

Framing the Critical Energy-Water Link



*13th IPEC Conference
San Antonio, TX*

*October 17-20, 2006
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National Energy Technology Laboratory



Objectives

- Provide a contemporary perspective on the energy-water relationship
- Enhance awareness
- Provide impetus for *new paradigm* when it comes to energy projects



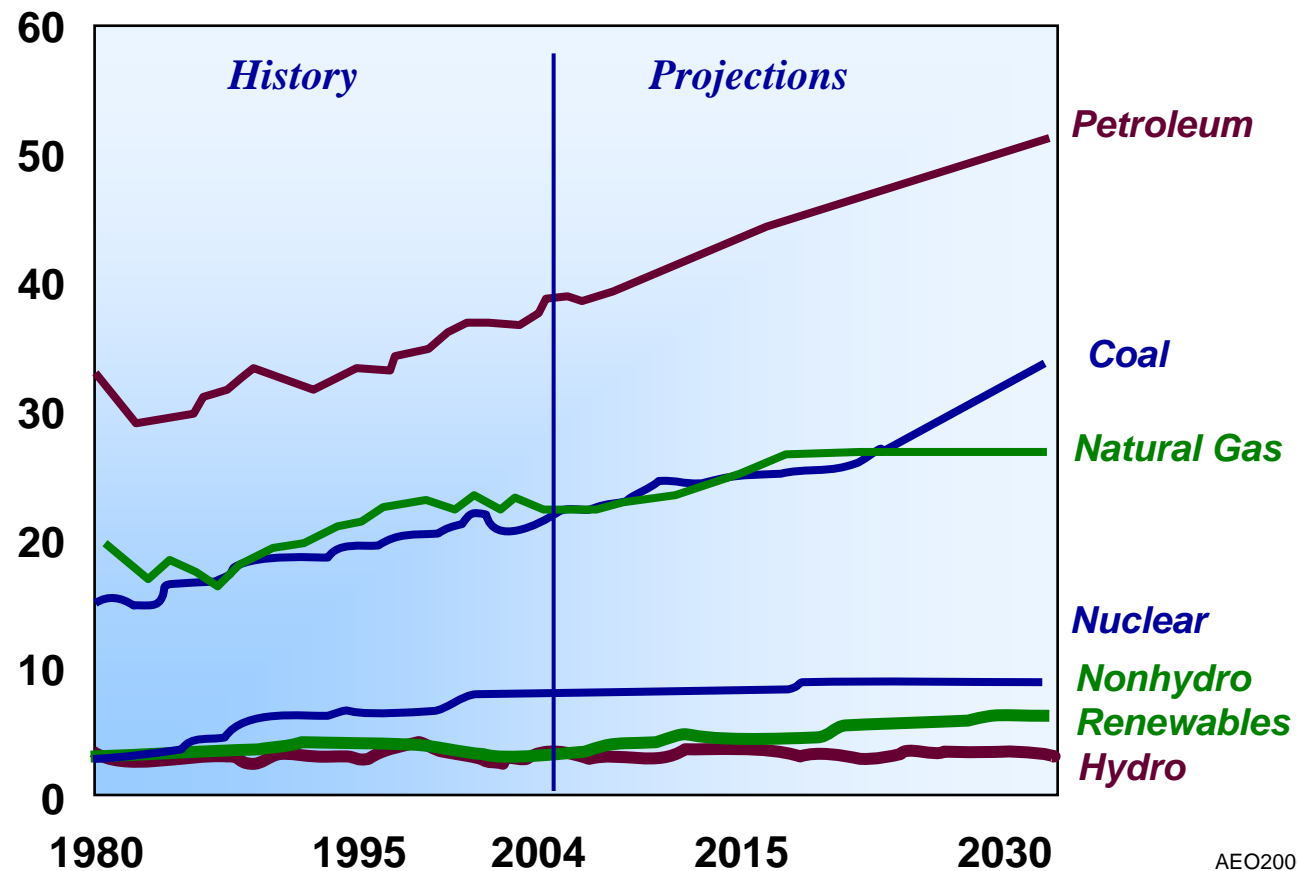
Outline

- Energy forecasts
- [Energy]-water relationships
 - Conventional
 - Emerging
 - “*On the peripheral*”
- Time for a *new* paradigm?



U.S. Energy Demand to Increase Water Requirements to “Track Btu’s” ?

*Energy Consumption by Fuel, 1980-2030
(quadrillion Btu)*

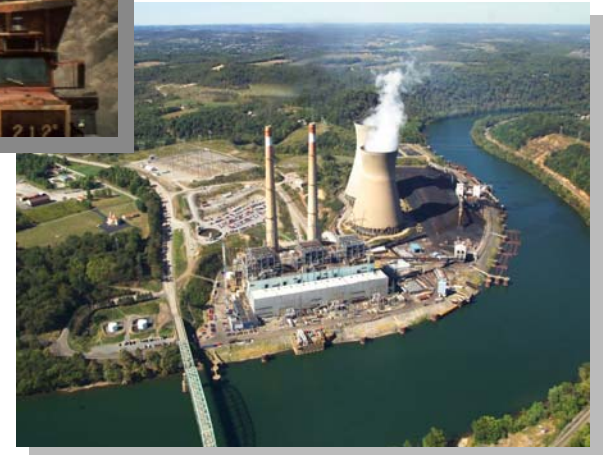
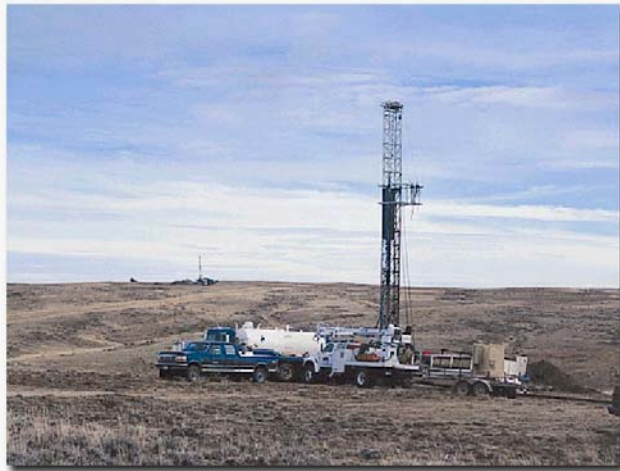


