

Framing the Critical Energy-Water Link



*13th IPEC Conference
San Antonio, TX*

*October 17-20, 2006
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Objectives

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



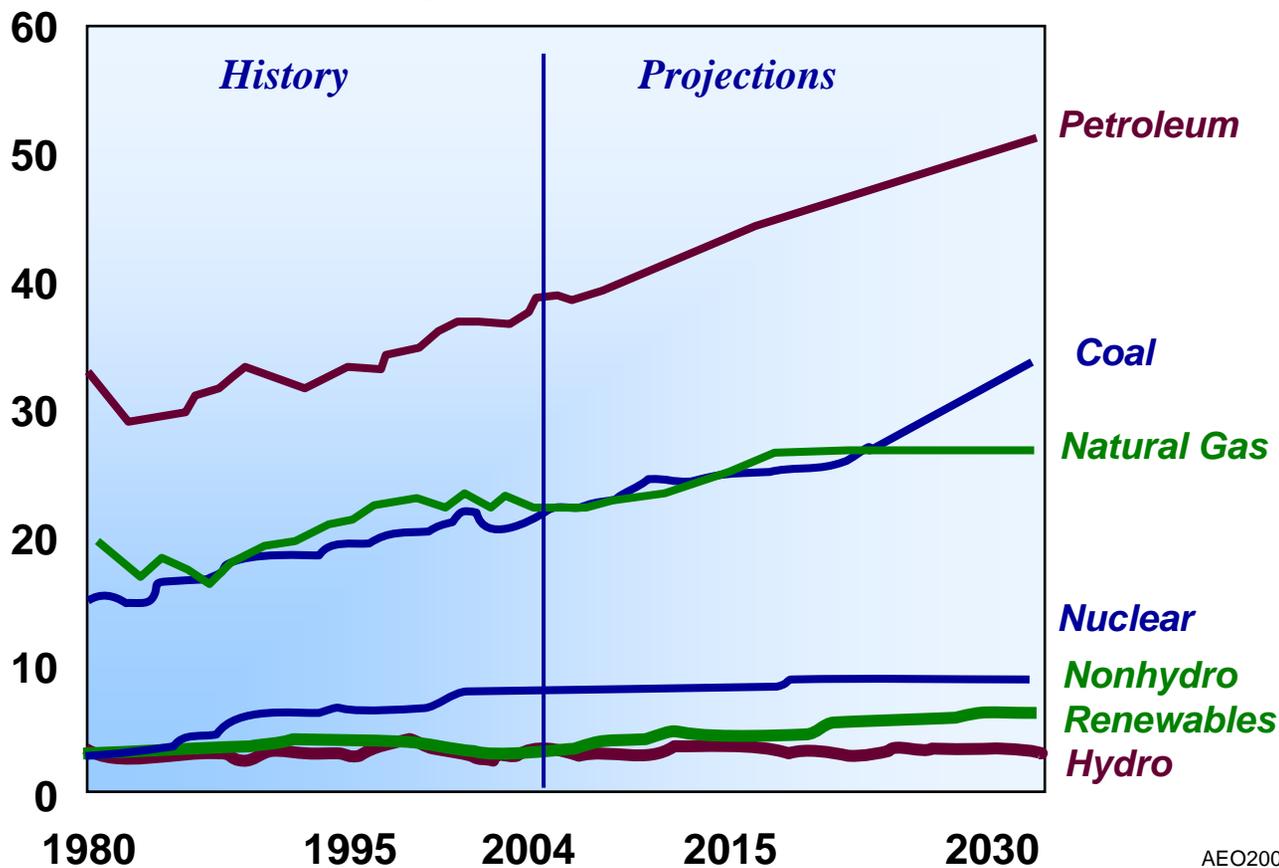
Outline

