and environmentally sound energy"*

Projected Thermoelectric Increases
(Capacity in 2025 vs 1995)

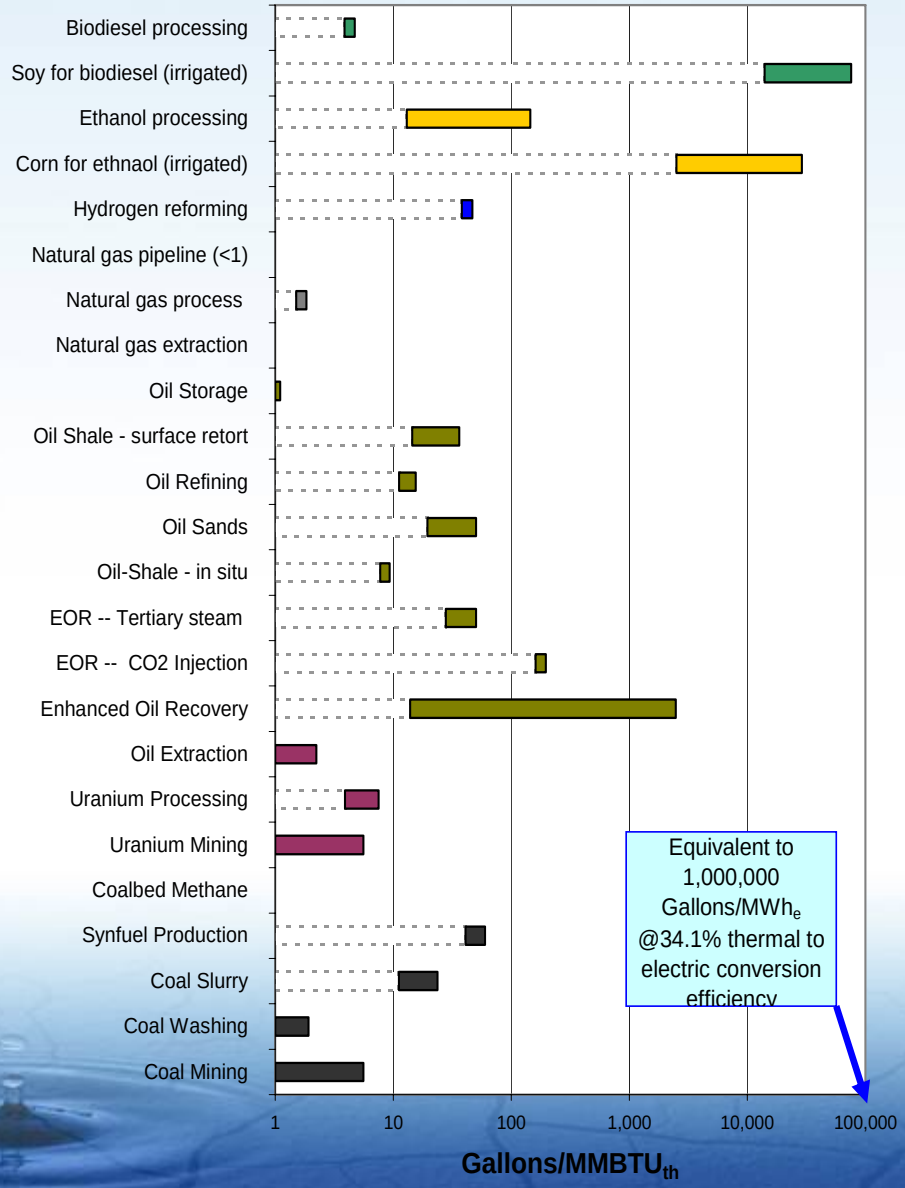


Future energy development will put new demands on water

- Many new technologies will be more water intensive
- Hydrogen economy would require even more water:



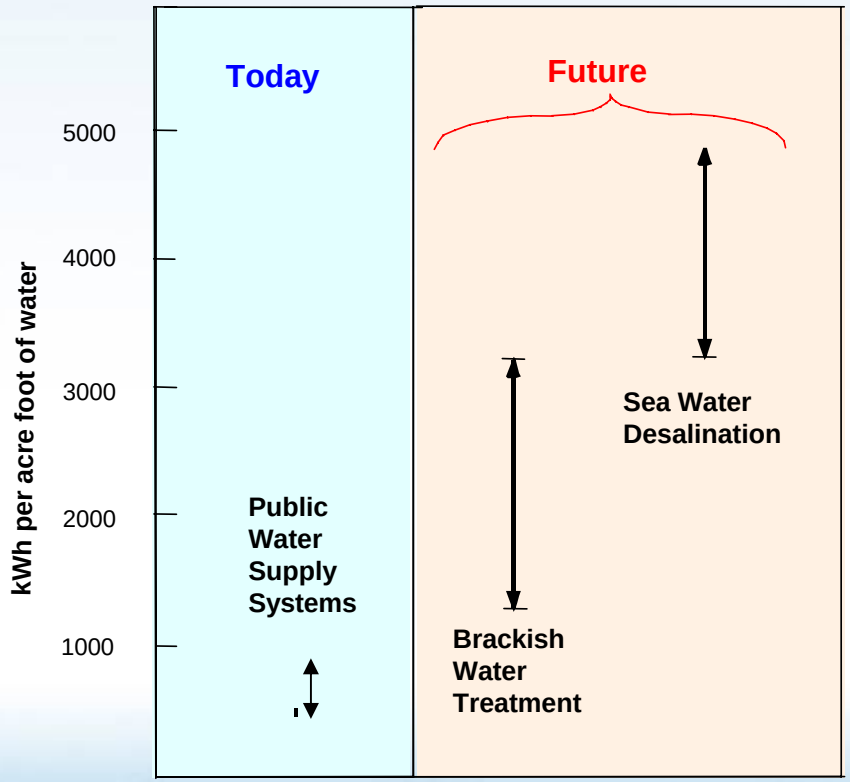
- Constraints will grow for energy development and power plant siting