AEO2006



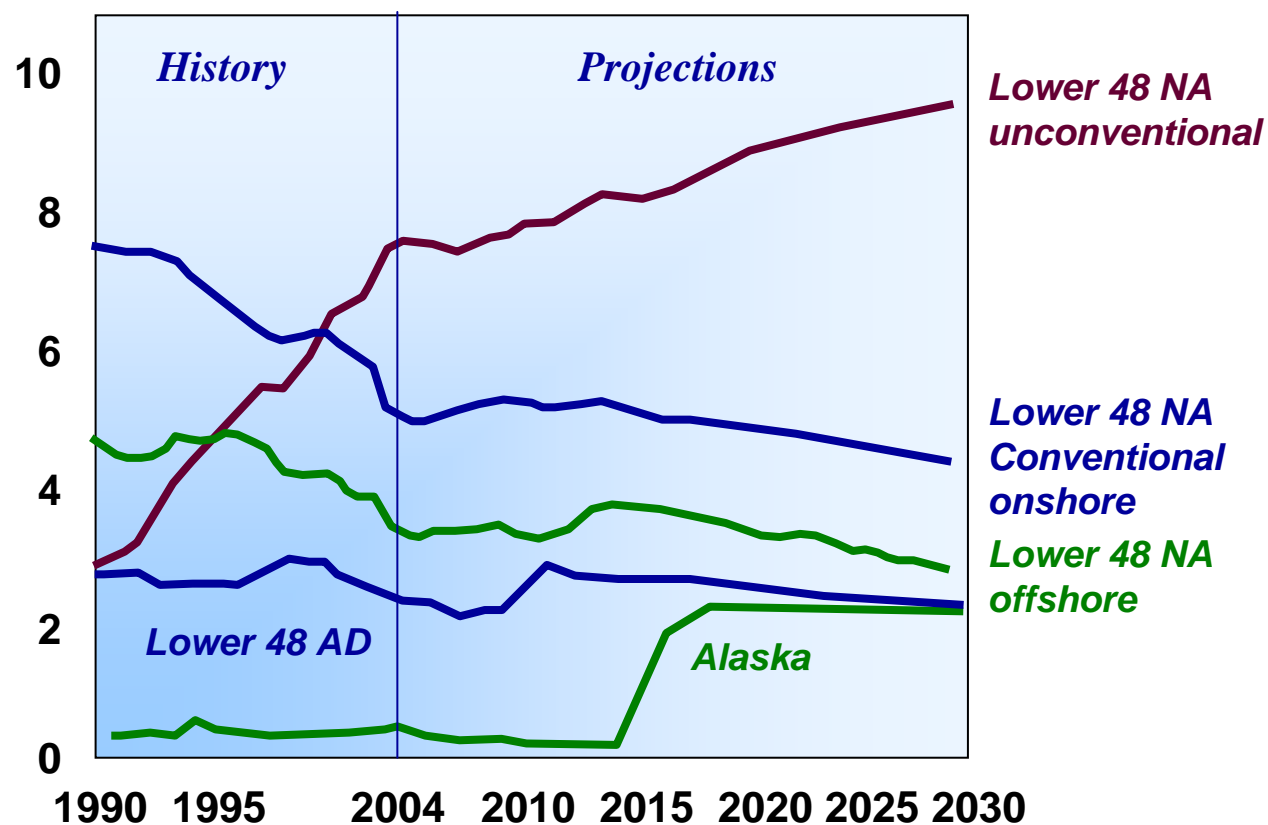
Energy and Water

A “Cradle to Grave” Relationship



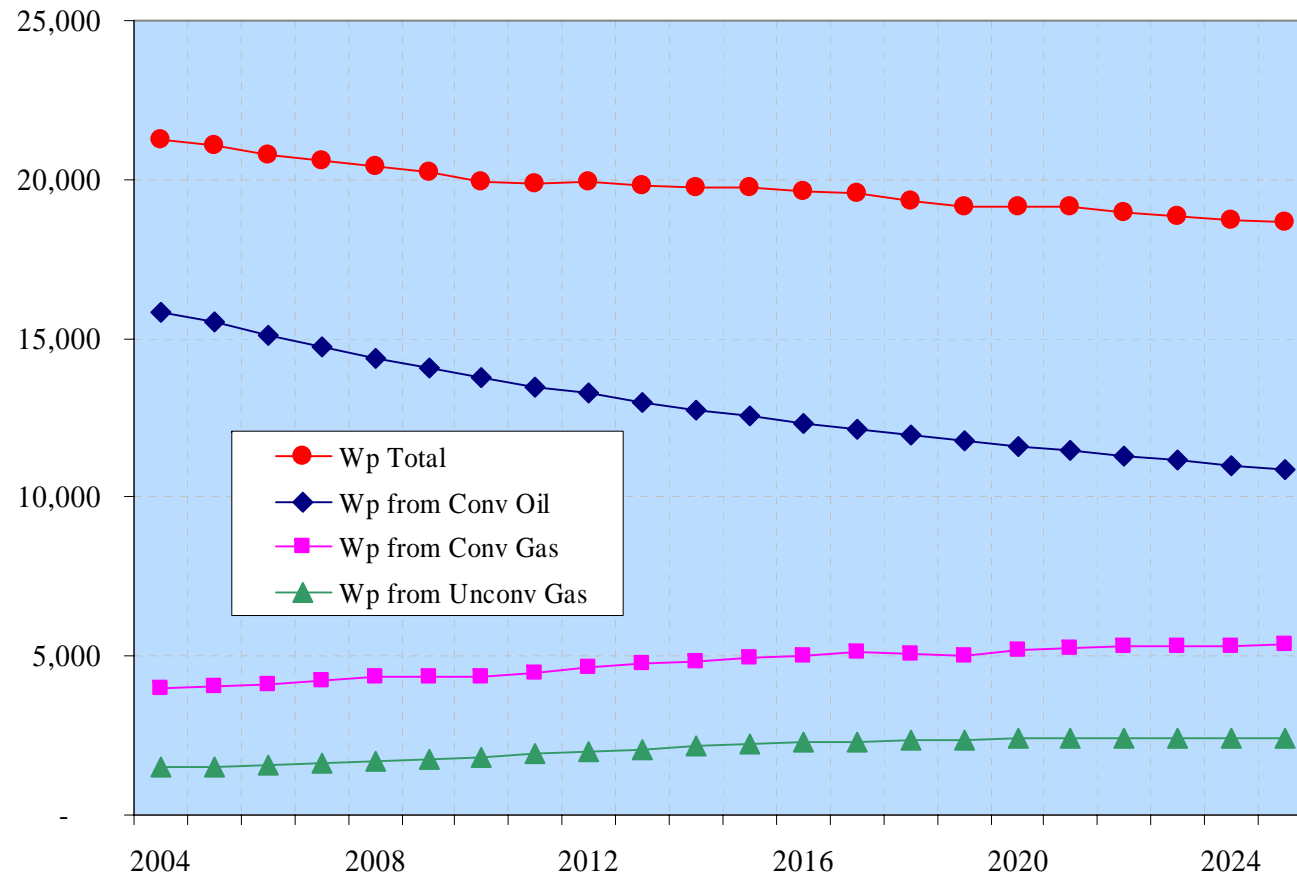
Domestic Supply Trends to Continue Increasing Reliance on UGR