- 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)*

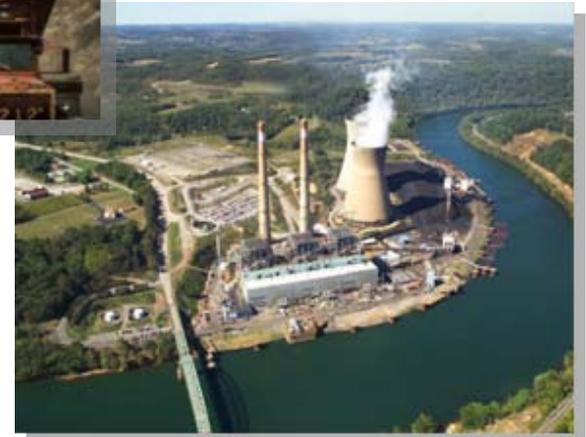


AEO2006



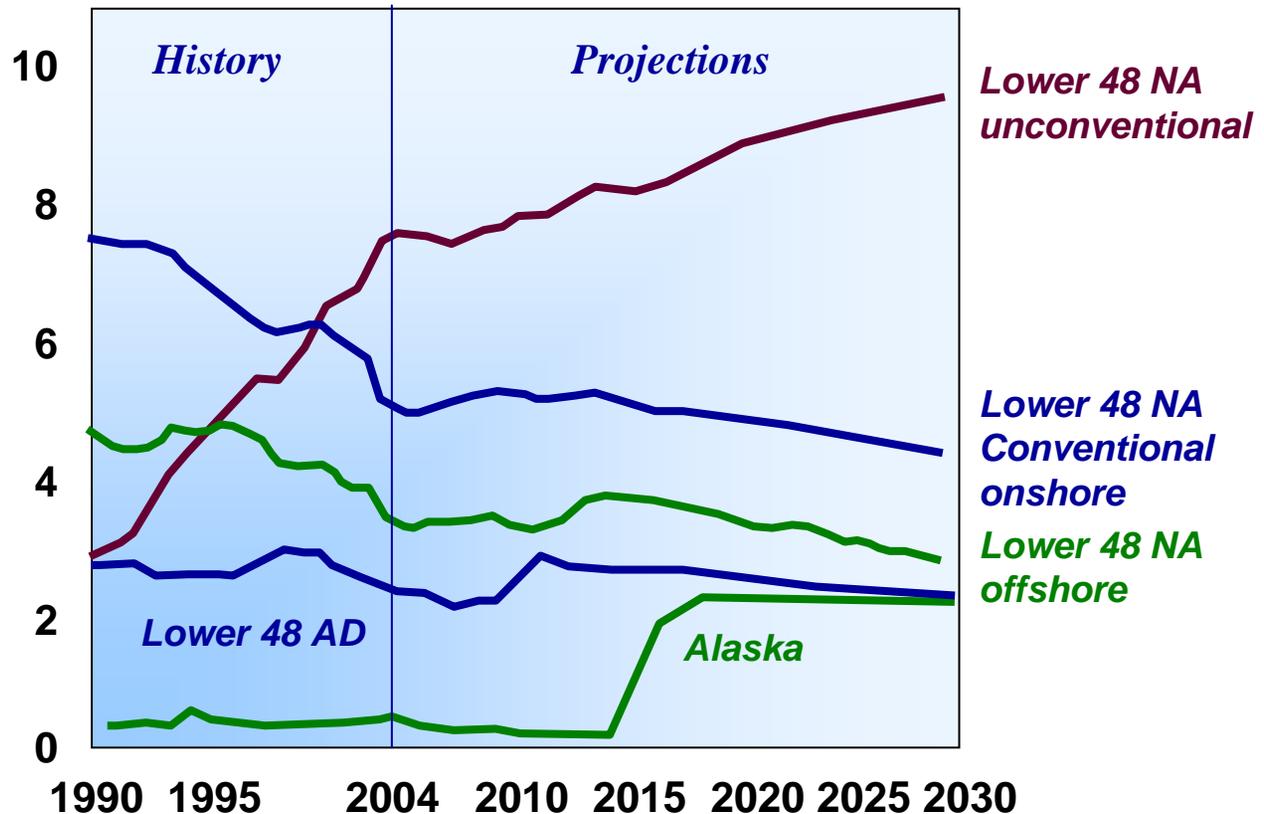
Energy and Water

A “Cradle to Grave” Relationship



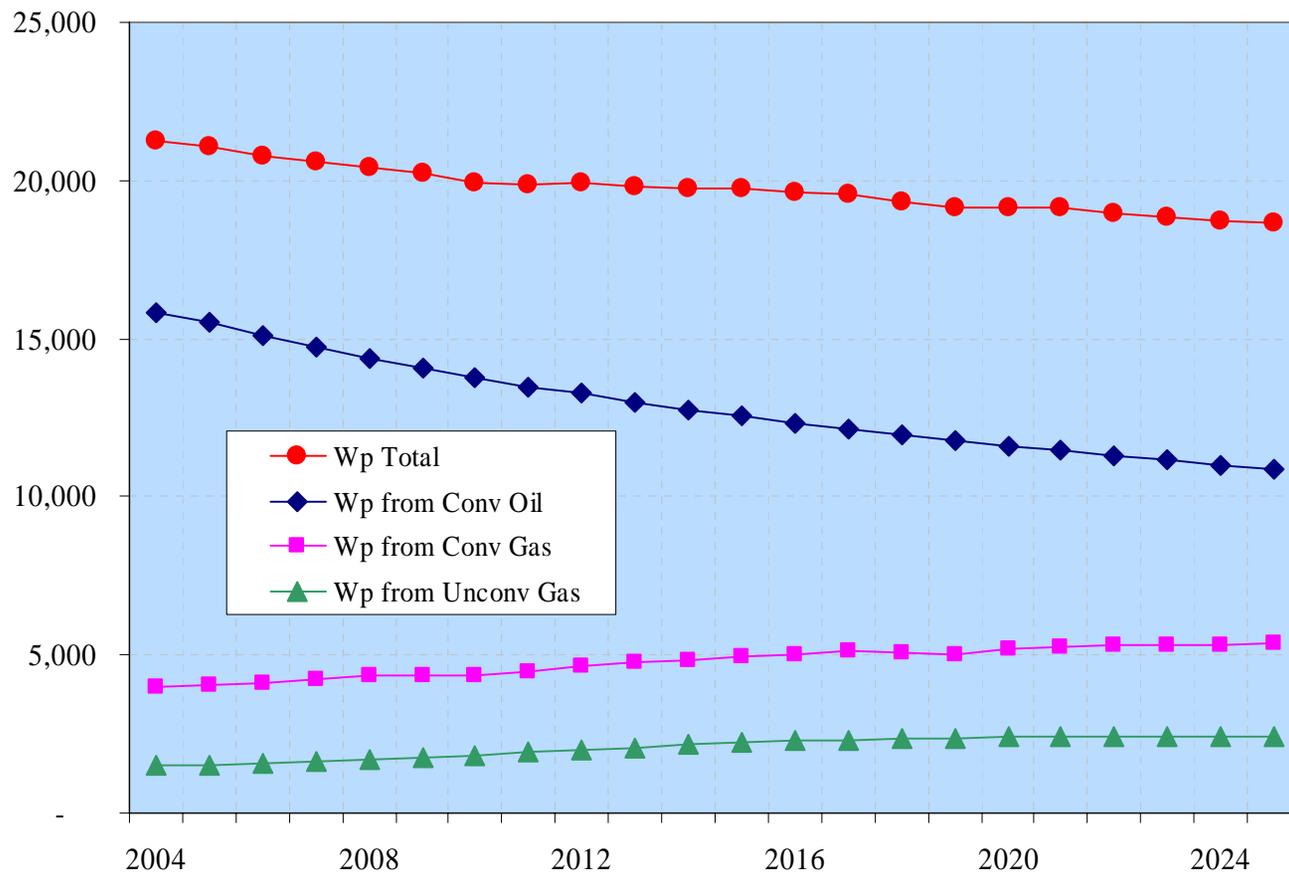
Domestic Supply Trends to Continue Increasing Reliance on UGR

