NATIONAL ENERGY TECHNOLOGY LABORATORY

DOE/Office of Fossil Energy's Energy & Water R&D Program

Thomas Feeley

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DOE/NETL Water-Energy R&D Activities

Power Generation

- Alternative "non-traditional" water sources
- Advanced cooling, recovery/reuse, and treatment technology
- Systems and engineering analysis

Carbon Capture & Storage

- Geological sequestration
- CO_2 capture technology
- Systems and engineering analysis

Water Availability & Quality Issues

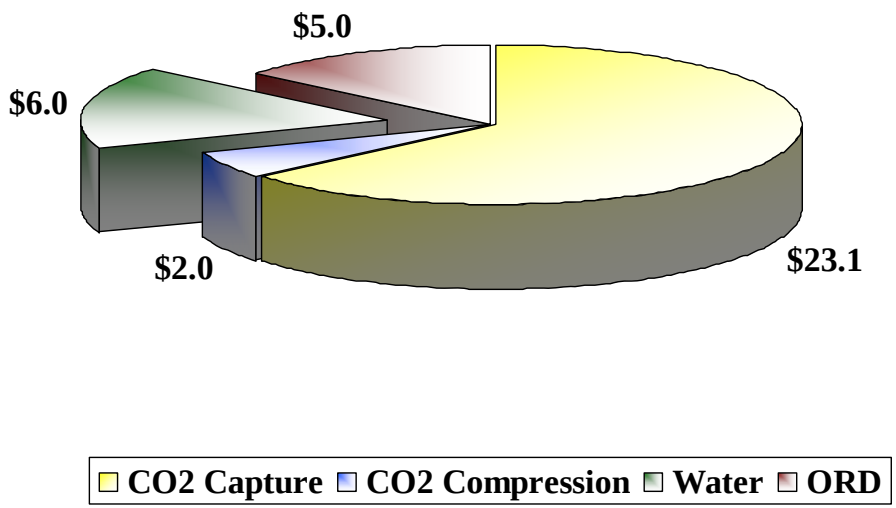
Oil & Gas Exploration

- Water management technology
- Coal bed methane and produced water
- Systems and engineering analysis

IEP Power Plant-Water R&D Program

- **Funded under Innovations for Existing Plants (IEP) Program**
- **Both inhouse and extramural R&D**
- **Research focused on:**
  - Advanced cooling
  - Water recovery & reuse
  - Non-traditional water
  - Advanced water treatment/detection
- **Supporting engineering and system analysis**

IEP Funding	
FY2008	FY2009
$36.1 M	$40 M



History

- **July 23-24, 2002 "Workshop on Electric Utilities and Water – Emerging Issues and R&D Needs," Pittsburgh, PA**

- **FY 2003 – 1st Competitive solicitation seeking advanced technologies in cooling, water recovery & reuse, non-traditional water, and detection/treatment**

- **FY 2008 – 2nd solicitation (Financial Opportunity Announcement) focused on advanced cooling, water recovery & reuse, and non-traditional water**

Three Things Power Plants Require

1) Access to transmission lines

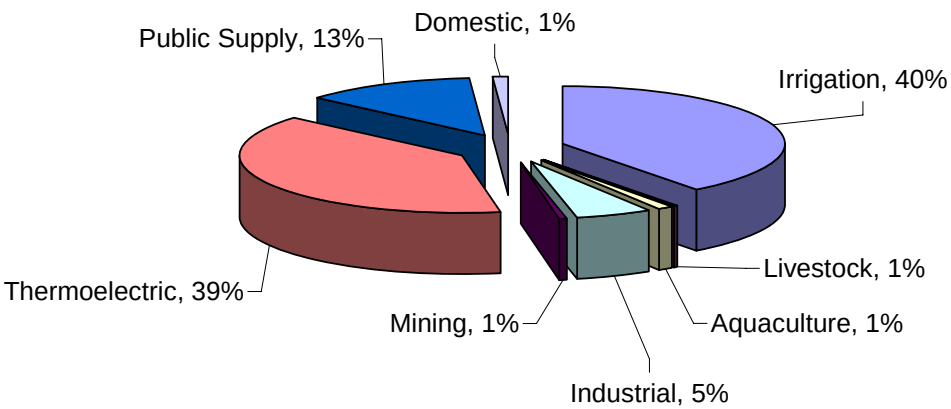
2) Available fuel, e.g., coal or natural gas

