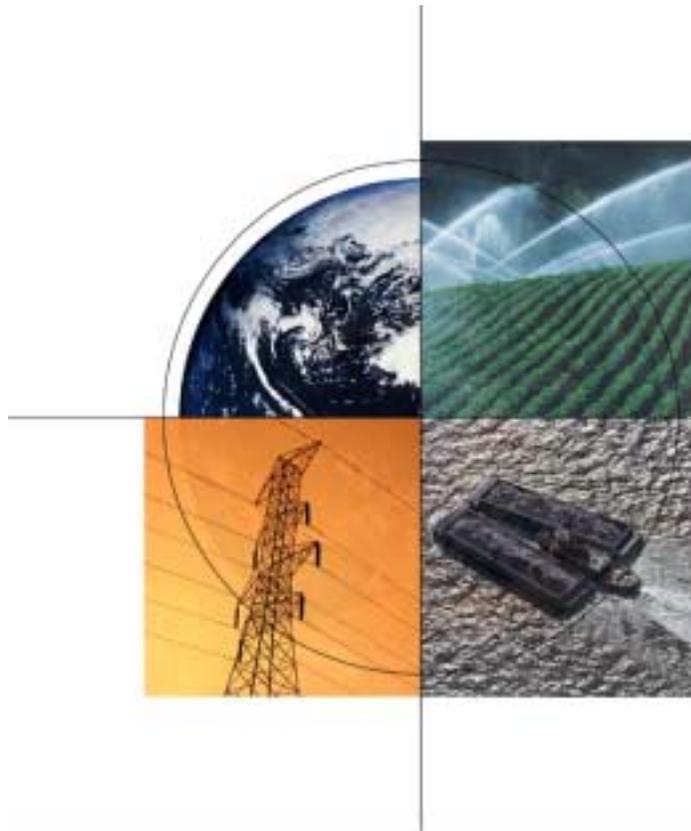


Emerging Issues and R&D Needs



*Workshop on Electric
Utilities and Water*

July 23-24, 2002

Rita A. Bajura, Director

National Energy Technology Laboratory



www.netl.doe.gov



completing the energy sustainability puzzle

WATER @ **ENERGY**

Stakeholder Workshop
June 11 - 12, 2002
Denver, CO

Sandia National Laboratories
 Los Alamos
 NETL

WORKSHOP on
Electric Utilities and Water:
Emerging Issues and R&D Needs

July 23-24, 2002
Pittsburgh Airport Hyatt Hotel,
Pittsburgh, Pennsylvania

sponsored by
 U.S. Department of Energy
 Office of Fossil Energy
 National Energy Technology Laboratory
 NETL

Sandia National Laboratories
 Sponsored by
 U.S. Department of Energy
 Sandia National Laboratory
 and Los Alamos National Laboratory
 Los Alamos



Presentation Outline

- **About NETL**
- **Energy and water issues**
- **Ongoing and planned research**



National Energy Technology Laboratory

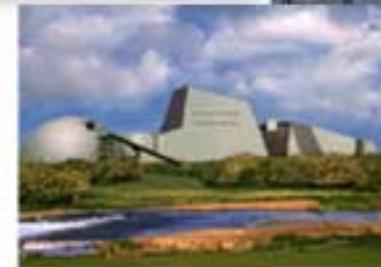


- **One of DOE's 17 national labs**
- **Government owned / operated**
- **Sites in:**
 - Pennsylvania
 - West Virginia
 - Oklahoma
 - Alaska
- **More than 1,100 federal and support contractor employees**



Our Mission

- **Resolve environmental, supply, and reliability constraints of producing and using fossil resources**
- Support development and deployment of environmental technologies to remediate DOE's weapons complex



NETL Plays Key Role in Fossil Energy Supply, Delivery, and Use Technologies

Electric Power Using Coal



Coal Production



Environmental Control



V21 Next Generation



Carbon Sequestration

Clean Liquid Fuels



Exploration & Production



Refining & Delivery



Alternative Fuels



Future Fuels

Natural Gas



Exploration & Production



Pipelines & Storage



Fuel Cells



Combustion Turbines



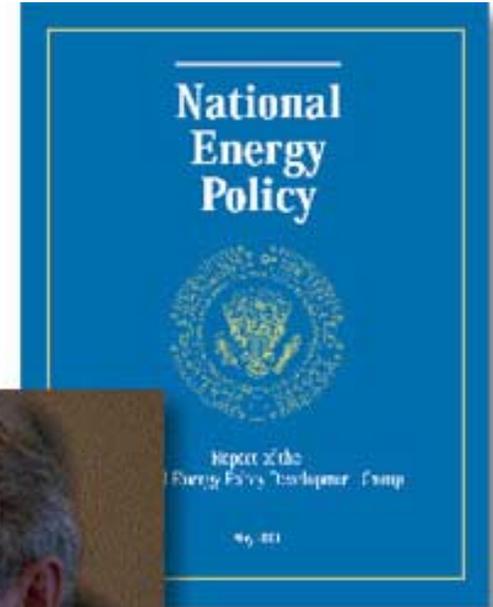
What We Do

- Shape, fund, and manage extramural RD&D
- Conduct onsite research
- Support energy policy development