*Natural gas production by source,
1980-2030 (trillion cubic feet)*

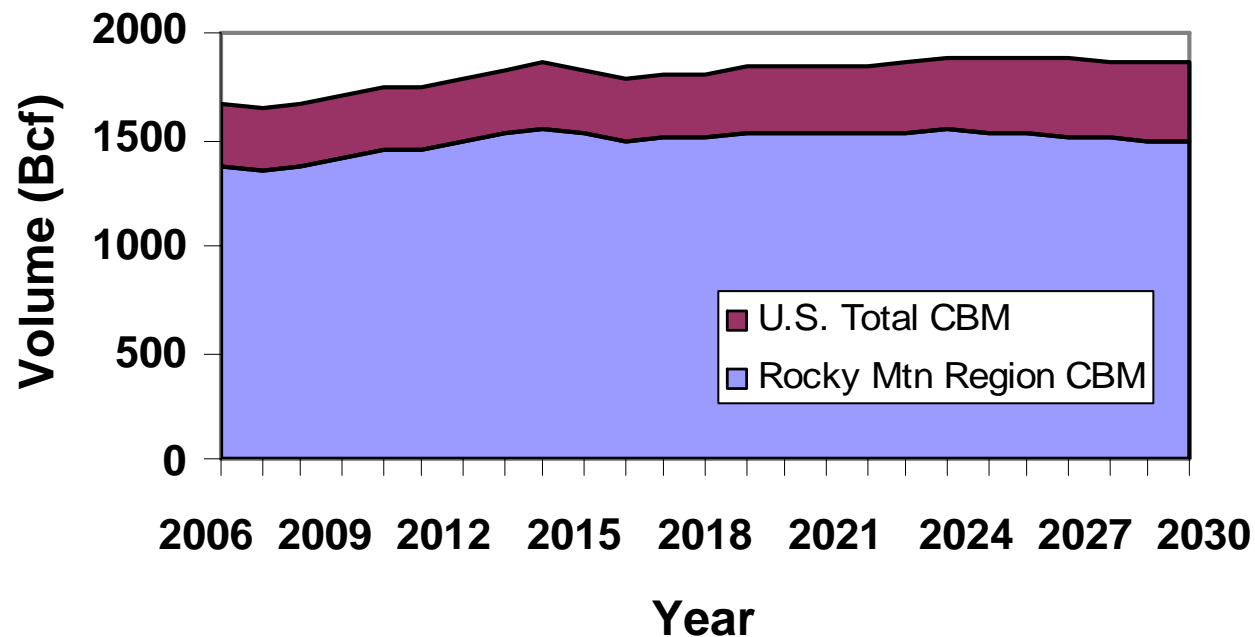


W_p (total) Volume Declines But Remains Significant

Produced Water Forecast (MMbbls) by AEO Resource Type
Lower 48 Onshore

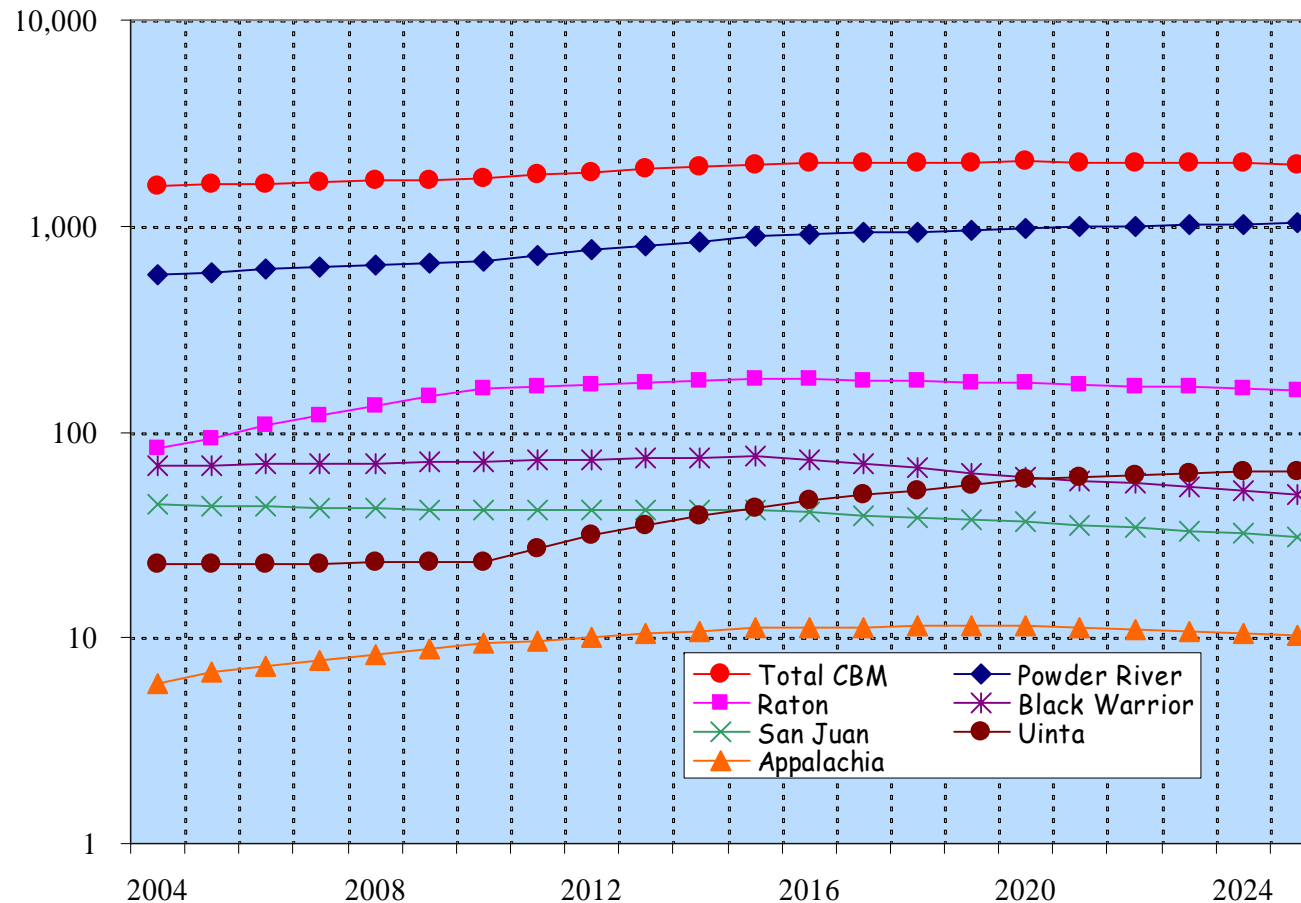


CBM Production Increases to Nearly 2 Tcf/yr Rocky Mtn. Basins/Plays Remain Dominant



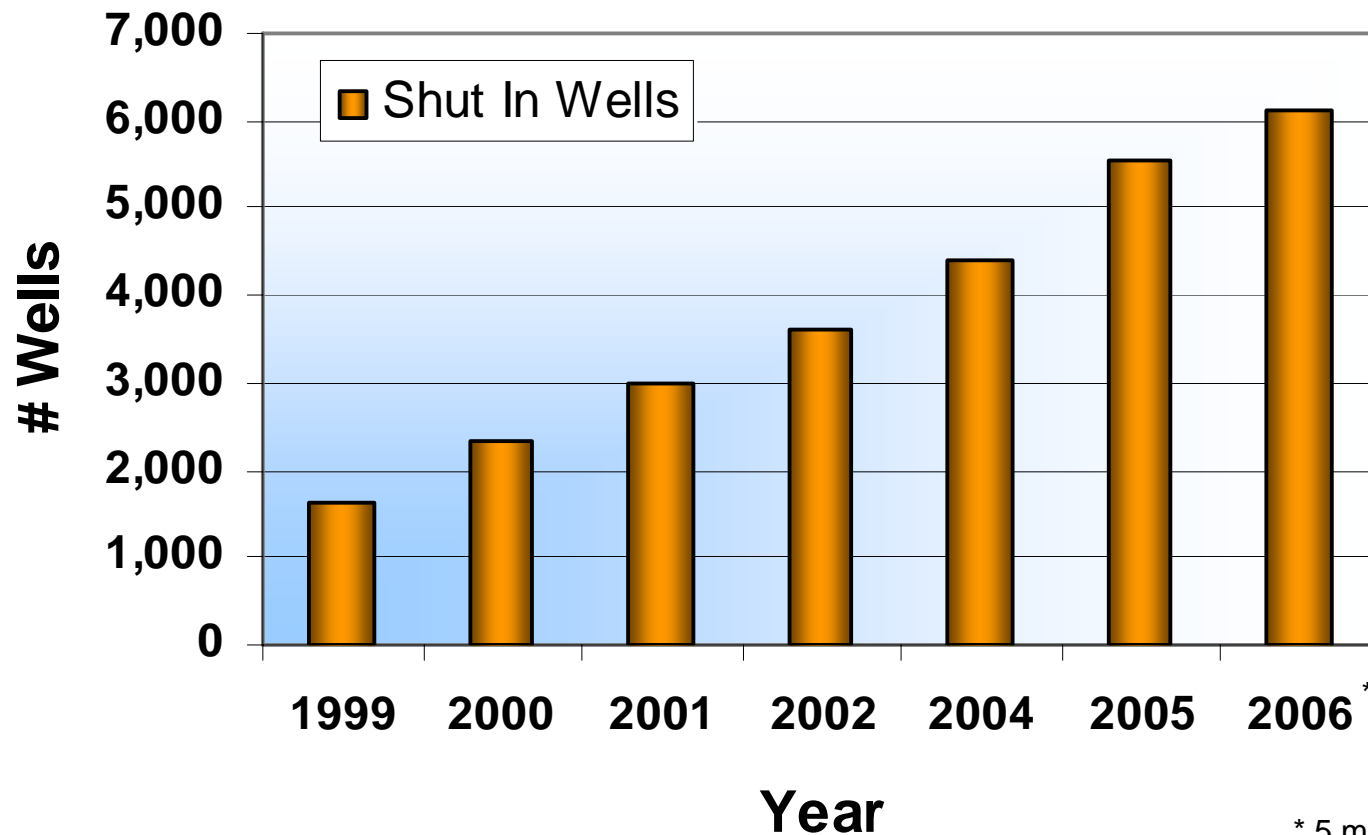
Expect a Commensurate Increase in W_p Volumes Water Management *Key* for Rocky Mountain Region