3) Water

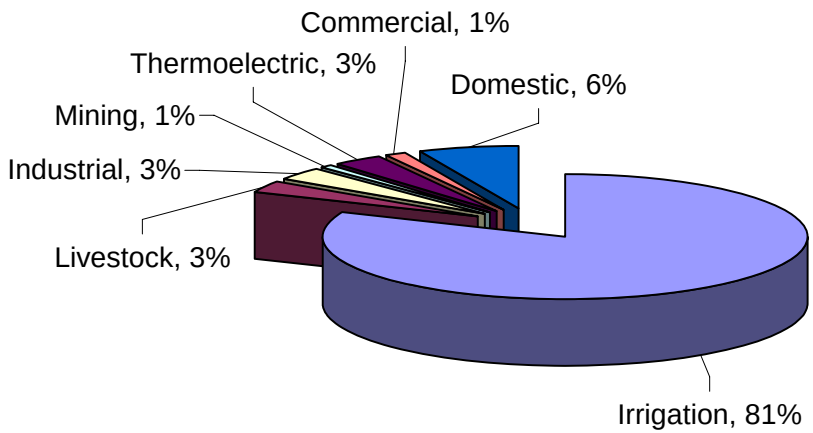
Thermoelectric Generation & Water

- **2000 thermoelectric water requirements:**
  - **Withdrawal: ~ 136 BGD**
  - **Consumption: ~ 4 BGD**

U.S. Freshwater Withdrawal (2000)



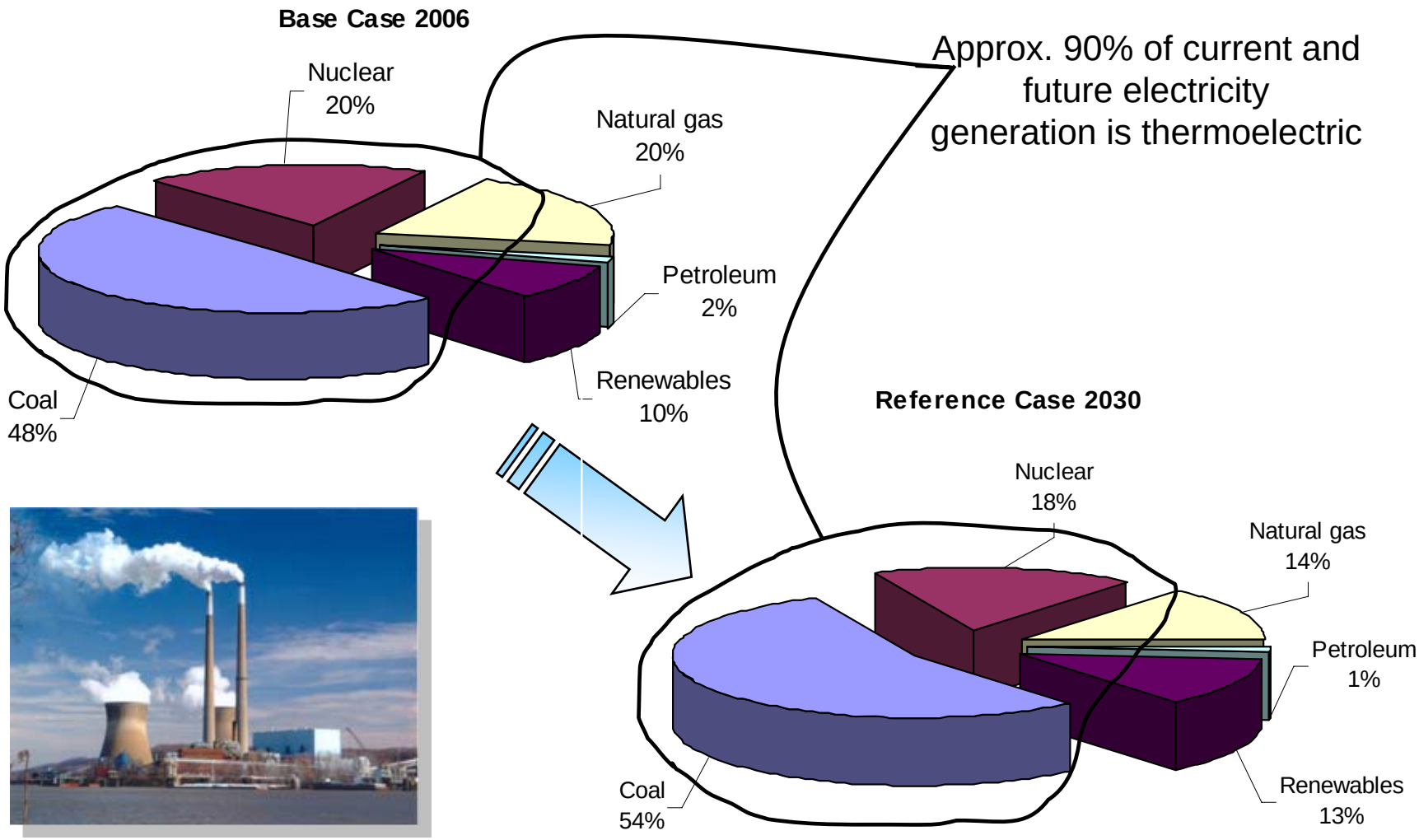
U.S. Freshwater Consumption (1995)