Presidential Priorities

President's National Energy Policy clearly articulates need to protect nation's water resources



**“Whiskey is for drinking;
water is for fighting.”**

– Mark Twain



Water Issues in the News

Nation

• E-mail this story • Subscribe to the newspaper • Sign up for e-mail news

09/02/00 - Updated 08:07 AM ET

Deluge only dents East's drought

By Tom Ichniowski
...ver the
...gon
...airfall after
...er good
...month
...rfall in
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Energy.gov
U.S. DEPARTMENT OF ENERGY

Inside the DOE
press room

DOE News
RELEASE DATE: August 1, 2001 [Print Friendly Version](#)

Study Shows Efficient Appliances Yield Dramatic Energy and Water Savings

SWEEP Study Reveals Significant
America

NATIONAL GEOGRAPHIC SPECIAL EDITION

Water

THE POWER, PROMISE,
AND TURMOIL OF
NORTH AMERICA'S
FRESH WATER

The World's Water 2000-2001

The Biennial Report on Freshwater Resources

- Water as a human right
- Water stocks and flows
- Water and food
- Desalination
- International watersheds
- Water recycling
- Dam removals
- Water events

Peter H. Gleick

THE WALL STREET JOURNAL

MARKETPLACE

California's Needs for Water and Electricity Pit One Against the Other

California has proposed using three power plants in Indian reservations, except from state water-sage rules.

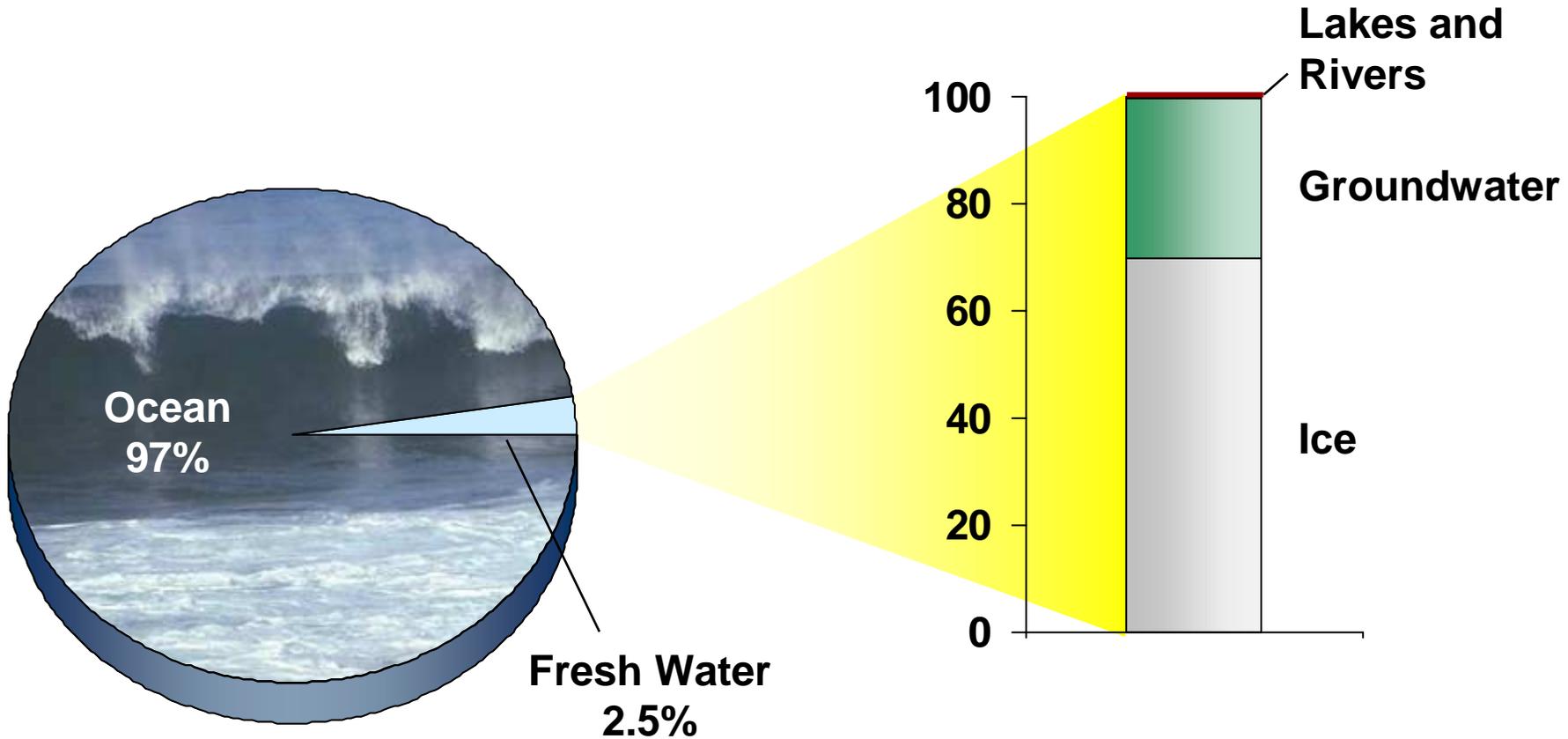
Technology: Verizon posts \$1 billion loss for second quarter Page B3

