Water Usage Impacts of CO_2 Capture Technologies - *Projections Through 2030*

EUEC

Energy & Environment Conference 2008

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Office of Systems Analyses and Planning

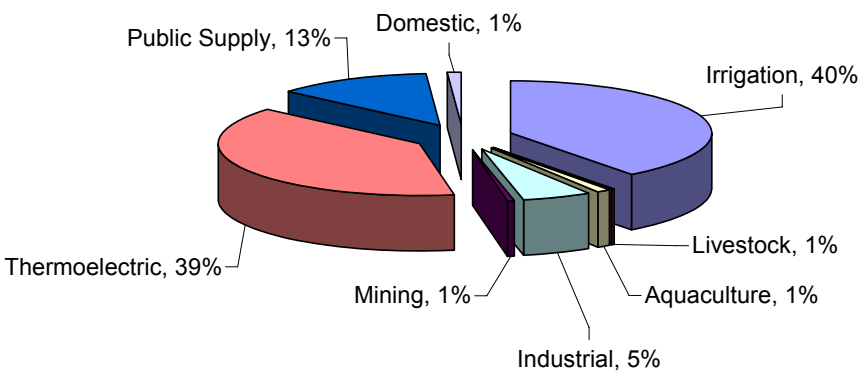
Water/Energy-Related Articles
Impacts on Power Plant Siting and Operation

- **Water Scarcity Seen Dampening Case for Biofuel**
  - *Reuters, October 2006*
- **Southern Drought Leads to Shutdown of Hydro, Forcing Utilities to Buy from Market**
  - *POWERnews, October 2006*
- **Idaho May Adopt Moratorium on Coal Power Due to Water Issues**
  - *Reuters, 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*

May 2006 Issue of Power Magazine

The Issues: Competing Water Uses

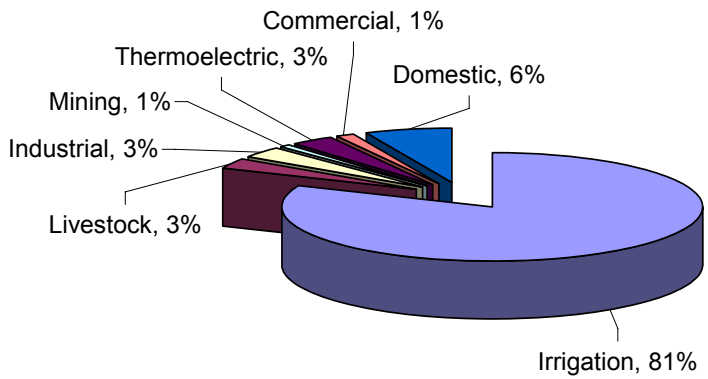
U.S. Freshwater Withdrawal (2000)



- **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 producing energy?**

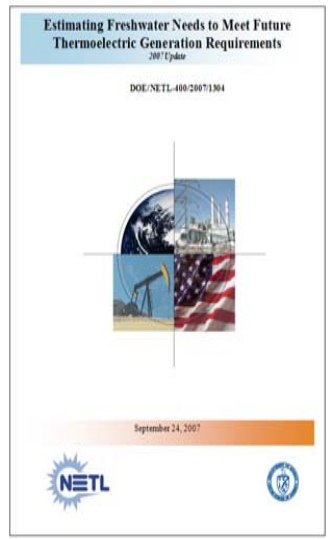
U.S. Freshwater Consumption (1995)



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

NETL's Water Needs Report

- **Thermoelectric Power Generation**
  - coal steam, combined cycle, other fossil steam, and nuclear
- **Projected National and Regional freshwater withdrawal and consumption through 2030**
- **Examine water use of deployed coal-fired power plants with carbon capture technologies**