- **Thermoelectric power plants compete with other use sectors.**

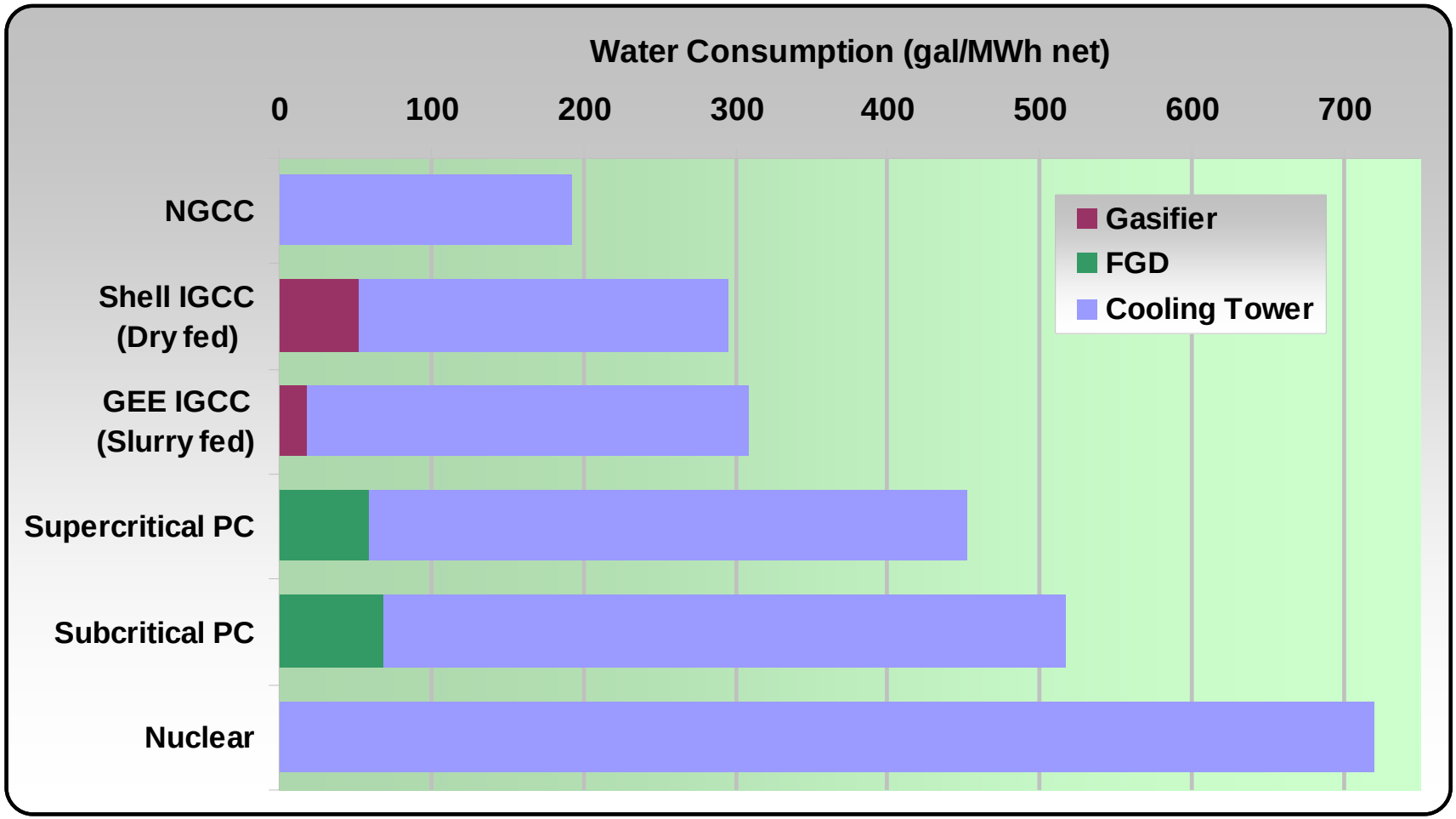
Sources: USGS, Estimated Use of Water in the United States in 2000, USGS Circular 1268, March 2004
USGS, Estimated Use of Water in the United States in 1995, USGS Circular 1200, 1998