Produced Water Forecast (MMbbls) by UnConv CBM Gas Play



W_p Management Issues ARE of Consequence! Powder River Basin CBM

Average number of shut-in coalbed methane wells



“ W_p Impacts” on Energy are Far-Reaching “Translation”...


- **3000 wells**
- **60 Mcf/d**
- **365 day/yr**
- **\$4/Mcf**
- **~ \$263 million/yr (gross)**
 - Royalties
 - Taxes
 - Reinvestment capital
 - ...etc.



...Far-Reaching – “Touching Consumers?”

An Implication?...You Be the Judge

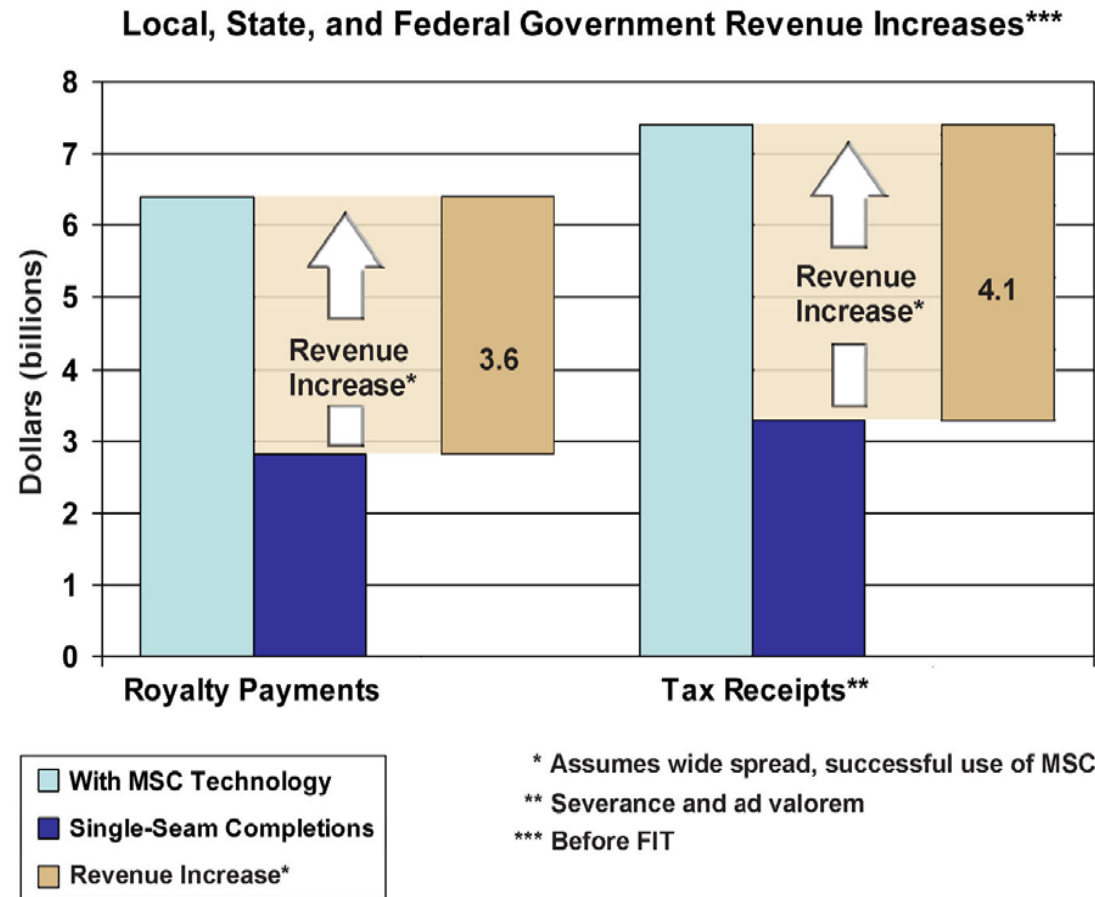
Credits And Charges Since Your Last Bill	
Balance from last bill	
Payment on Aug 18, 2006 - Thank You	
Balance	
Current Charges	
Residential Service Rate	
Monthly Service Charge	
Gas Usage Charge	
XXXXXX \$16.0080	
Municipal Surcharge	
Excise Tax	
Total Current Charges	
Total Account Balance	



\$16.0080



Technology Advances Can Yield Sign. Benefits Water Management Requires \geq Attention