Health: FDA orders Pfizer to pull Lipitor ad, calling it "misleading" Page B3

Price Fixing



Global Water Availability



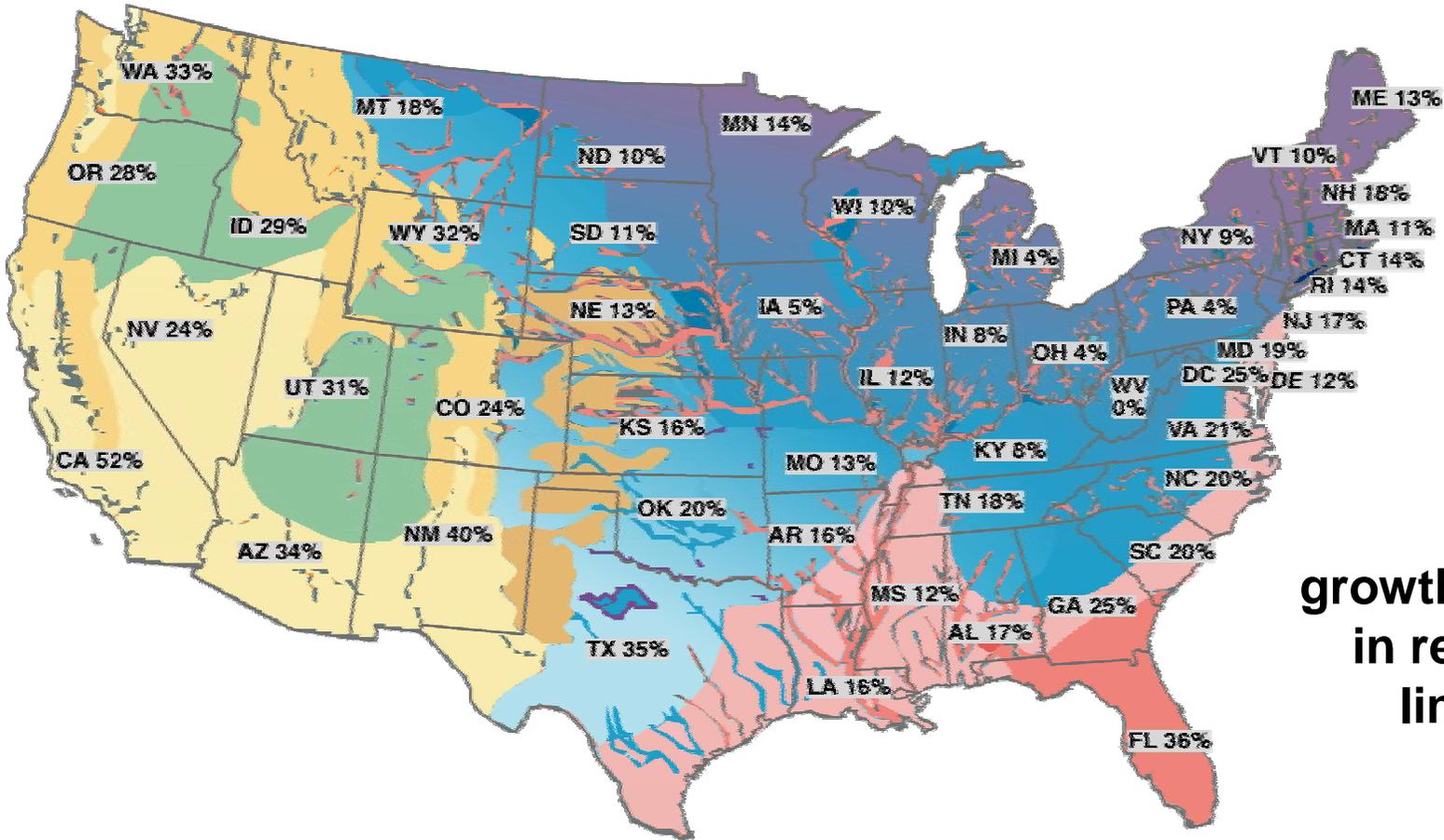
Desalination and Energy

- **Growing desalination market**
- **Energy 20-50% of operating cost**
- **Research needed to address:**
 - High capital and maintenance costs
 - Brine disposal issues



**Umm Al Nar Desalination Plant,
United Arab Emirates**

Relative Water Availability and Projected Change in Population (2000-2020)



Highest population growth projected in regions with limited water resources



Less Water



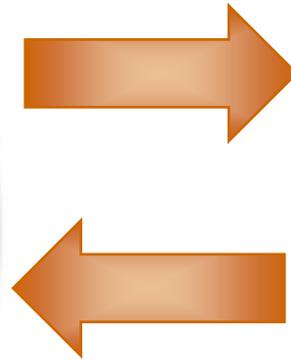
More Water

NETL, M. Chan 03/15/02
U.S. Census / USGS

Water and Energy Inextricably Linked

Thermoelectric power generation is second largest user of water in United States

80% of cost of treating, processing, and pumping water is for energy



Energy and Water Interdependency



**Electric Power
Supply / Demand
Imbalance**



**Water Impact
Disruption of
Irrigation Pumps**



**Agricultural Impact
Crop Losses**



**Banking & Finance Impact
Financial Losses**

California's energy crisis of 2000 clearly demonstrated interdependency between energy, water, and economic health