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

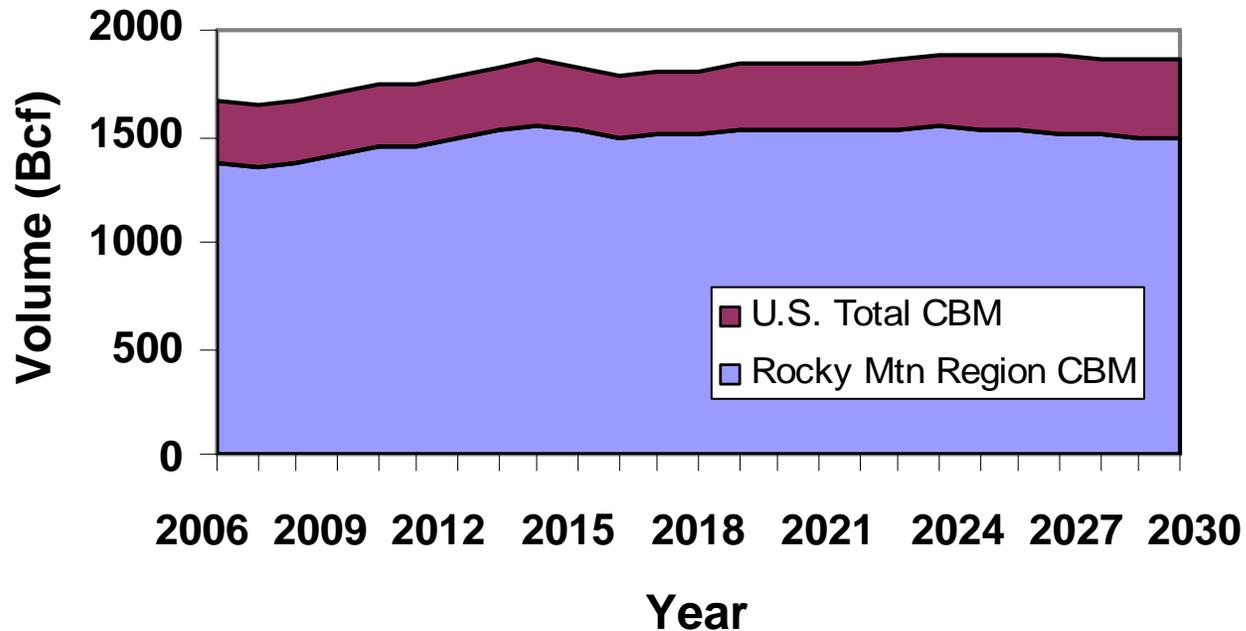


W_p (total) Volume Declines But Remains Significant

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

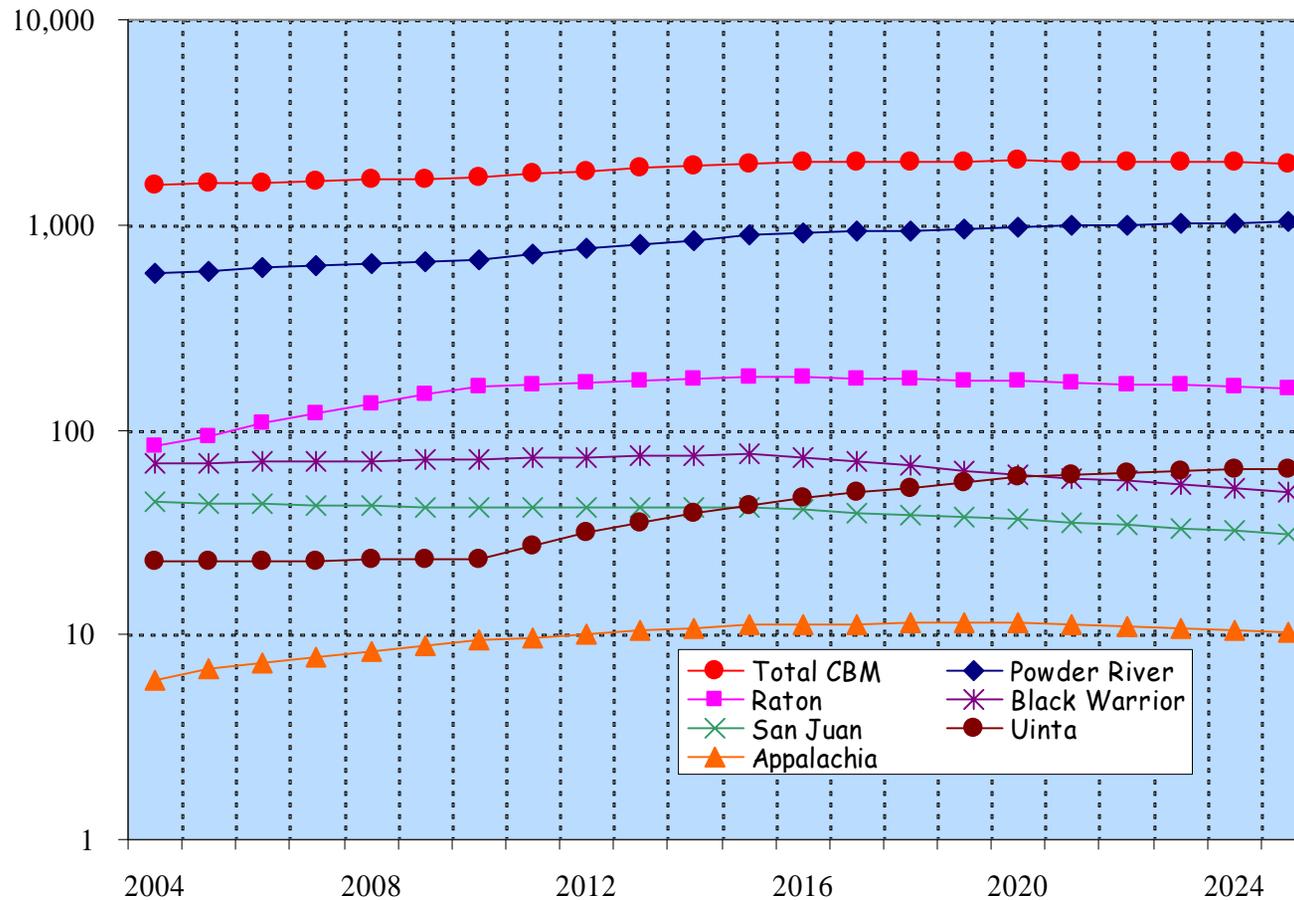


CBM Production Increases to Nearly 2 Tcf/yr Rocky Mtn. Basins/Plays Remain Dominant



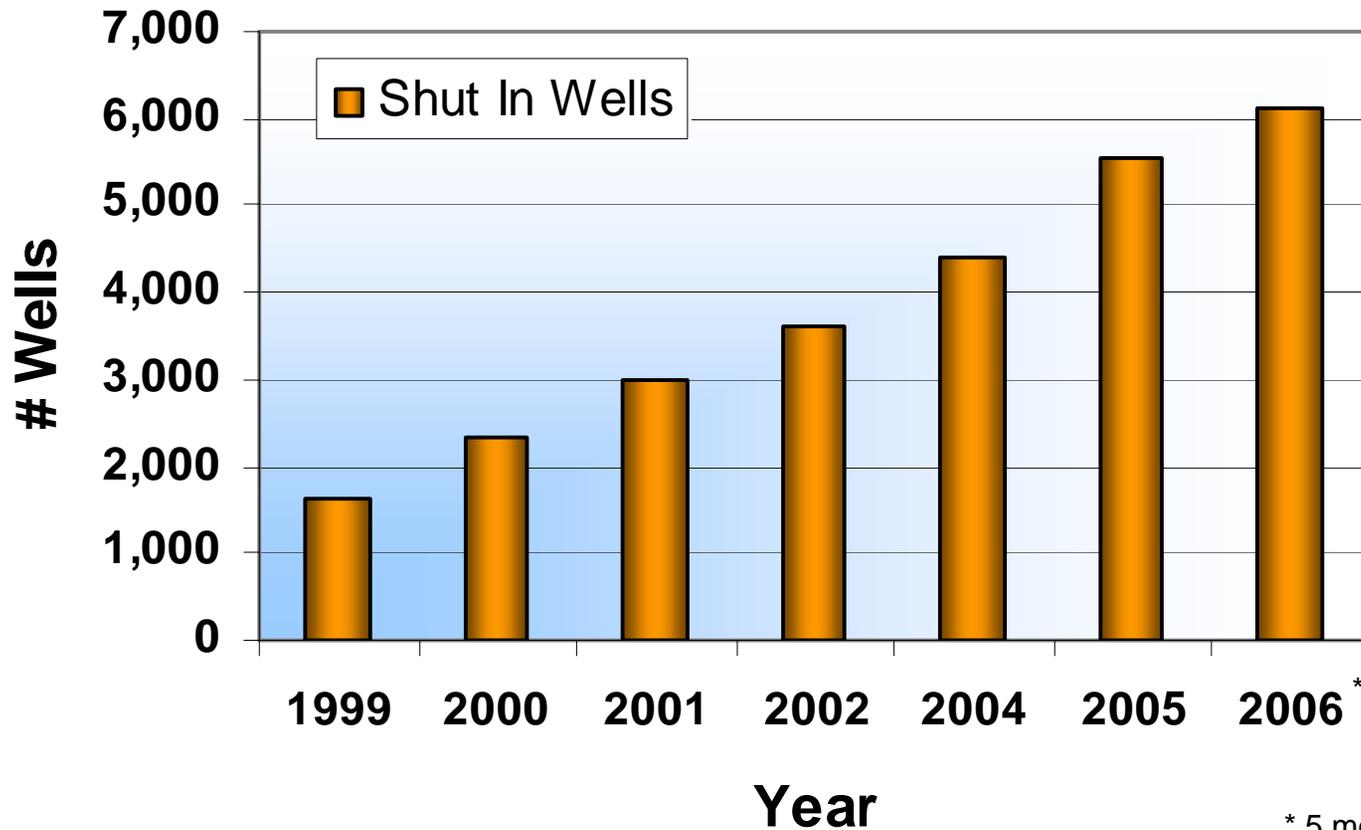
Expect a Commensurate Increase in W_p Volumes Water Management *Key* for Rocky Mountain Region

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



* 5 mos.