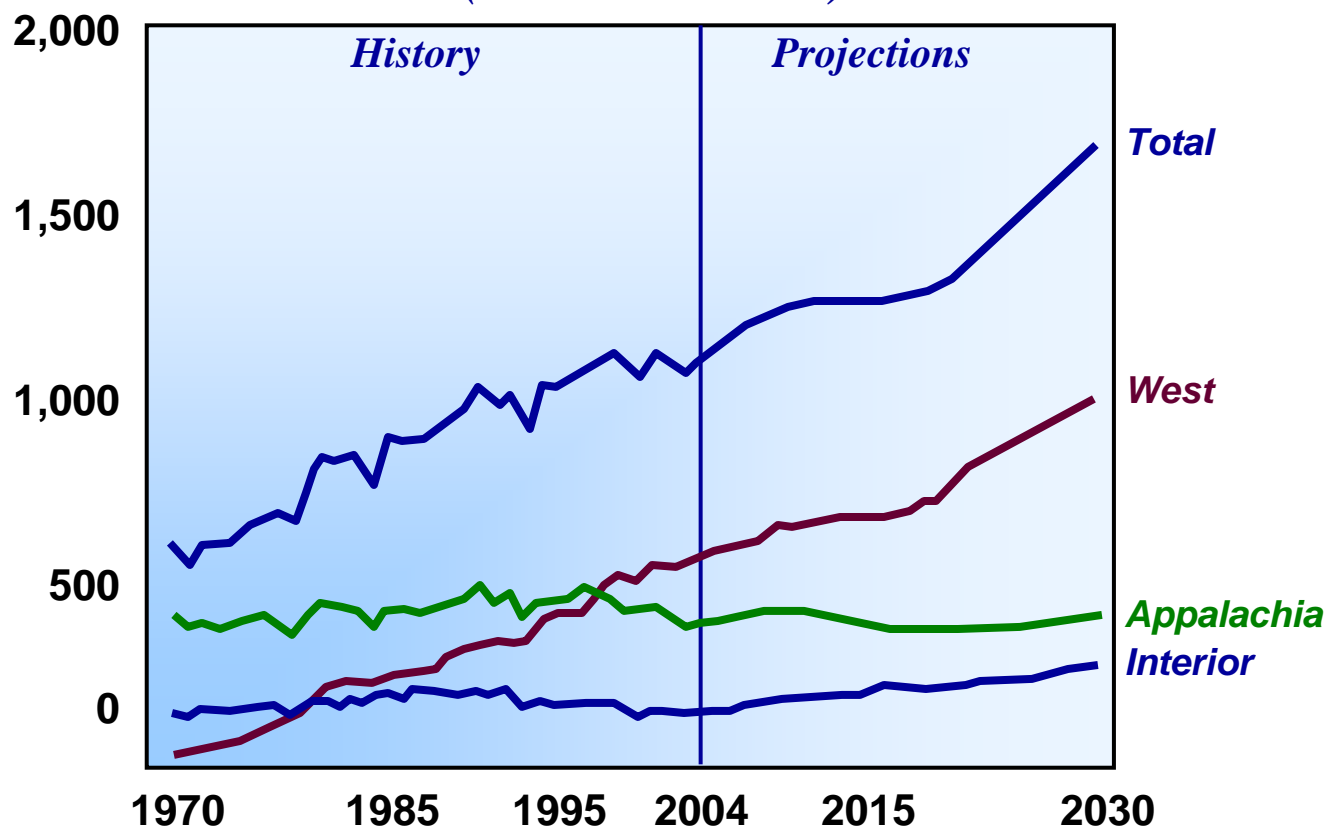


Potential Economic Benefits Associated with MSC



Coal Continues to Fuel the Nation

*Coal Production by Region, 1970-2030
(million short tons)*



Coal Mining/Coal Prep



Underground Operations

Water Affects Working Conditions/Safety



Legacy Operations Encumber Today's Industry

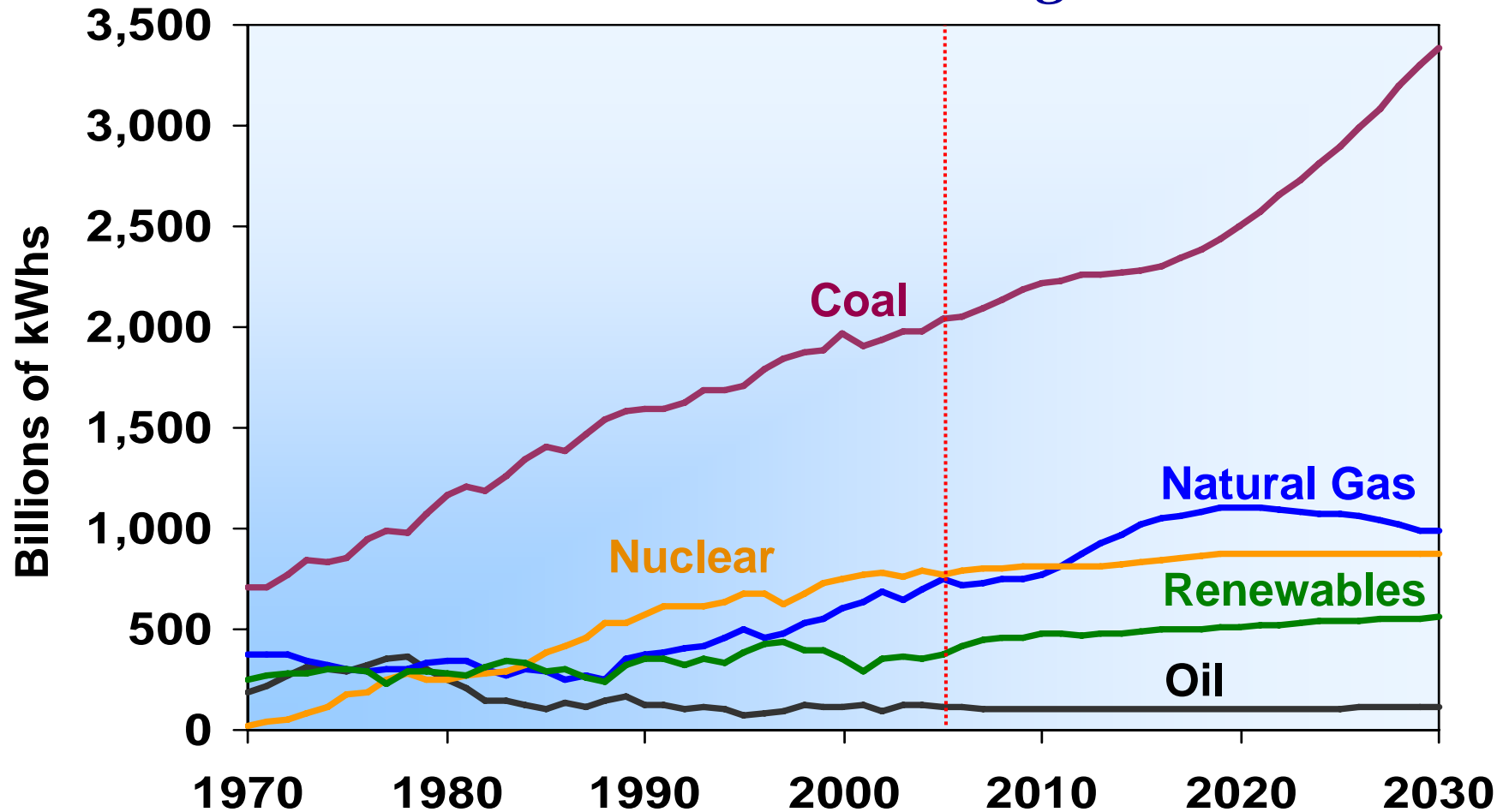


Current Practices are Environmentally *Aligned*



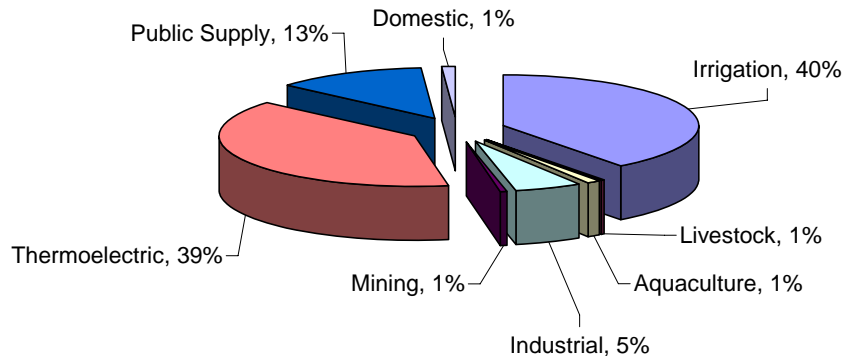
Electricity Demand Forecast to 2030

Coal Remains *King*



The Issues: Competing Water Uses

U.S. Freshwater Withdrawal (2000)

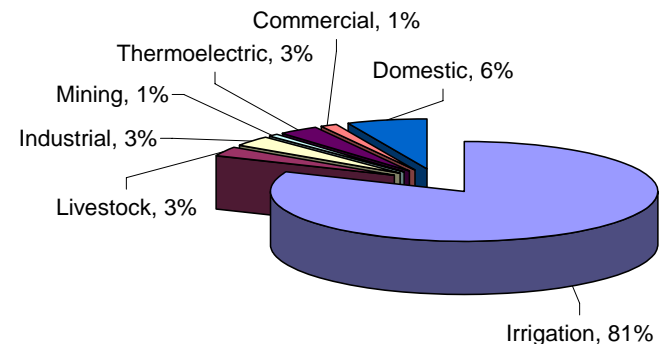


- **2000 thermoelectric water requirements:**

- **Withdrawal: ~ 136 BGD**
- **Consumption: ~ 3 BGD**

- **Thermoelectric competes with other users, including in-stream use.**
- **Which is more important: drinking and personal use, growing food, or energy production?**