U.S. Electricity Generation by Fuel Type



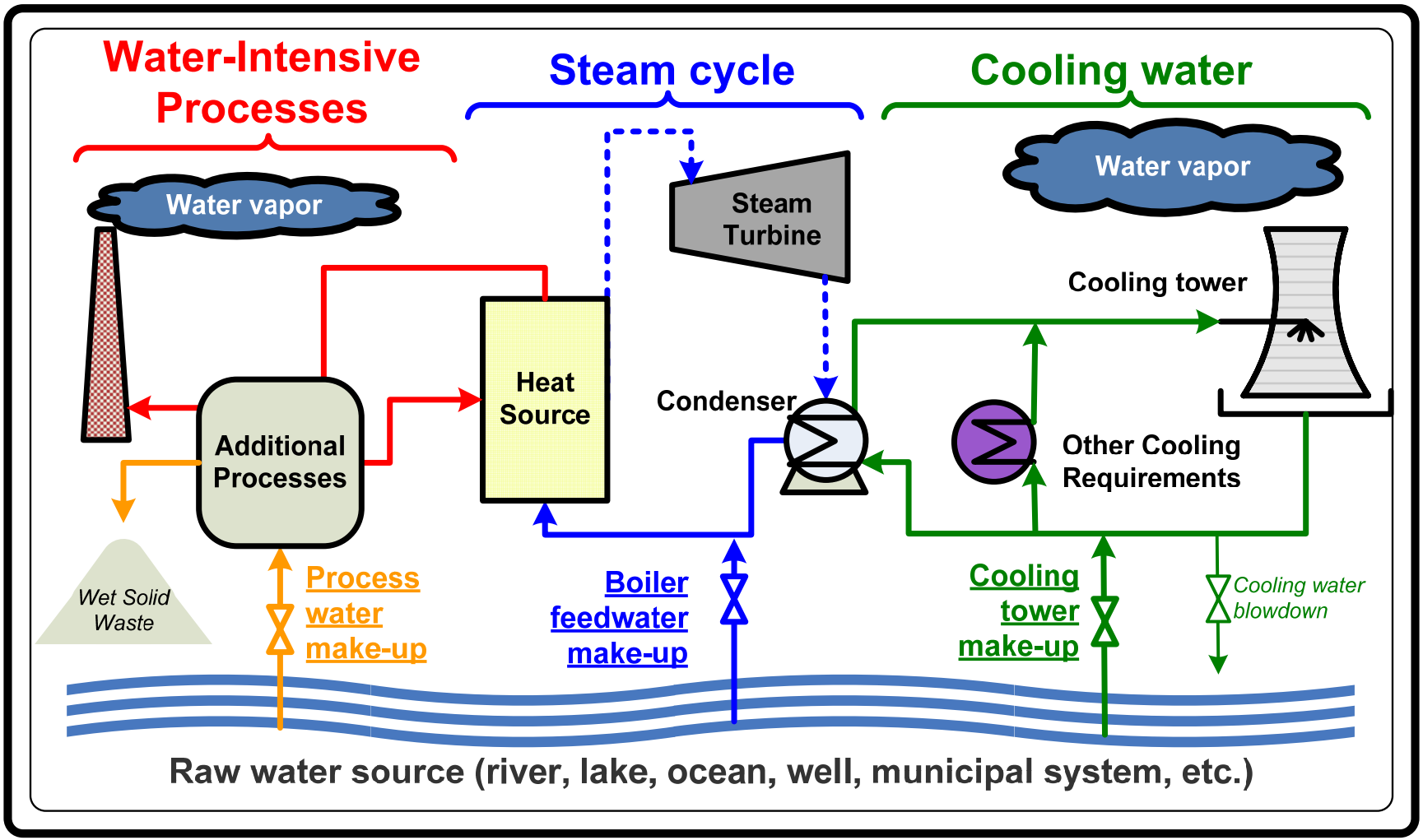
Reference: Energy Information Administration / Annual Energy Outlook 2008 (June 2008 Release)

Thermoelectric Power Plant Water Consumption



Plants equipped with wet re-circulating cooling towers

Water Flow Schematic for Power Plants



Water/Energy-Related Articles

Water is Impacting on Power Plant Siting and Operation

- **Drought Could Force Nuke-Plant Shutdowns**
  –*The Associated Press, January 2008*

- **Sinking Water and Rising Tensions**
  –*EnergyBiz Insider, December 2007*

- **Stricter Standards Apply to Coal Plant, Judge Rules; Activists Want Cooling Towers for Oak Creek**
  –*Milwaukee Journal Sentinel, November 2007*

- **Journal-Constitution Opposes Coal-Based Plant, Citing Water Shortage**
  –*The Atlanta Journal-Constitution, October 2007*