“ 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

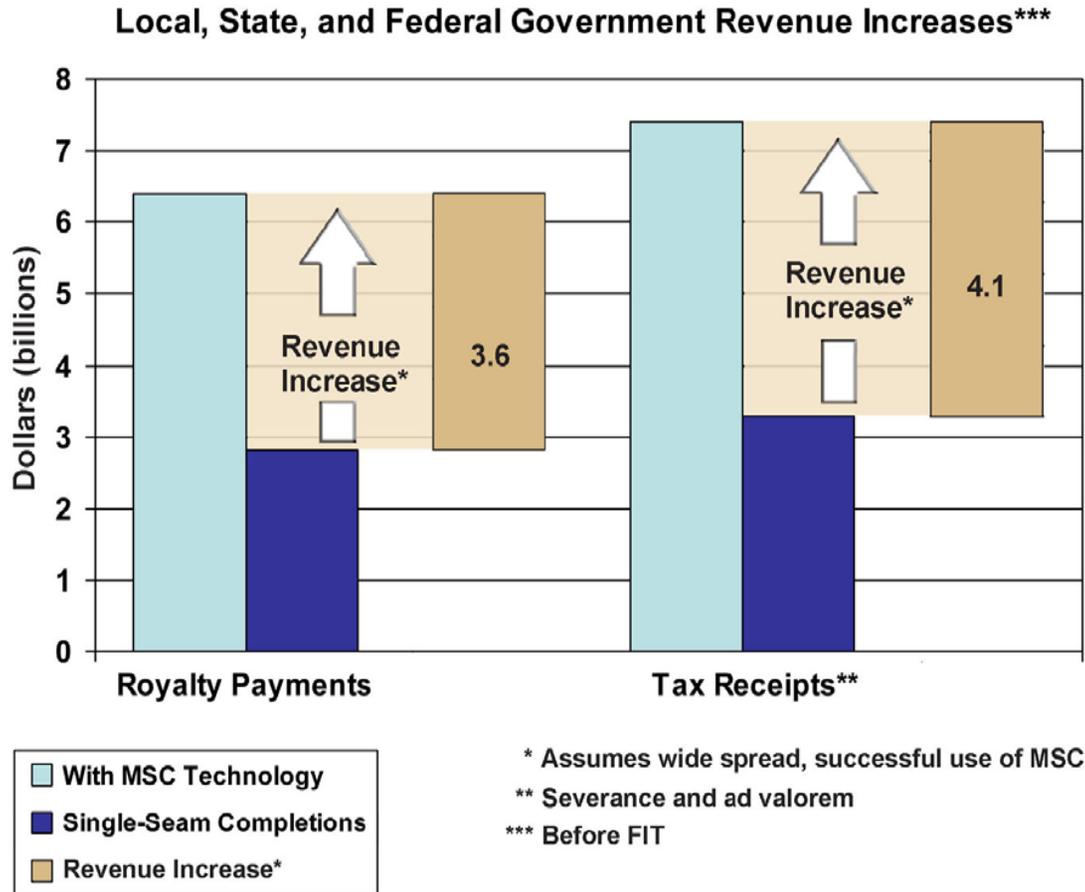


\$16.0080



Technology Advances Can Yield Sign. Benefits

Water Management Requires \geq Attention

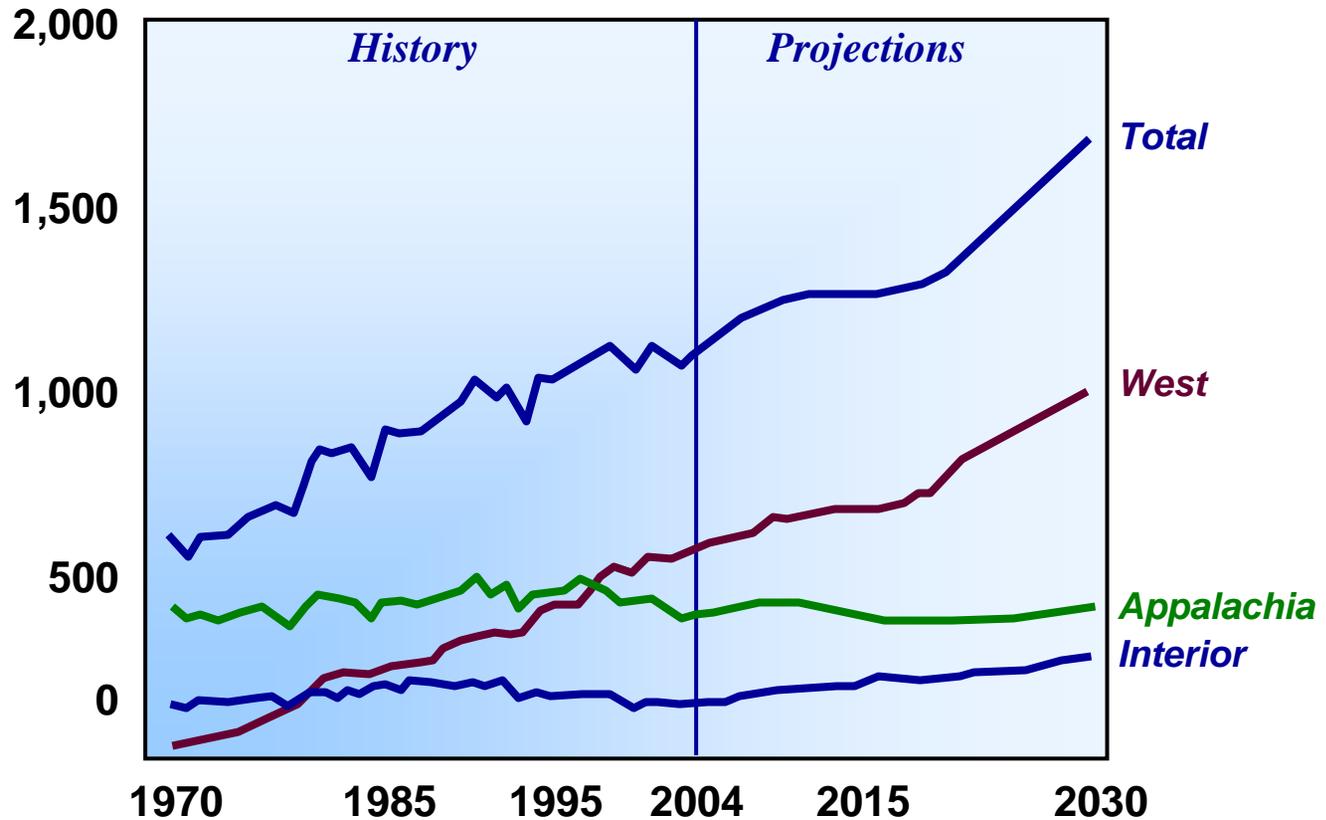


Potential Economic Benefits Associated with MSC



Coal Continues to Fuel the Nation

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

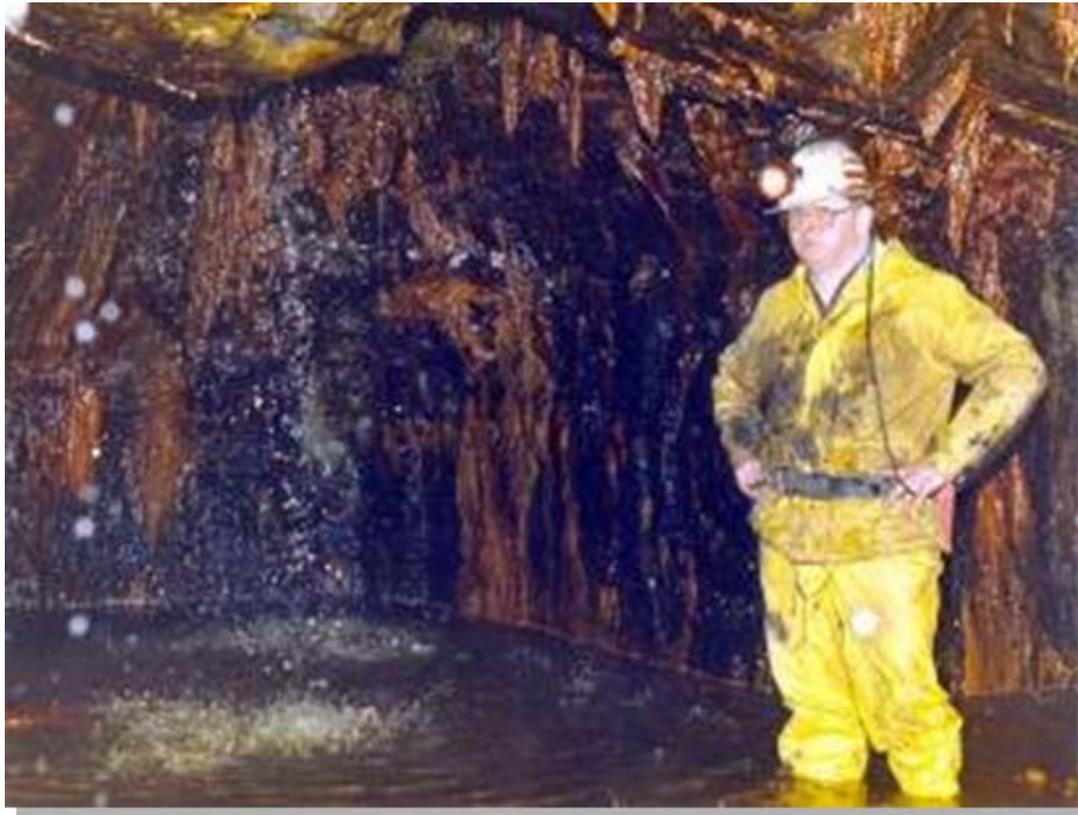