U.S. Freshwater Consumption (1995)

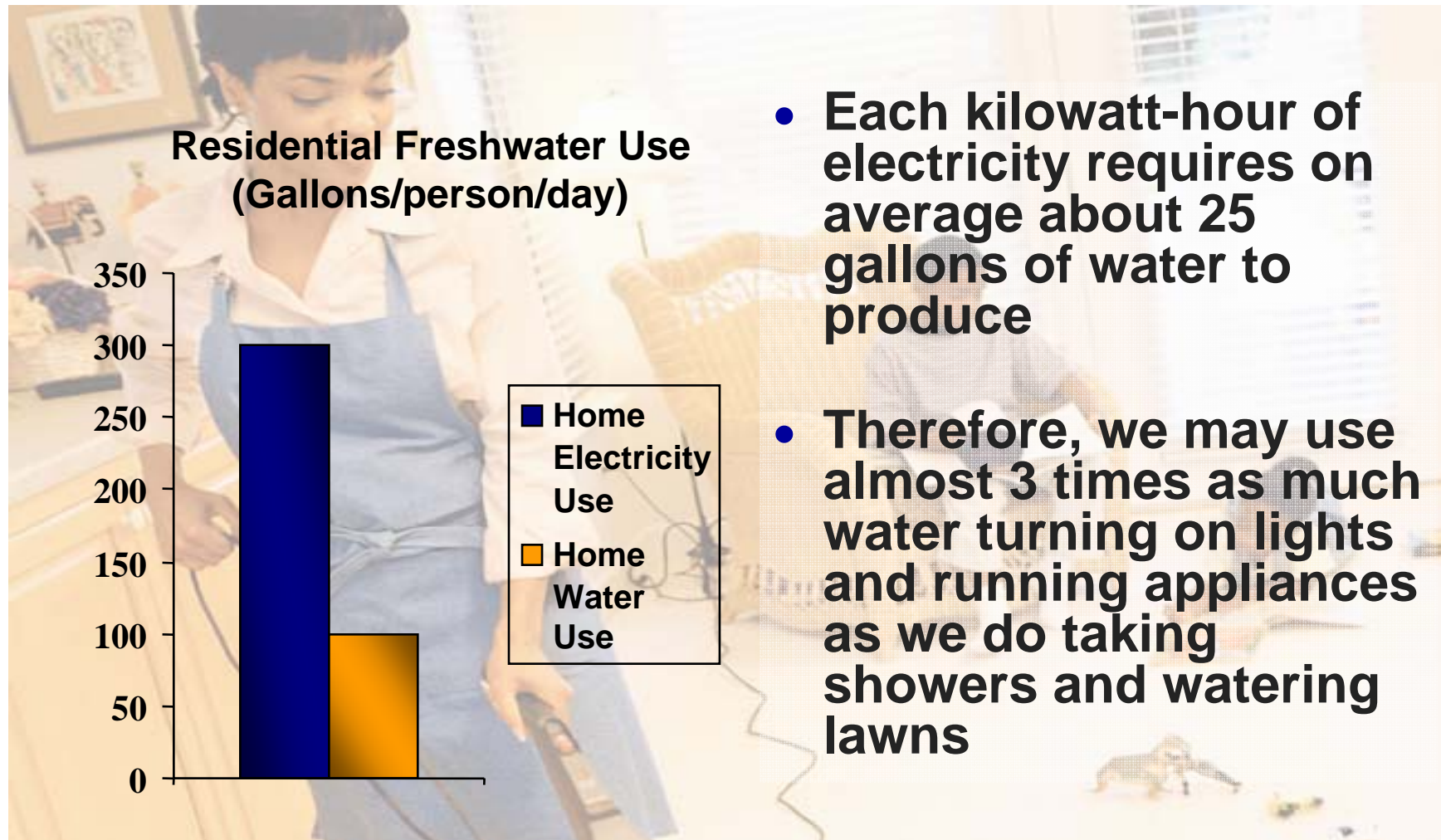


USGS, *Estimated Use of Water in the United States in 2000*, USGS Circular 1268, March 2004

USGS, *Estimated Use of Water in the United States in 1995*, USGS Circular 1200, 1998



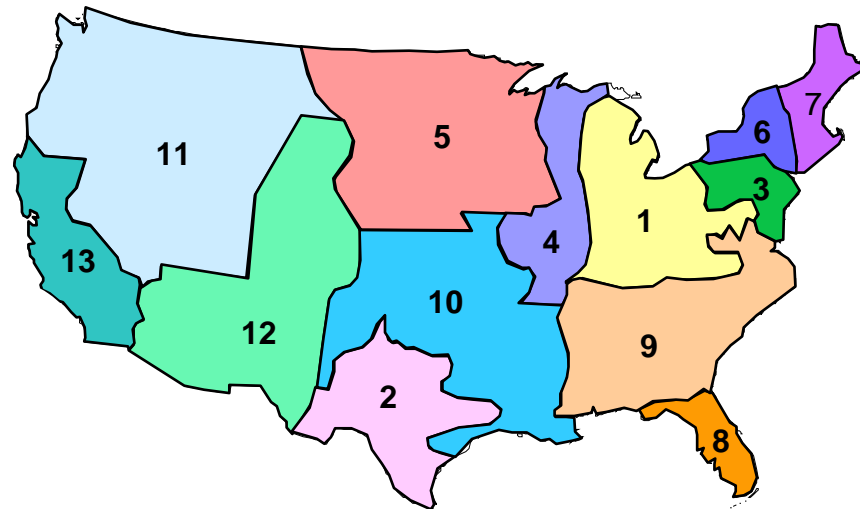
Water and Electricity Are Inextricably Linked



- Each kilowatt-hour of electricity requires on average about 25 gallons of water to produce
- Therefore, we may use almost 3 times as much water turning on lights and running appliances as we do taking showers and watering lawns