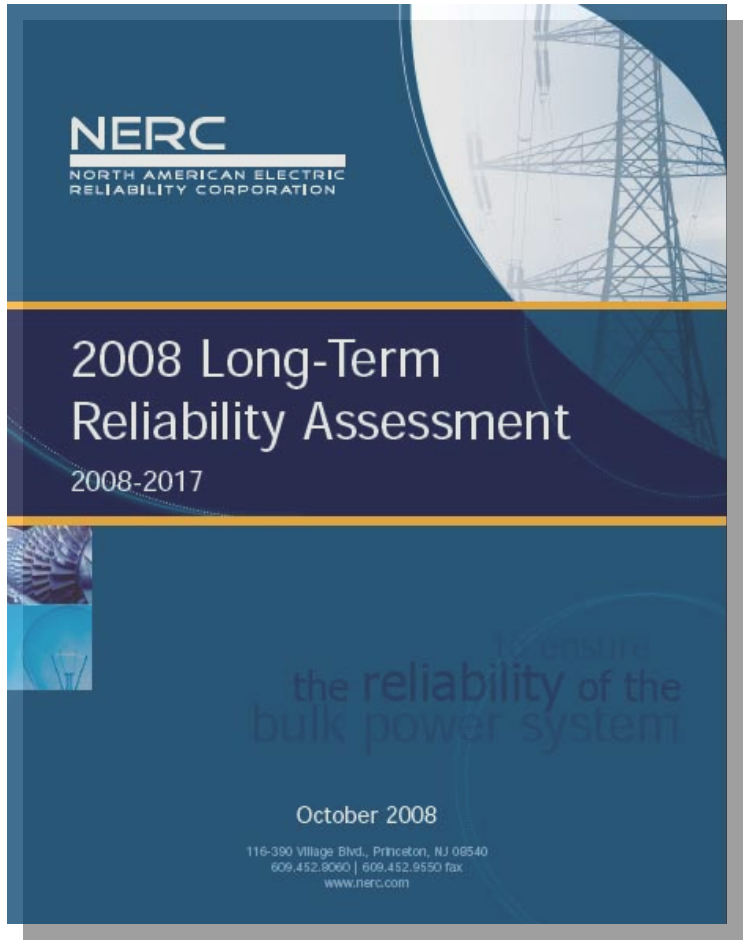
- **Maryland County Denies Cooling Water to Proposed power plant**
  –*E-Water News Weekly, October 2007*

- **Water Woes Loom as Thirsty Generators Face Climate Change**
  –*Greenwire, September 2007*