Coal Mining/Coal Prep



Underground Operations

Water Affects Working Conditions/Safety



Legacy Operations Encumber Today's Industry

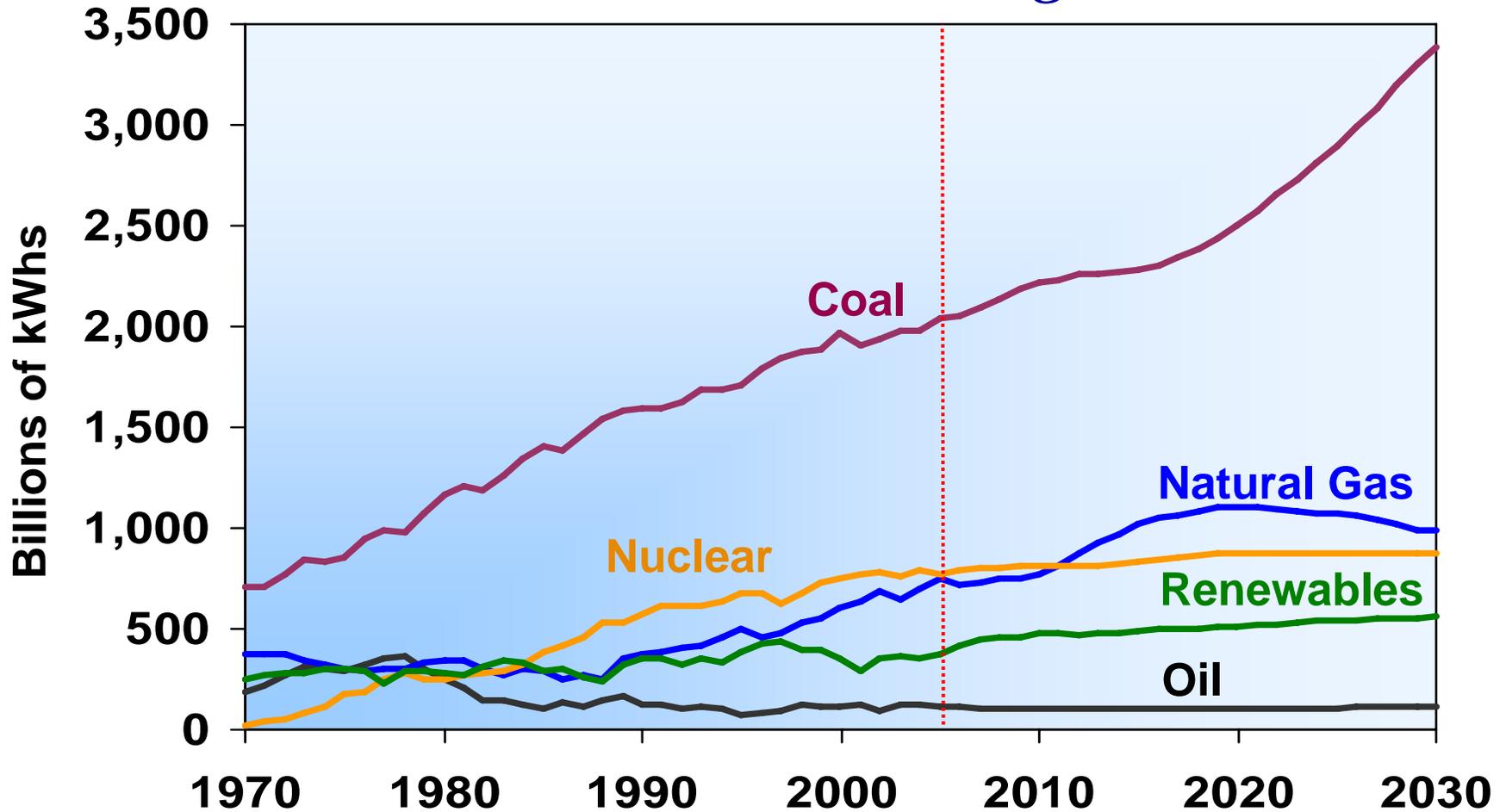


Current Practices are Environmentally *Aligned*



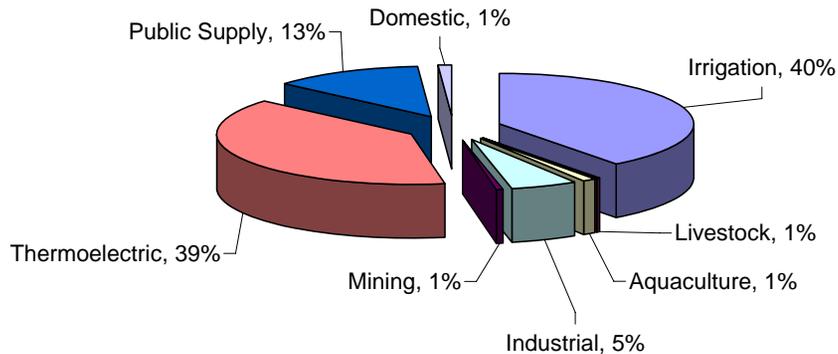
Electricity Demand Forecast to 2030

Coal Remains *King*



The Issues: Competing Water Uses

U.S. Freshwater Withdrawal (2000)