Thermoelectric Power Plant Water Reqmnt's NERC Sub-Regions

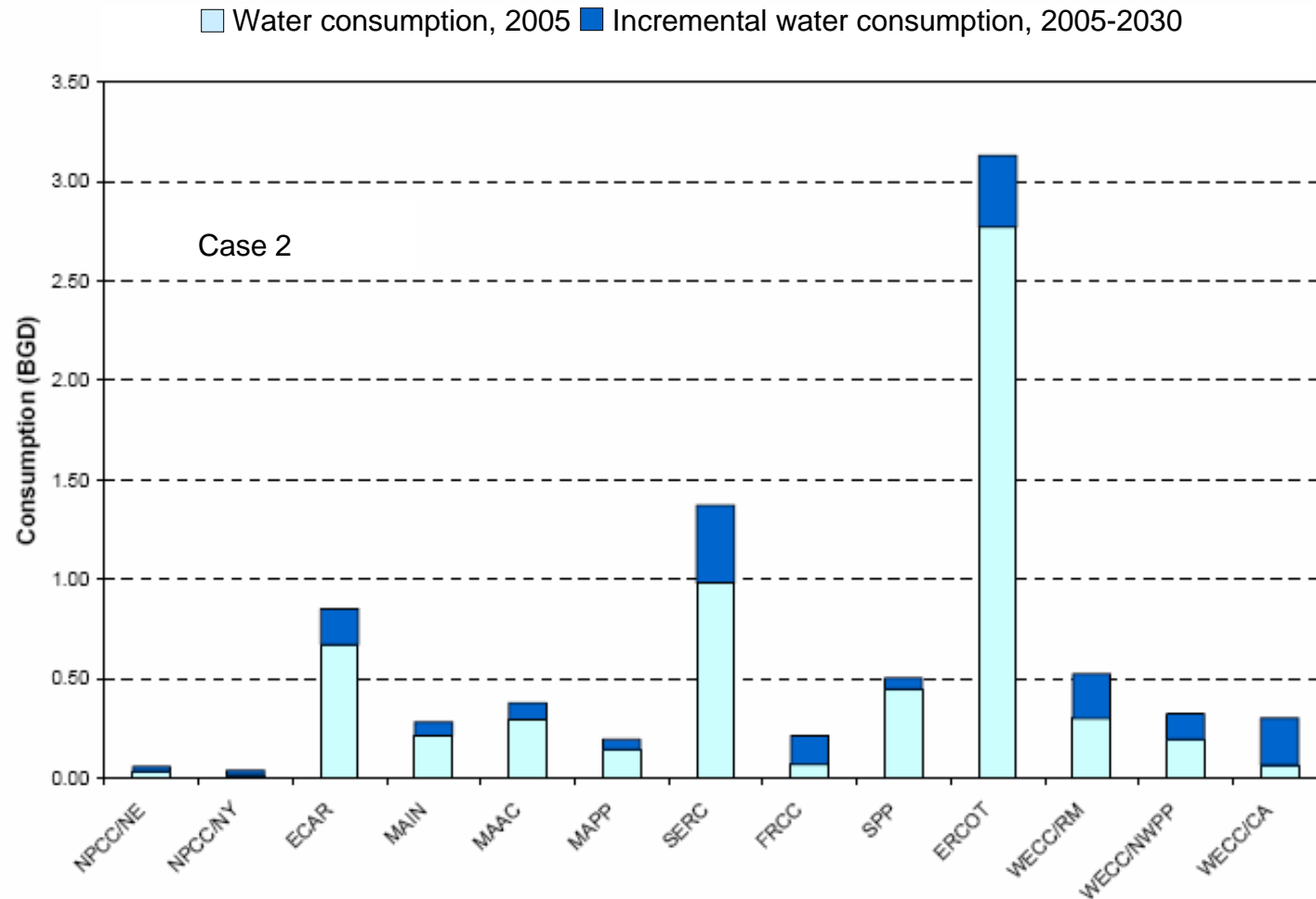
Region Number	Abbreviation	Region
1	ECAR	East Central Area Reliability Coordination Agreement
2	ERCOT	Electric Reliability Council of Texas
3	MAAC	Mid-Atlantic Area Council
4	MAIN	Mid-America Interconnected Network
5	MAPP	Mid-Continent Area Power Pool
6	NPCC/NY	Northeast Power Coordinating Council / New York
7	NPCC/NE	Northeast Power Coordinating Council / New England
8	FRCC	Florida Reliability Coordinating Council
9	SERC	Southeastern Electric Reliability Council



10	SPP	Southwest Power Pool
11	WECC / NWCC	Western Electricity Coordinating Council/Northwest Power Pool
12	WECC/RM	Western Electricity Coordinating Council / Rocky Mountains, AZ, NM, southern NV
13	WECC/CA	Western Electricity Coordinating Council / California



Water Consumption Varies by Region But Increases in Every Region



Recent Articles on Water-Related Impacts on Power Plant Siting and Operation

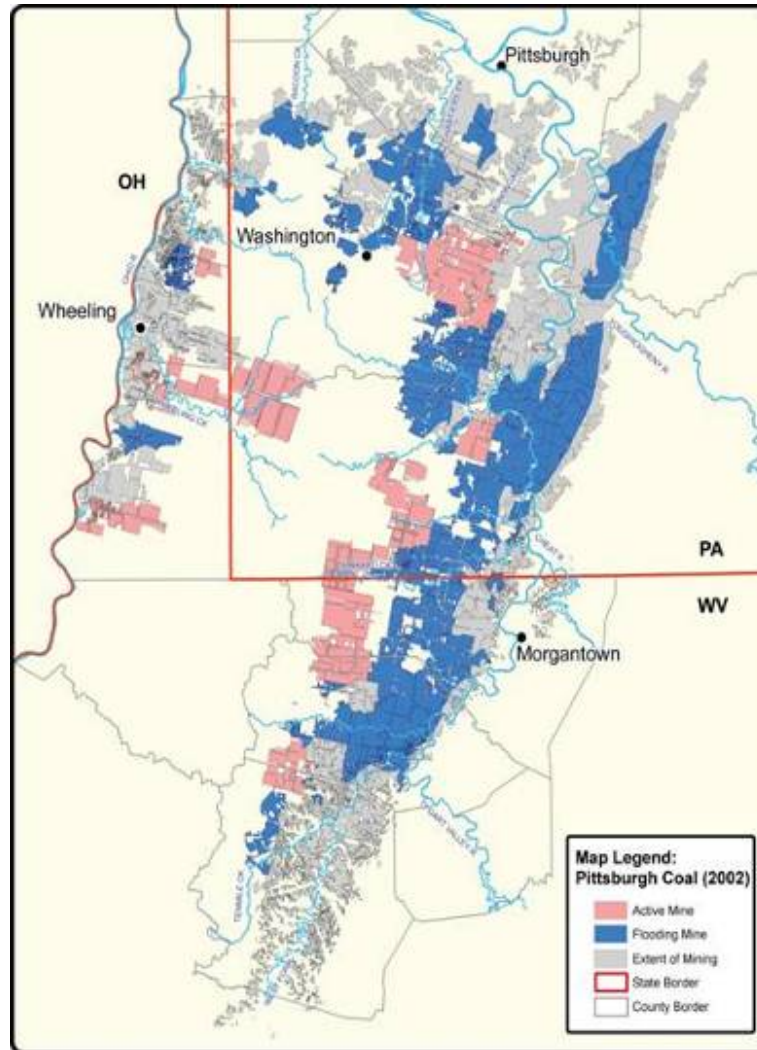
- **Idaho May Adopt Moratorium on Coal Power Due to Water Issues**
 - Reuters, March 2006
- **Sempra Energy Halts Gerlach Project Study**
 - Associated Press, March 2006
- **Desert Rock Water Agreement Passes Navajo National Committee**
 - The Daily Times, February 2006
- **California's Efforts to End Use of Sea Water to Cool Plants Could Jeopardize 24 GW**
 - POWERnews, March 2006
- **New Power Plants to Dry Up Water Supplies?**
 - Transcript from Great Lakes Radio Consortium, August 2005
- **Feds Order Susquehanna Power Plants and Others to Stop Killing Off Fish**
 - Lancaster New Era, February 2005



May 2006 Issue of Power Magazine



Alternative Sources of Cooling Water Mine Pools



Pennsylvania Already Using Mine Pool Water for Cooling

- Exelon Corp.'s Limerick nuclear power plant reduced water withdrawal from Delaware River using water from Schuylkill County, PA coalmine during 4-5 month trial run in summer 2003
- A number of other small generators in the anthracite region of Pennsylvania are using mine water for cooling