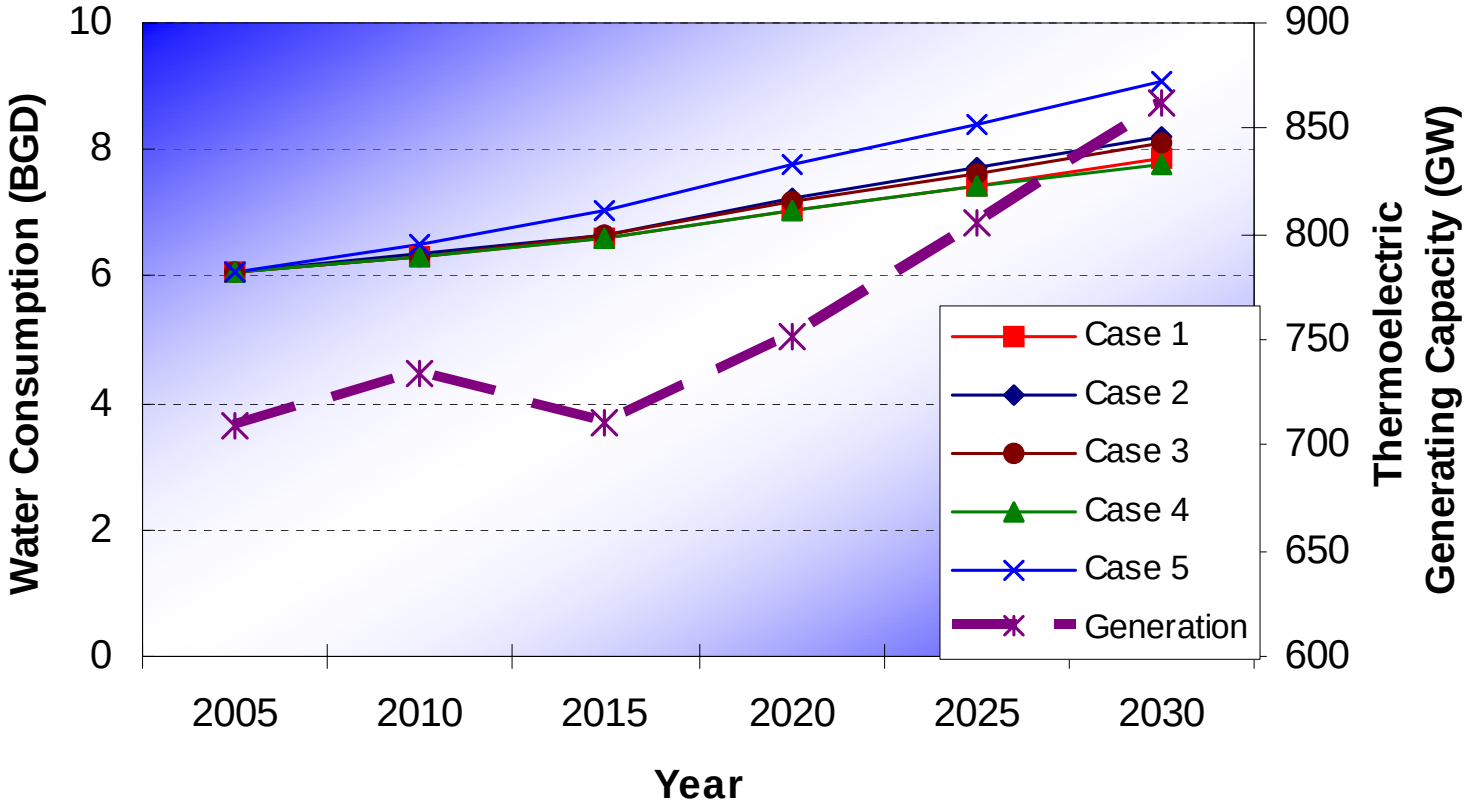
May 2006 Issue of Power Magazine

NERC 2008 Reliability Assessment

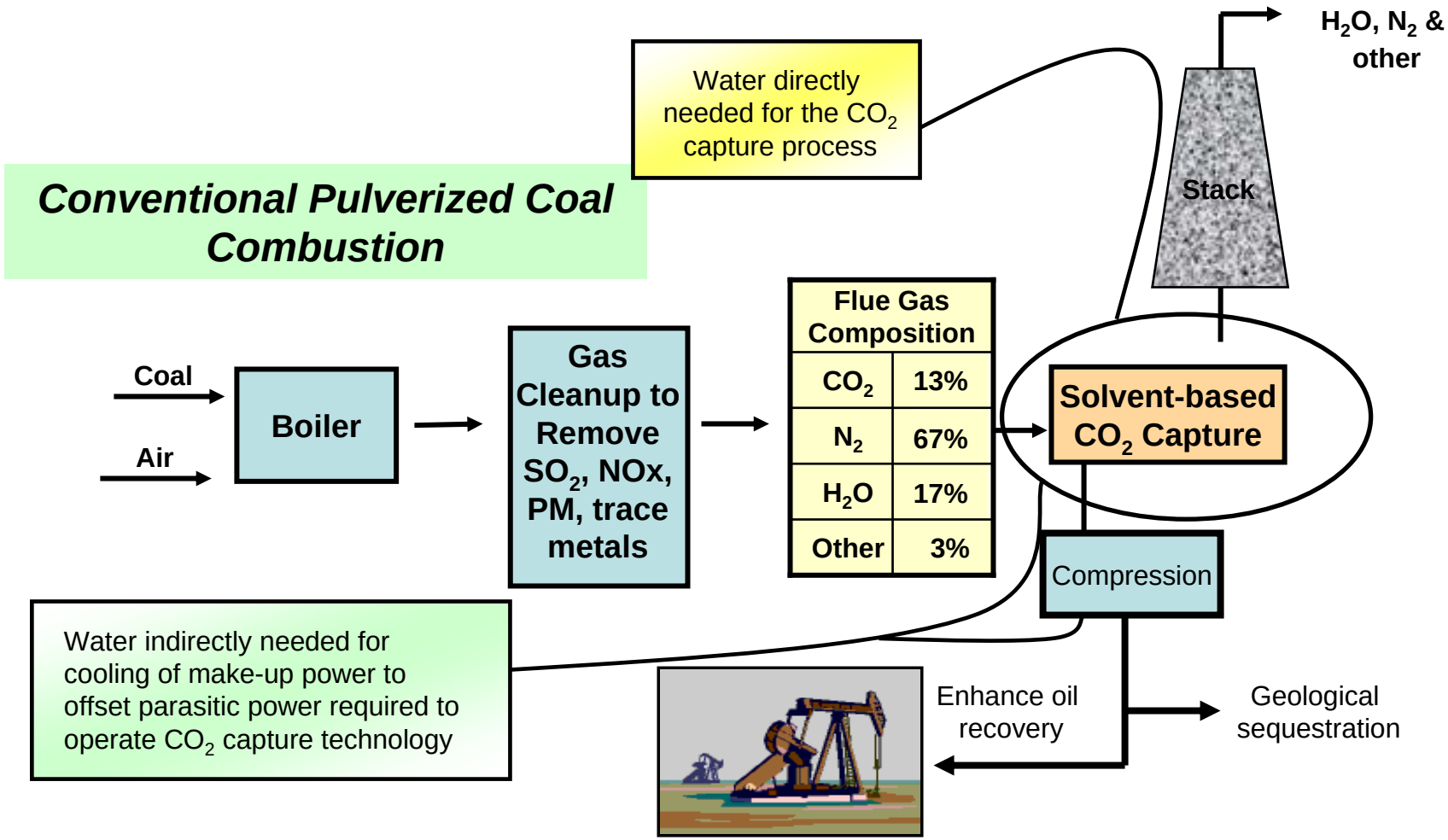
"Demand for water is increasing in North America and it is a vital resource requiring careful management. Thermal power plants require sufficient levels and quantities of water for cooling. Understanding the industry's role in water use and the implications of reduced water availability on bulk power system reliability requires careful study."