Two Largest U.S. Fresh Water Use Categories



- **Power Plants**

- 131,900 Mgal / day used
- 3,300 Mgal / day consumed

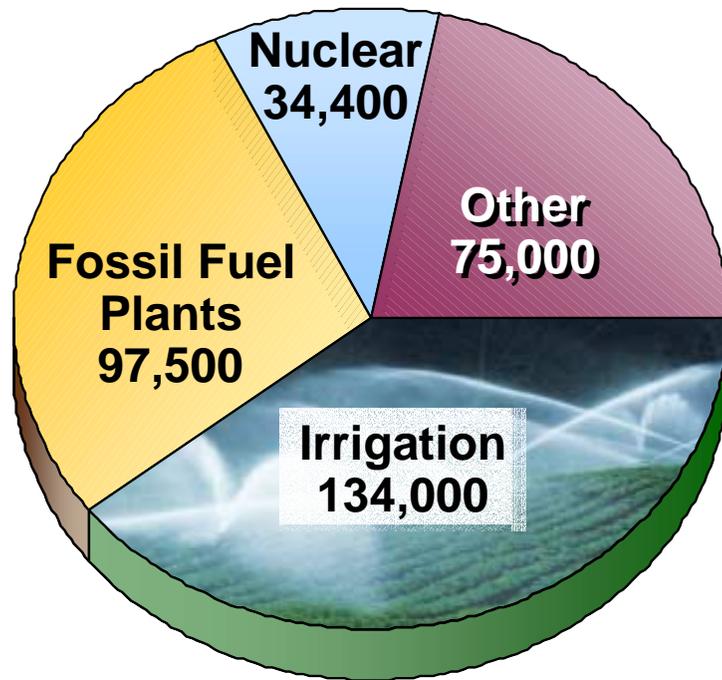


- **Irrigation**

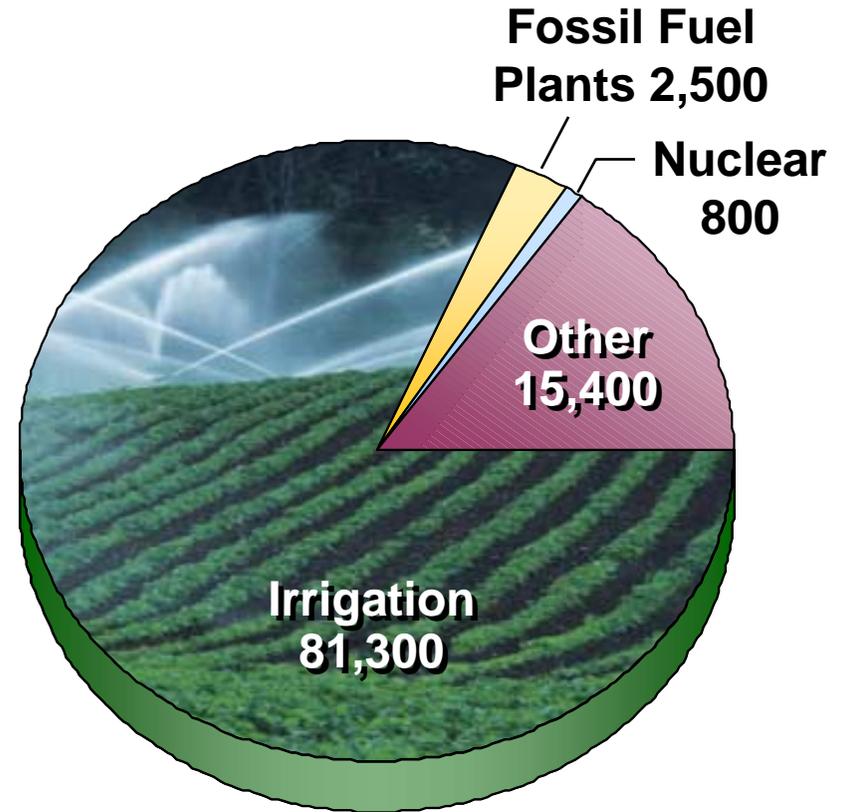
- 134,000 Mgal / day used
- 81,300 Mgal / day consumed