Limerick Nuclear Power Plant

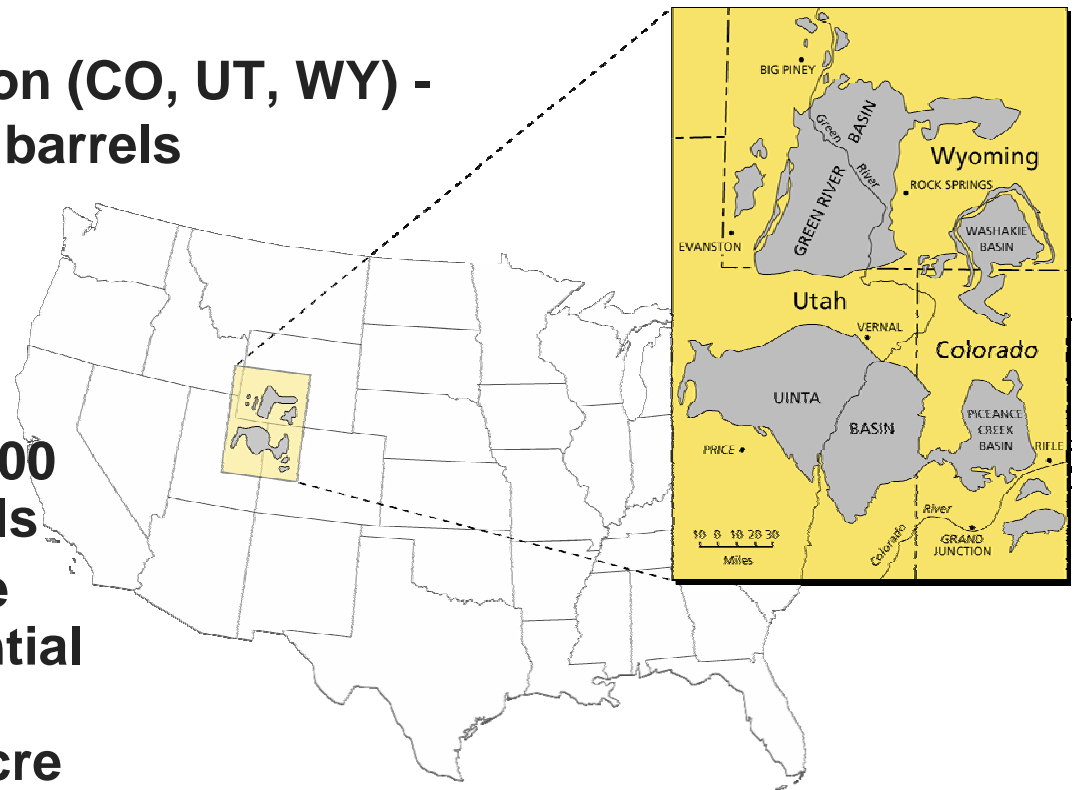
Company Name	Plant Location	Generating Capacity (MW)	Cooling Water Source
Gilberton Power Co.	Frackville, PA	80	Unnamed mine pool
Northeastern Power Co.	McAdoo, PA	50	Siverbrook Mine
Panther Creek Generating Station	Nesquehoning, PA	83	Lausanne Mine
Schuylkill Energy Resources	Shenandoah, PA	80	Maple Hill Mine
WPS – Westwood Generation	Tremont, PA	31	Lyken Mine
Wheelabrator Frackville Energy Co.	Frackville, PA	42	Morea Mine



Western Oil Shale Resources

Water Requirements? – *Do the Algebra*

- Green River Formation (CO, UT, WY) - estimated 1.5 trillion barrels
- Initial development - high-grade oil shale yielding 25 or more gallons per ton; estimated between 400 and 750 billion barrels
- Some portions of the basin have the potential of yielding over 2.5 million barrels per acre
- 2 - 5 bbls H₂O per bbl product ---
[contemporary data required!]



Even Energy Imports Impacted by H₂O Concerns Open Rack Vaporizers



Bio-Fuels and Water

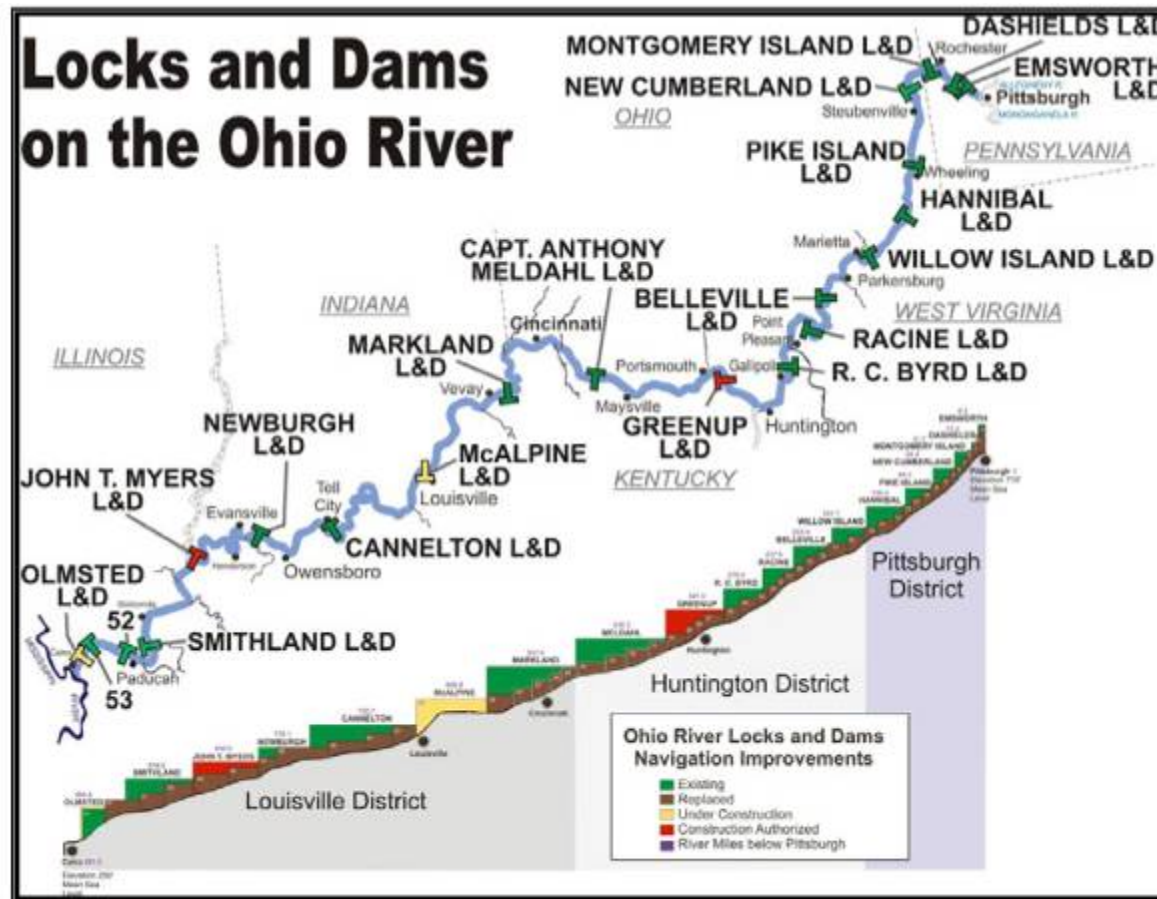
There's No Escaping the *Nexus*!

4 billion gallons (2006)
7.5 billion gallons (2012)
3 to 7-12 gallons H₂O/gallon? (varies)
Irrigation water – vol. is significant



Energy Infrastructures Are Tied to *Water*

Ohio River Mainstem Profile



Closing Remarks

- Knowledge
- Awareness
- *Energy*”y”zed
- Aren't [energy] projects really water projects
 - with associated high-value *by-products* that keep the county [world] running?
 - It's all about one's perspective....