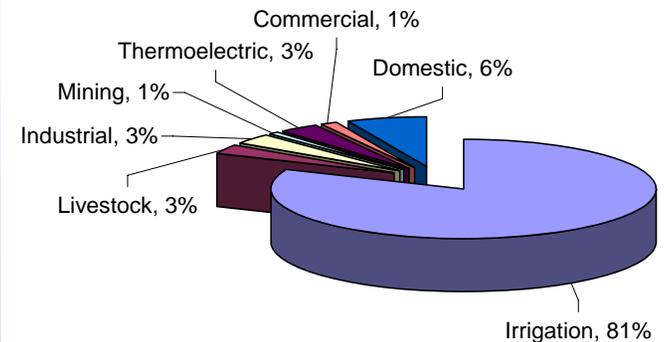


- **2000 thermoelectric water requirements:**

- **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)

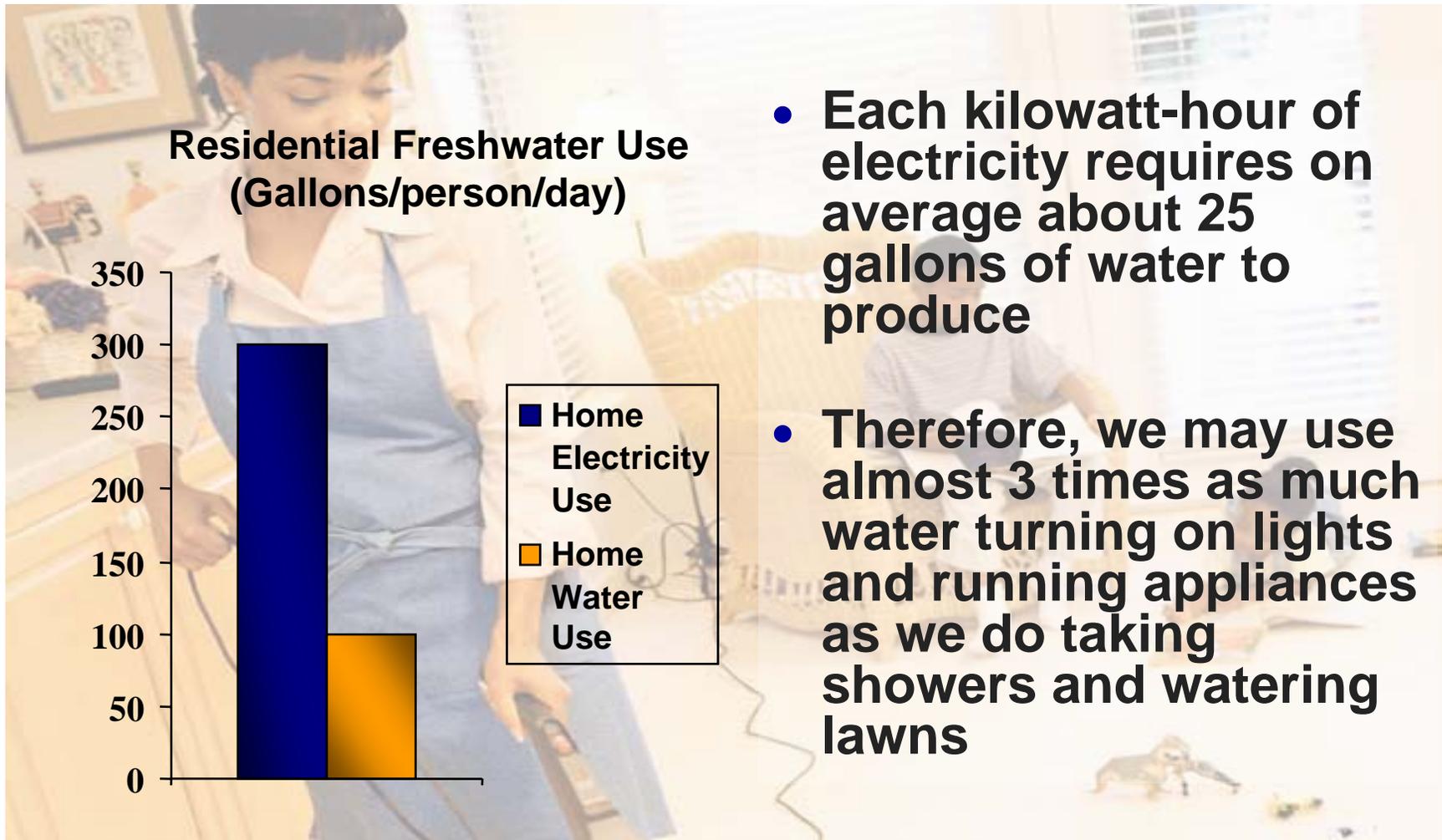


USGS, Estimated Use of Water in the United States in 2000, USGS Circular 1268, March 2004