Average Daily National Freshwater Consumption for Thermoelectric Power Generation

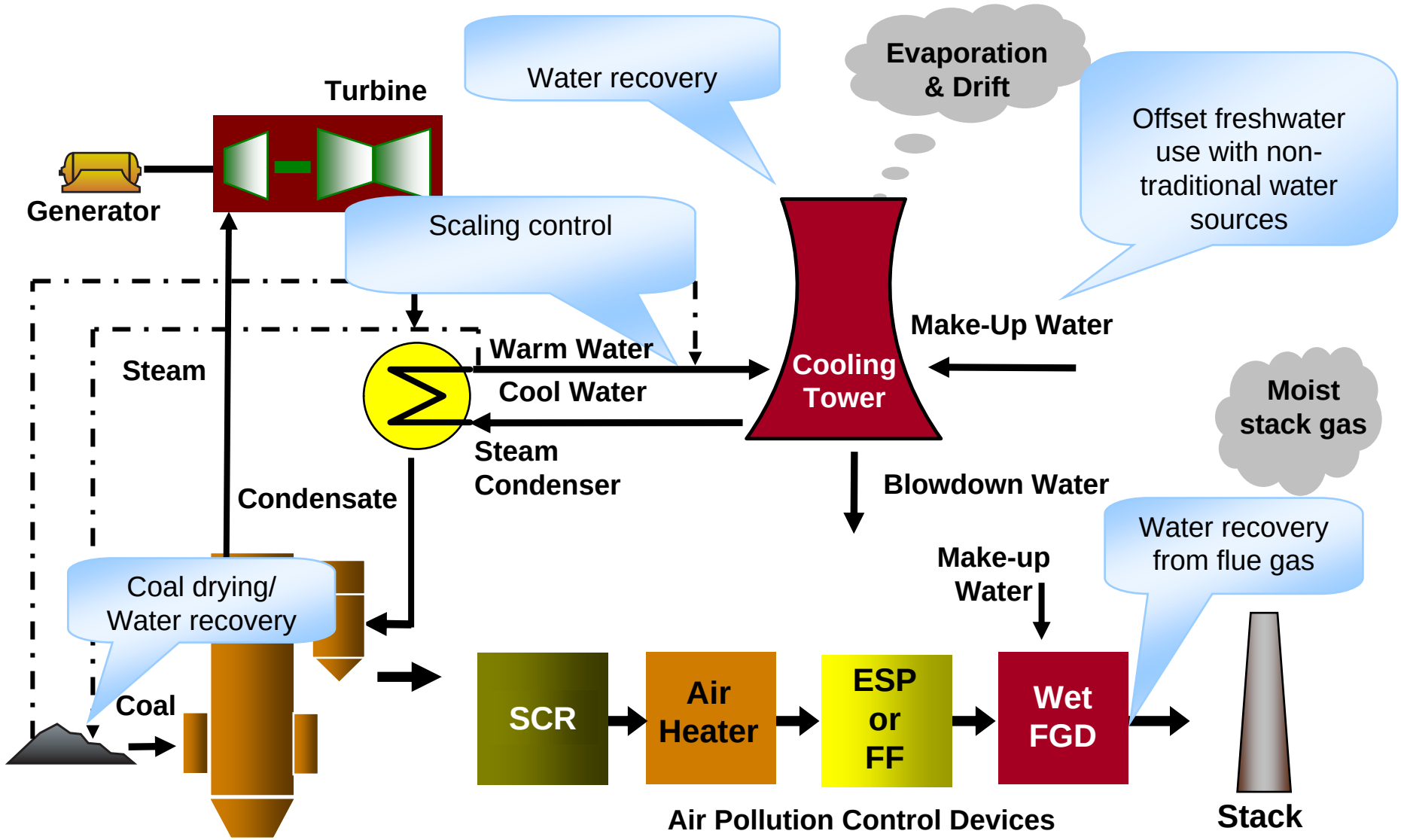


Water and CO_2 Capture



Source: NETL "2007 Pulverized Coal Oxyfuel Combustion Power Plants" August 2007 Final Report.

NETL Water Management R&D



IEP Water-Energy R&D Goals

Short-term goal

- Technologies ready for commercial demonstration by ***2015***
- Reduce freshwater withdrawal and consumption by ***50%*** or greater
- Levelized cost of less than ***$3.90*** per thousand gallons freshwater conserved

Long-term goal

- Technologies ready for commercial demonstration by ***2020***
- Reduce freshwater withdrawal and consumption by ***70%*** or greater
- Levelized cost of less than ***$2.60*** per thousand gallons freshwater conserved

Zebra Mussel Control Technology

- NETL funded New York State Museum, Cambridge Field Research Laboratory, Cambridge, New York

- Tested more than 700 soil and water samples before discovering *Pseudomonas fluorescens*, a naurally occurring bacterium