Water Withdrawals and Consumptive Use

Mgal / Day



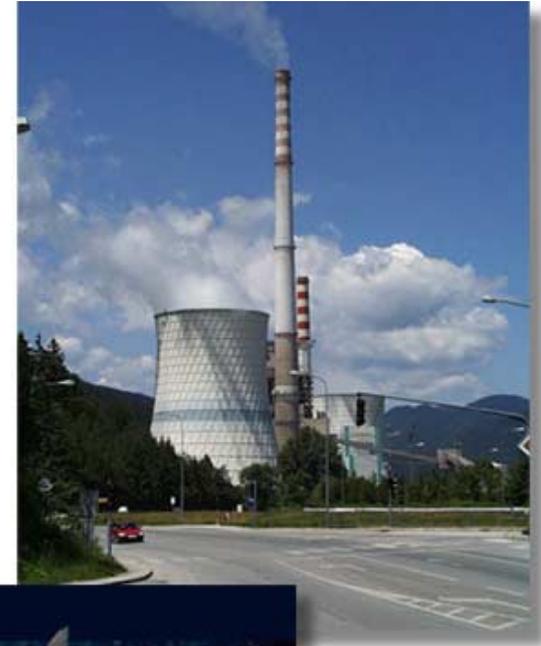
Withdrawals



Consumptive Use

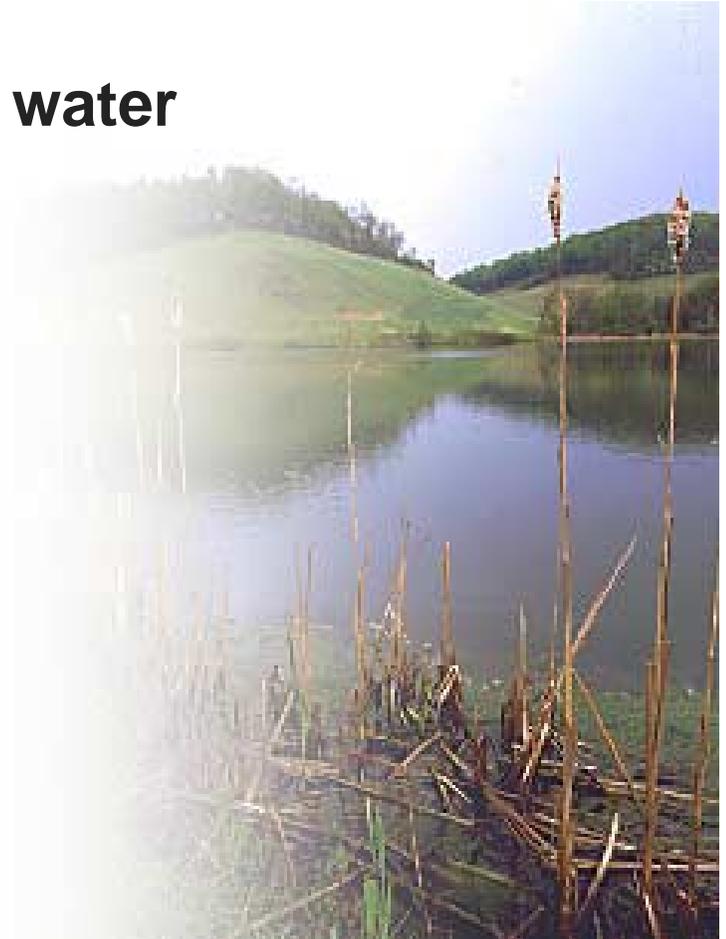
Thermo Power Plants Discharge Most of Water They Use, But . . .

- **Cooling water intake structures may impact aquatic organisms**
- **Regulations have been proposed to address adverse environmental effects**



Issues and Ongoing and Planned Research

- **Electric utilities and cooling water**
- **Water quality trading**
- **Carbon sequestration**
- **Air-water interface**
- **Mining and watersheds**
- **Coalbed methane**