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

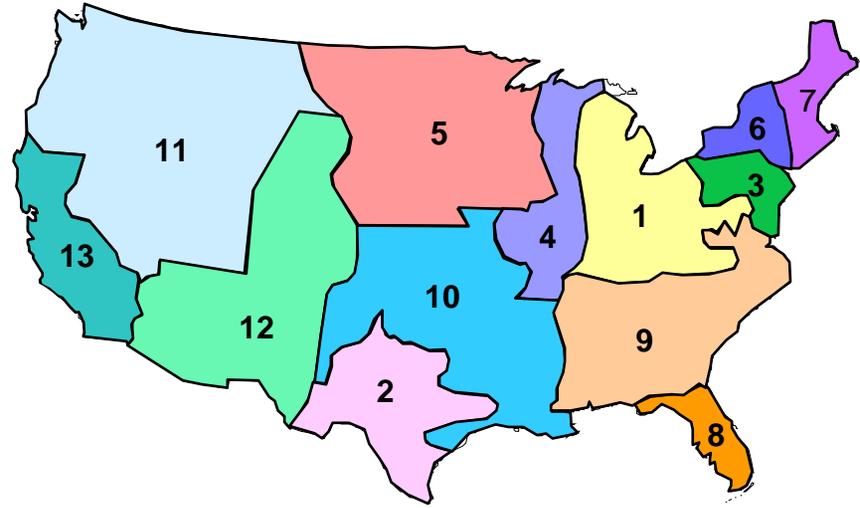


Water and Electricity Are Inextricably Linked



Thermoelectric Power Plant Water Reqmnt's NERC Sub-Regions

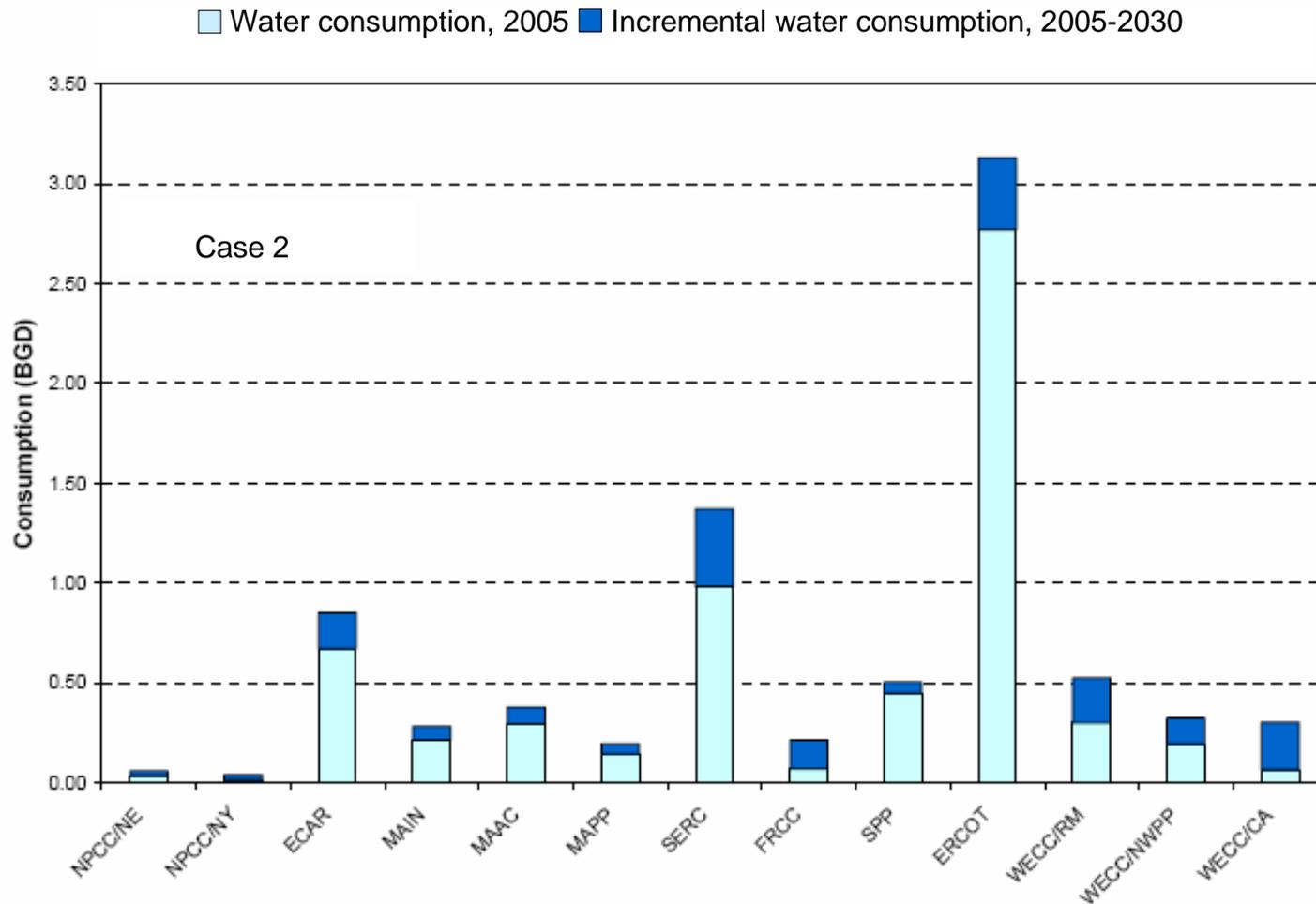
Region Number	Abbreviation	Region
1	ECAR	East Central Area Reliability Coordination Agreement
2	ERCOT	Electric Reliability Council of Texas
3	MAAC	Mid-Atlantic Area Council
4	MAIN	Mid-America Interconnected Network
5	MAPP	Mid-Continent Area Power Pool
6	NPCC/NY	Northeast Power Coordinating Council / 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

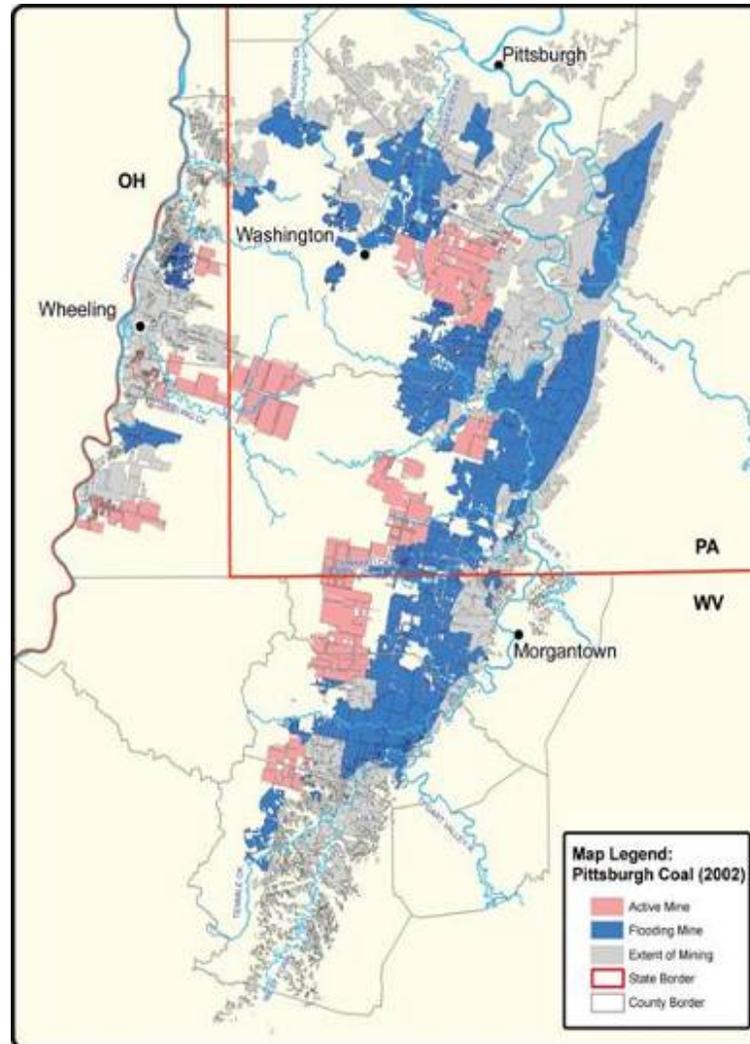
- **Idaho May Adopt Moratorium on Coal Power Due to Water Issues**
 - Reuters, March 2006
- **Sempra Energy Halts Gerlach Project Study**
 - Associated Press, March 2006
- **Desert Rock Water Agreement Passes Navajo National Committee**
 - The Daily Times, February 2006
- **California's Efforts to End 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