- U.S. Bureau of Reclamation tested bacteria on mussels in 2008 at hydroelectric plant on Colorado River near Laughlin, Nevada -- results said to be promising

Quagga mussels

- Bacteria to be commercially available to power industry and water treatment plants in 2009

Key Takeaways

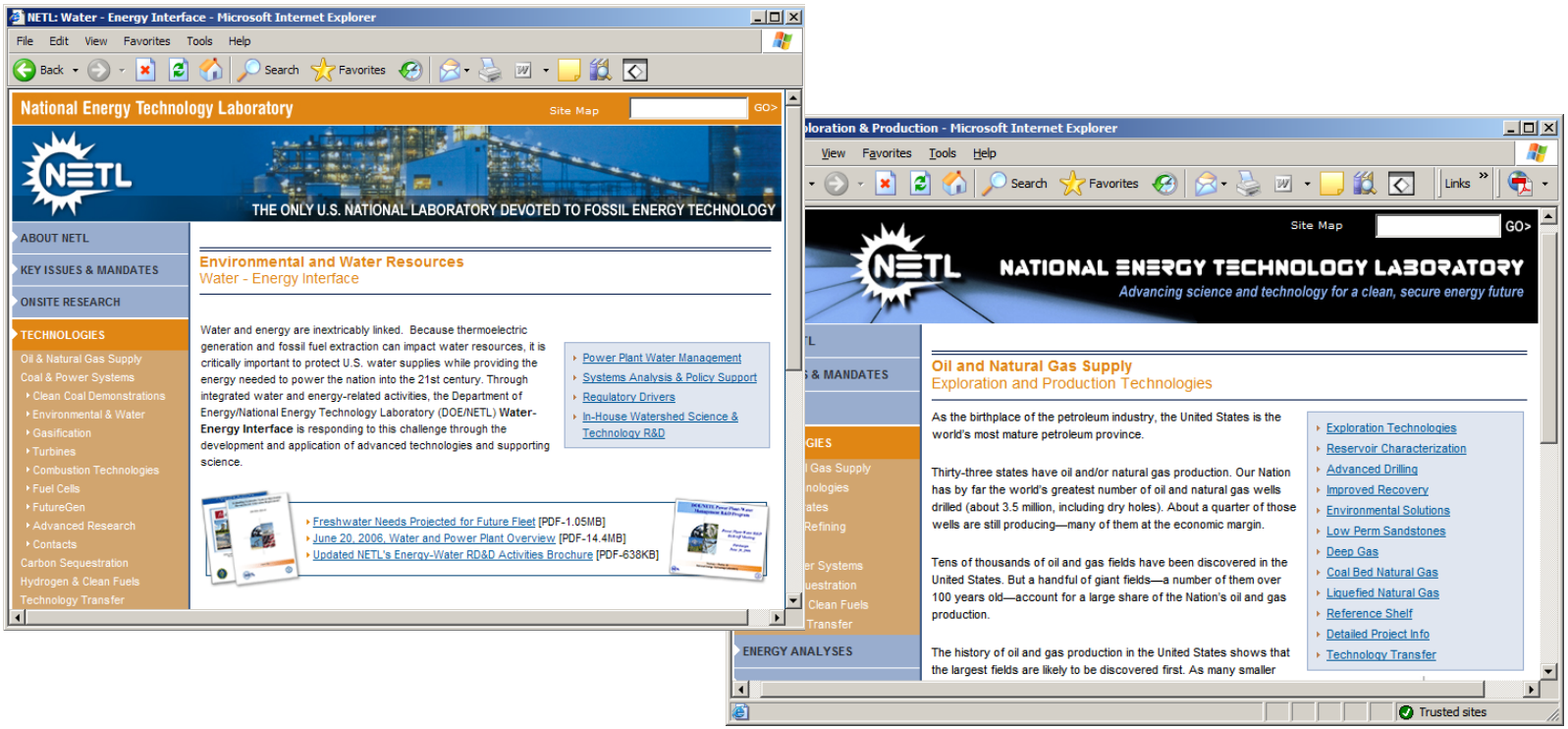
- **Water and energy interconnected**
  - Water critical to operation of existing thermoelectric power plants and siting/permitting of new plants
  - Deployment of CO_2 capture technology projected to increase thermoelectric water withdrawal and consumption

"Whiskey is for drinking; water is for fighting."

– Mark Twain

- **DOE's Office of Fossil Energy actively engaged in energy-water research and supporting systems analysis and data management; but continued RD&D needed to bring advanced water management technologies to state of commercial readiness**
- **Continued collaboration and coordination with other Federal agencies critical to success**

To Find Out More About NETL's Energy-Water R&D



http://www.netl.doe.gov/technologies/coalpower/ewr/water/index.html

http://www.netl.doe.gov/technologies/oil-gas/EP_Technologies/Environmental/Env_Science/water.html