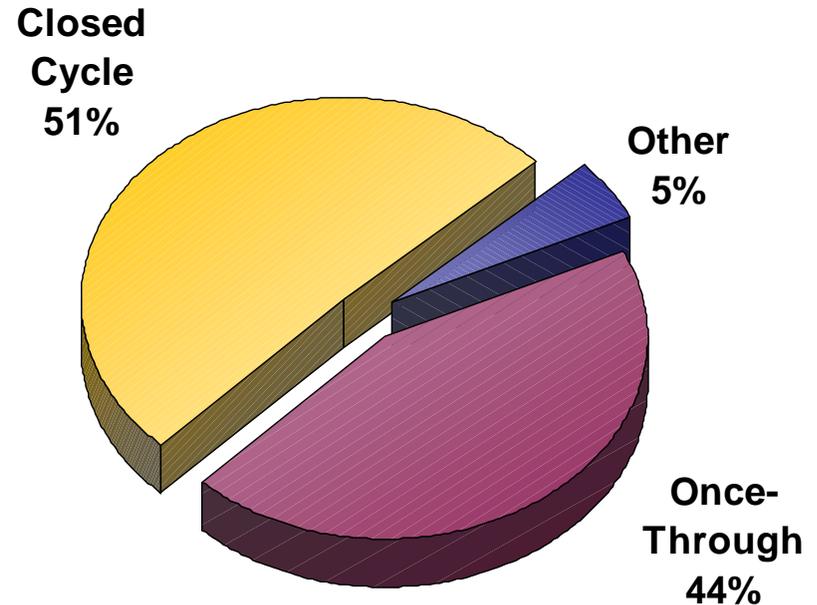


Power Plant Cooling



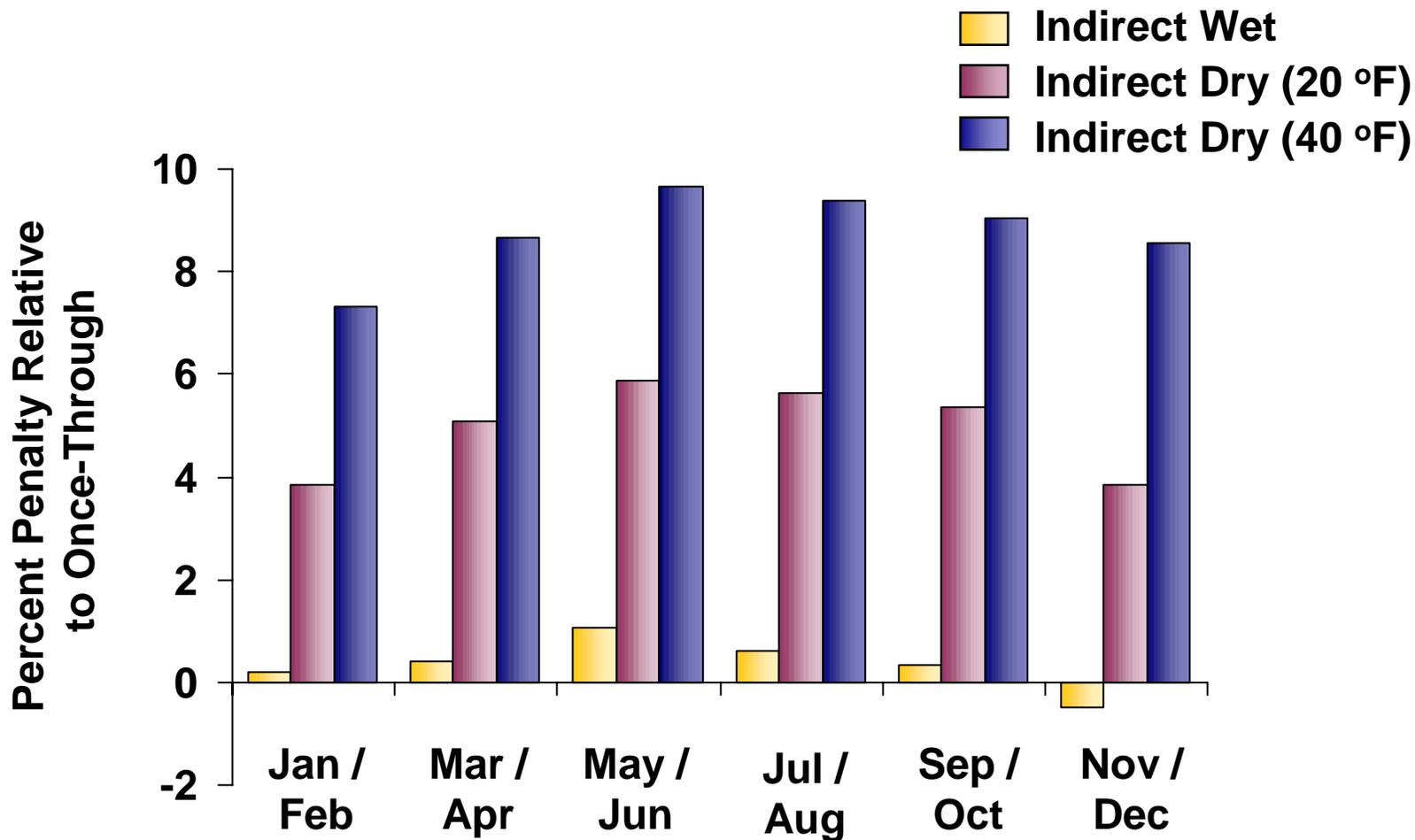
- Largest use of water for condenser cooling
- EPA proposed cooling water intake structure regulations for new and existing plants
- Proposed regulations could impact plant efficiency
- Zebra mussels can also impact plant operation and efficiency

Potential Impact of Cooling Water Regulations on Existing Steam Electric Utility Boilers



**250,000 MW of Total Capacity
Employing Once-Through
Cooling**

Indirect Wet or Dry Cooling Could Have Significant Energy Penalty



Zebra Mussels

Ongoing Research

- Effect of calcium on zebra mussel populations and distribution
- Effectiveness of toxin from species of common soil bacterium of genus *Pseudomonas*



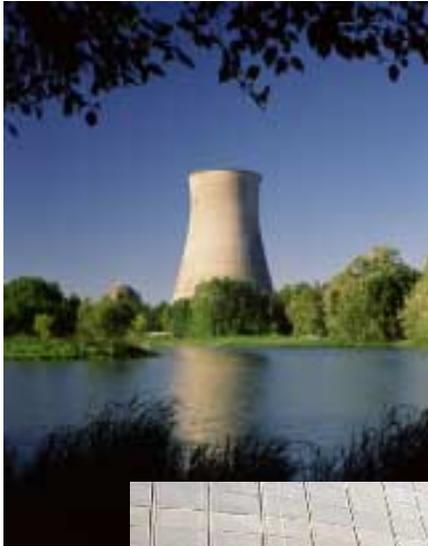
Zebra Mussel Distribution in North America



Intake Grate Partially Blocked by Zebra Mussels

Power Plant Water Issues

Planned Activities



- **Competitive procurement:**
 - Non-traditional sources of process and cooling water
 - Wet- and dry-cooling technology
 - Cooling water intake / outflow structures
 - Process and wastewater treatment and / or reuse
 - Advanced sensors and controls