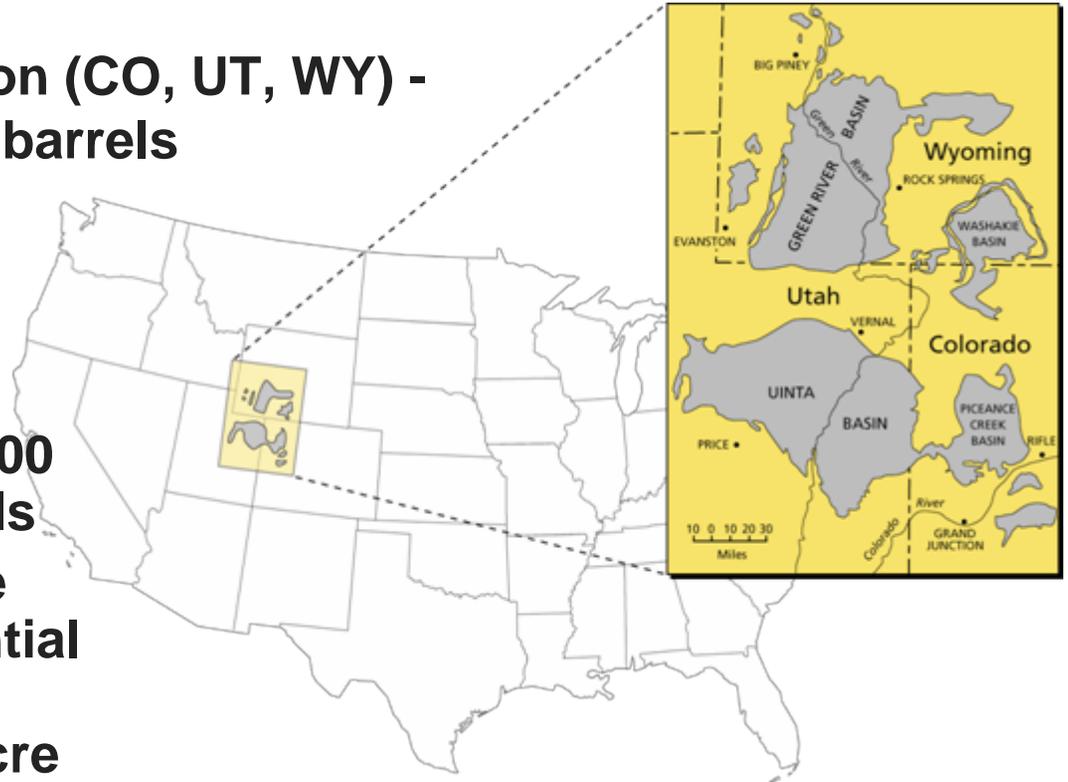
Company Name	Plant Location	Generating Capacity (MW)	Cooling Water Source
Gilberton Power Co.	Frackville, PA	80	Unnamed mine pool
Northeastern Power Co.	McAdoo, PA	50	Siverbrook Mine
Panther Creek Generating Station	Nesquehoning, PA	83	Lausanne Mine
Schuylkill Energy Resources	Shenandoah, PA	80	Maple 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

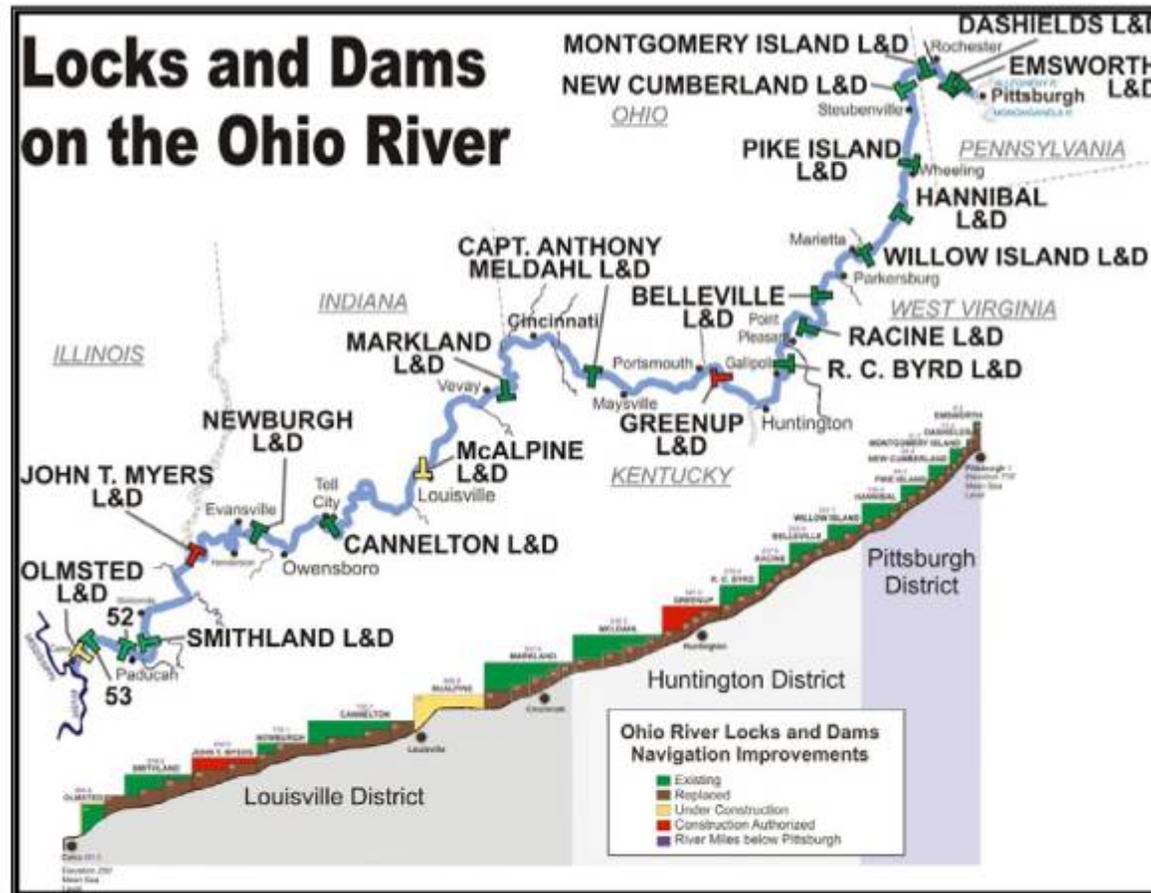
There's No Escaping the *Nexus*!

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....



Framing the Critical Energy-Water Link

Water is fundamental to energy production and use including coal mining, crude oil and natural gas production, and electric power generation. The volumes of water related to these operations are substantial, e.g., the ± 20 billion barrels of water co-produced with oil and natural gas annually from the onshore, lower-48 United States. Primary energy requirements are forecast to increase by over 25 percent during the next two decades and *water* will be central in moving myriad projects forward in order to meet society's needs.

In the U.S., produced water comprises approximately 98 percent of the total volume of exploration and production (E&P) *waste* generated by the industry. Produced water volumes and qualities are highly variable as are management costs. Coalbed methane produced water has received much attention of late in terms of management options and costs. Further, the debate over managing produced water won't subside anytime soon. Consider the following: a recent forecast of U.S. natural gas supply anticipates the production of nearly 2 Tcf/yr from coalbed methane operations. More than 80 percent of this total is expected to be produced from plays in the Rocky Mountain region an area where current water management options have constrained production, stymied operations, and drove many to seek resolution via the courts.

A contemporary and thorough treatise of energy and water will be presented at the conference with emphasis on produced water issues including emerging options and strategies for managing the inflows and discharges. Considerations which tie to nontraditional energy source, e.g., oil shale are also examined. The information is intended to broaden awareness, encourage dialogue, and provoke new ideas across affected stakeholder groups many with divergent goals. In the end, the collective efforts of many entities, both private and public, will be required to deliver balanced solutions to the energy-water nexus.

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RE: 13th IPEC Conference; Oct. 2006