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

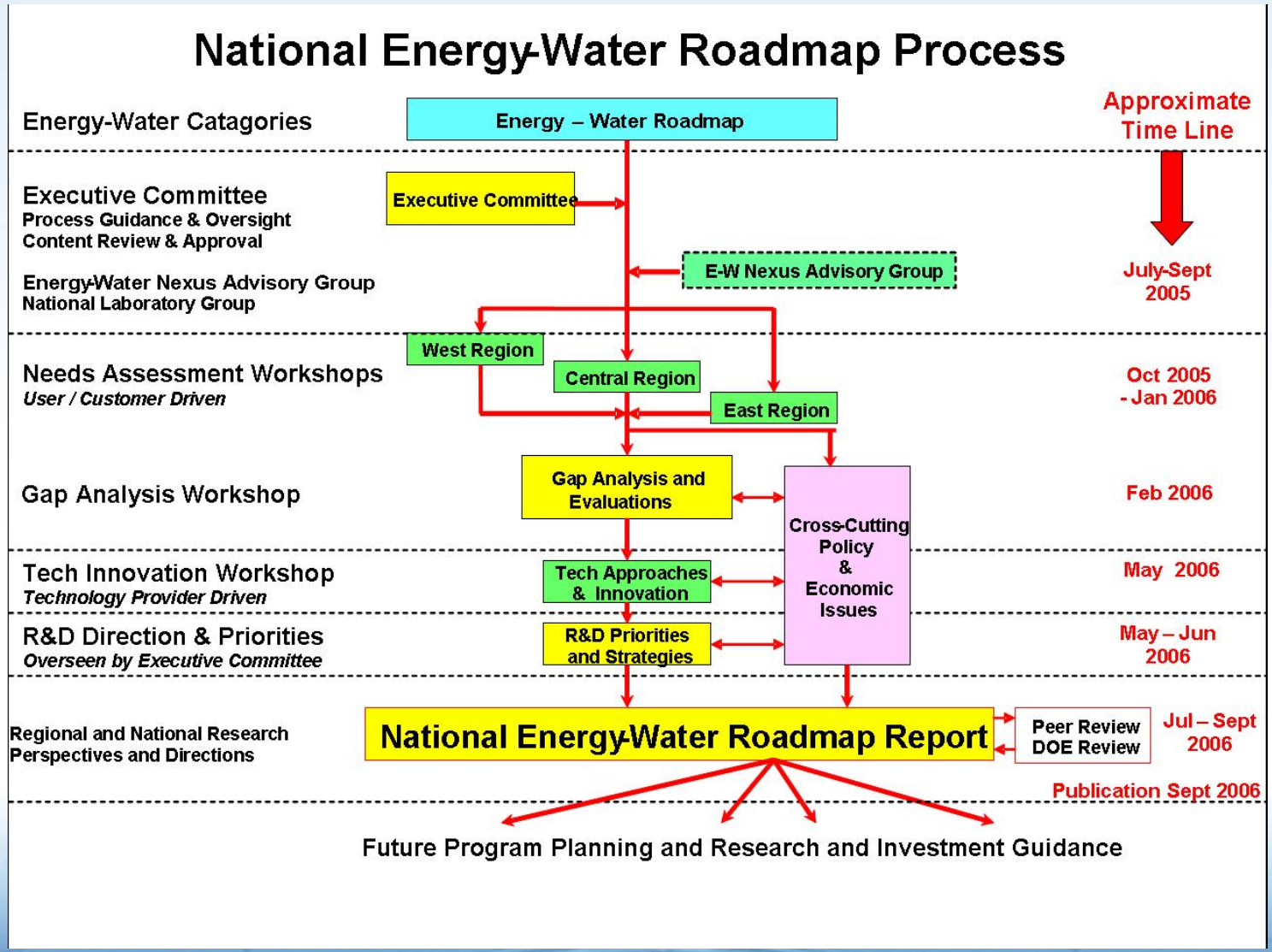


Source: EPRI (2000), Water Desalination Task Force (2003)

Energy-Water Roadmap Planning and Implementation Team

- Sandia National Laboratories
  - Coordinate roadmap efforts – workshops, gap analysis, ranking efforts, and roadmap report
  - www.sandia.gov/energy-water
- Executive Committee
  - Representatives from - energy utilities, water management groups, environmental groups, energy and water regulators, utility associations, oil and gas, natural resource experts
- National Lab Advisory team
  - Support science and technology issues analysis
- UNM Utton Transboundary Center and Lawrence Berkeley National Laboratory
  - Coordinate policy, regulatory, and economic issues analysis

Energy-Water Roadmap Process



Energy-Water Needs Assessment Regions

Needs Assessment Workshop Overview

- Three regional workshops: Nov 2005 through mid-January 2006
  - Kansas City, Baltimore, Salt lake City
  - 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

Summary of Major National Needs and Issues Identified the Regional Workshops

1. Need for Integrated regional energy and water resource planning and decision support
2. Oil and gas produced water treatment for use
3. Water needs for emerging/renewable energy resources
4. Improved biofuels/biomass water use efficiency
5. Improved water efficiency in thermoelectric power generation
6. Energy efficiency for impaired water treatment and use
7. Improved water supply and demand characterization/monitoring
8. Infrastructure changes for improved energy/water efficiency

Examples of Identified Science and Technology Research Directions

- Improved data on regional water availability and sustainability
  - Statistical determination of monitoring needed, improved water data collection and frequency
- Coordinated regional natural resources planning
  - Modeling and decision support tools for improved resource management and utilization
  - Climate 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 efficiencies
  - Co-location of energy and water production facilities to improve overall resource efficiency

Energy-Water Science and Technology Roadmap Summary

- Results from all Workshops are presented at www.sandia.gov/energy-water
- Primary needs and issues are similar throughout the country - except for the Northeast
- People are thinking out of the box to find new solutions, but policy and regulatory improvements are needed to accelerate implementation
- Final report available September 2006