Water Quality Trading

- EPA proposed innovative, flexible approach to water quality improvement under Clean Water Act's TMDL program
- Would allow for water quality trading between point and non-point sources within a watershed
- Proven successful through pilot programs



Water Quality Trading

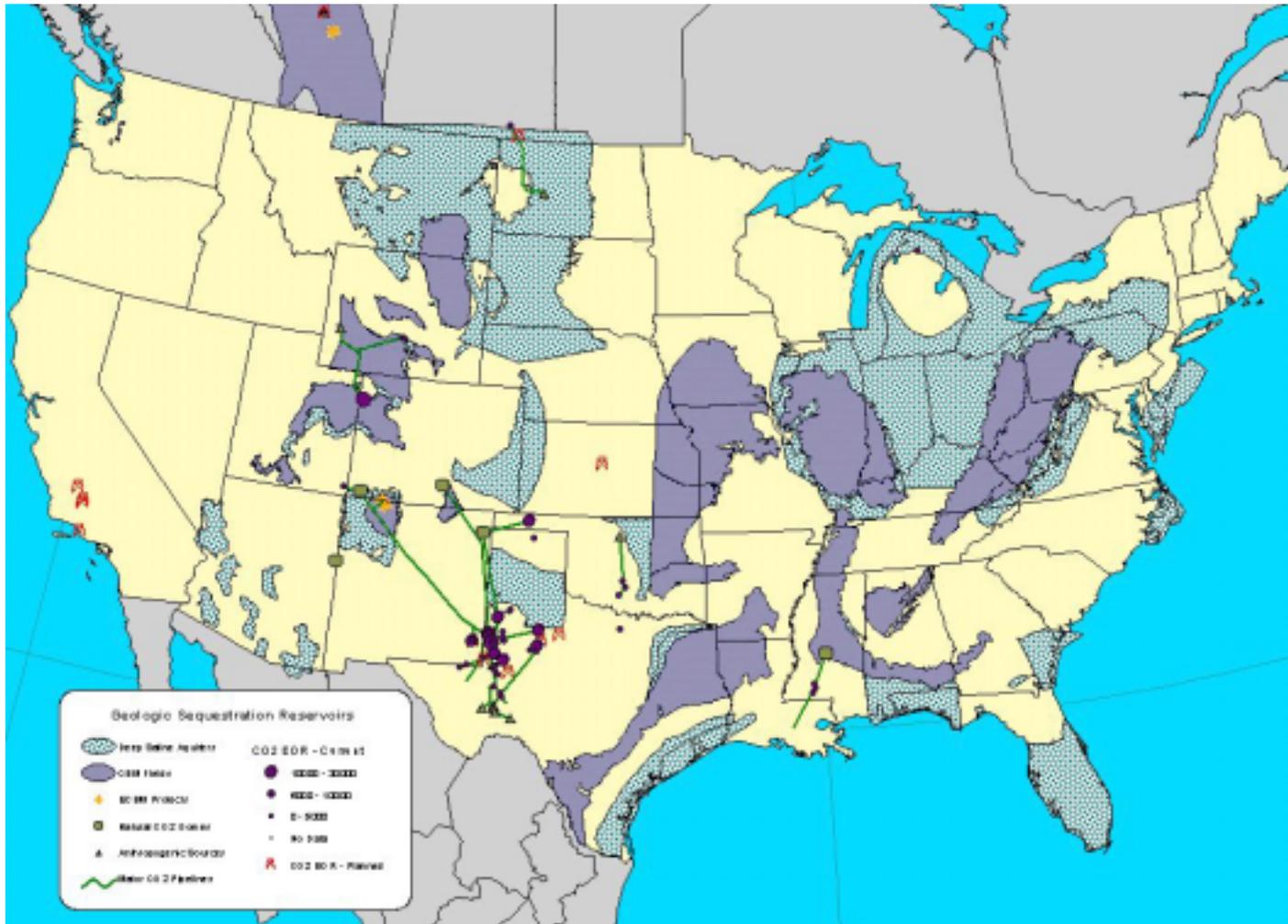
Ongoing Research



**Untreated Acid Mine Drainage in
West Virginia Stream**

- **Initiate summer 2002 pilot project in Cheat River watershed in West Virginia**
- **Partnering with EPA, electric utility and coal companies, and regional and local watershed groups**
- **Project will involve surface mine reclamation, water-quality monitoring, and carbon sequestration**

Carbon Sequestration Options



- Deep Saline Formations
- Deep Coal Seams
- Enhanced Oil Recovery Fields

Terrestrial Sequestration

Enhancing Eco-Assets

- Partnering with electric-utility industry to reclaim disturbed lands in order to:
 - Capture and store carbon
 - Improve surface and groundwater quality
 - Provide wildlife habitat
 - Increase aesthetic and economic value



Reclaimed Surface Mine

Air-Water Interface

How Might It Affect Power Plants?

- Emissions of Hg, NO_x, and SO₂ from coal-fired power plants coming under increased scrutiny
- Power plants may be required to reduce emissions to address water quality concerns



Mercury Emissions and Water

NETL's Research Activities

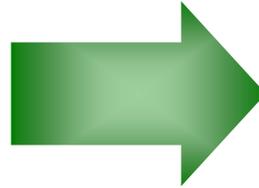
- Collaborating with TVA and EPRI to assess transport and transformation of Hg in power plant plumes
- Conducting Hg deposition sampling at Holbrook, PA, PM_{2.5} monitoring site as part of national Mercury Deposition Monitoring Program



**Hg Wet Deposition
Monitoring Station**

Mining and Watersheds

Mining Industry of the Future



Abandoned Mining Operations

Reclaimed Surface Mines

- Mining used 3,770 Mgal / day of water in 1995
- Mining can impact both ground and surface waters



*Photos: Chuck Meyers, Office of Surface Mining
"Estimated Use of Water in the United States in 1995," USGS Circular 1200, 1998*

Mining-Watershed Science & Technology

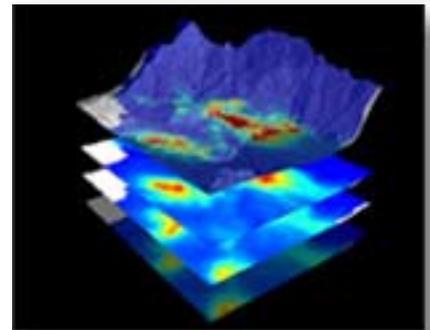
Ongoing Activities

- **Remote sensing capabilities:**
 - Thermal infrared
 - Very low frequency
 - Magnetometry
 - Terrain conductivity
- **Can be used to survey and map water pollution sources**
- **Completed airborne remote sensing to assist EPA in mapping and controlling mercury ground water pollution at Sulfur Bank Superfund site**

**NETL
Airborne
Remote
Sensing
Platform**



**Conductivity
“Stack” of
Sulfur Bank
Mercury Mine**



Mining-Watershed Science & Technology

Ongoing Activities

- More than 10,000 miles of streams in the United States affected by acid mine discharge
- Successful development and application of active and passive treatment technology to address acid mine discharge



**Active and Passive
Treatment Technology**

Coalbed Methane (CBM)

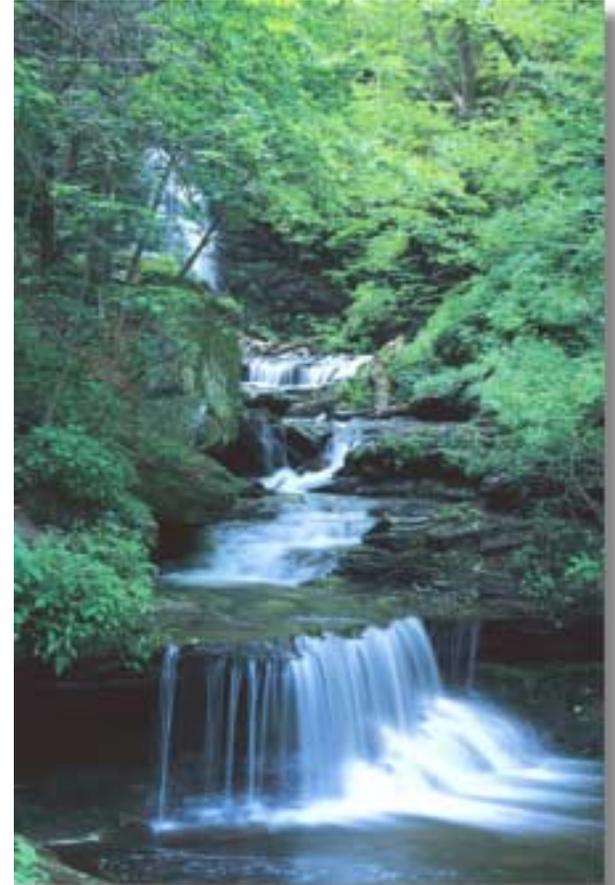
- **7.5% of total U.S. production**
- **Powder River Basin CBM**
 - 151.2 million Mcf CBM in 2000
 - 337.9 million barrels (14 billion gallons) of produced waters
- **Potential produce water issues**
 - Groundwater and drinking water contamination
 - Stream morphology alteration and sedimentation



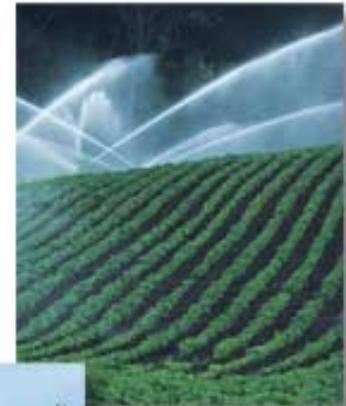
CBM Produced Waters

Ongoing Activities

- **Working collaboratively with:**
 - EPA, BLM, various state agencies
 - Operators and industry associations
 - Service companies and suppliers
 - Ranchers and farmers
 - Environmental concerns
- **Initiating R&D through March 2002 solicitation directed at:**
 - Lower cost treatment processes
 - Beneficial use of produced waters
 - Best management practices



Electric Utilities & Water: Emerging Issues and R&D Needs



*Photos lower left and right:
Chuck Meyers, Office of Surface Mining*