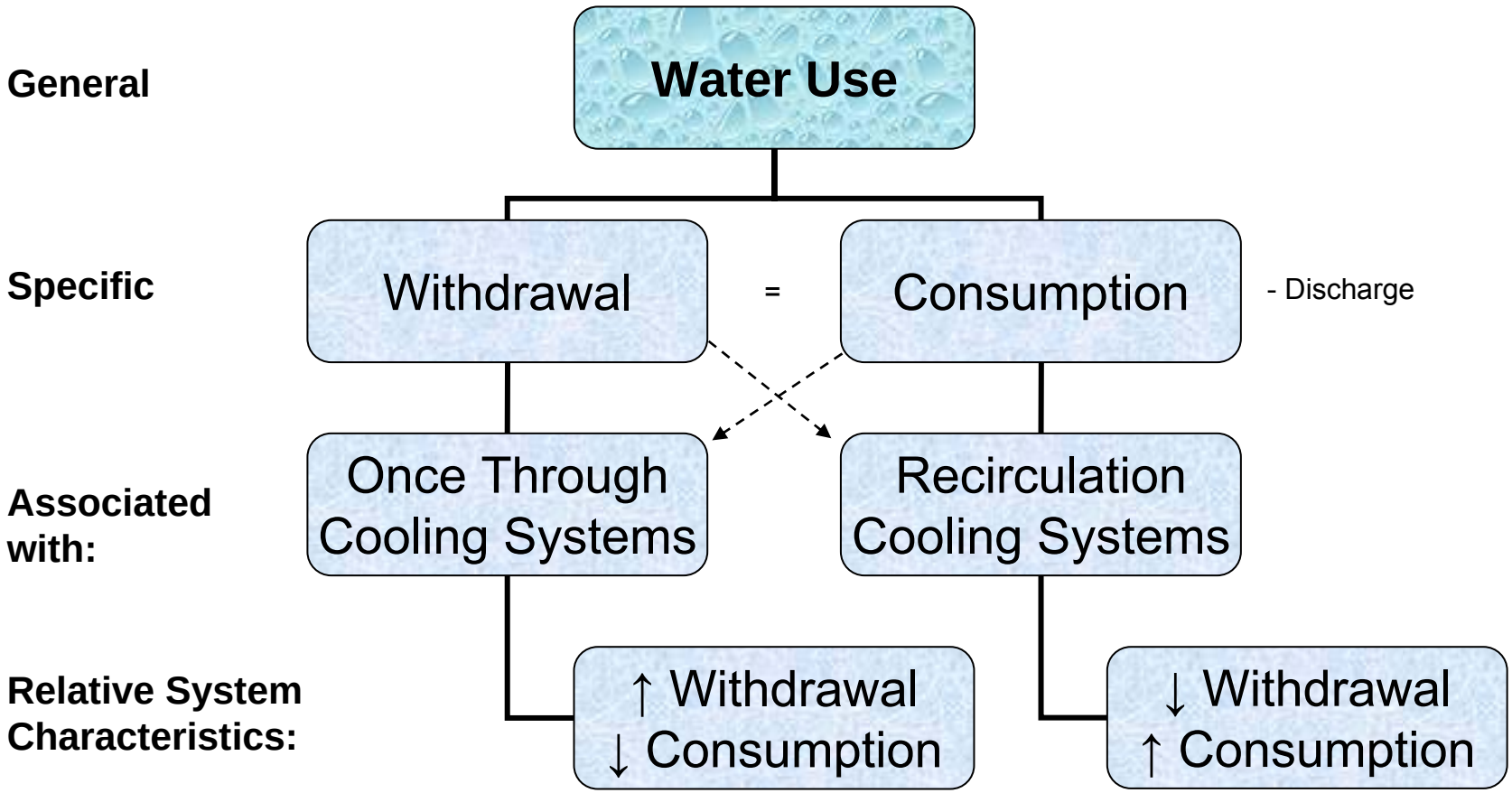
NETL's Water Need Report

- **Thermoelectric water use**
  - 5 Cases
    - Cooling systems for new additions
    - Water sources
    - Retrofit of once through systems
  - No Carbon Capture
- **Carbon Capture water use**
  - 3 Scenarios
    - Make-up power for carbon capture retrofits

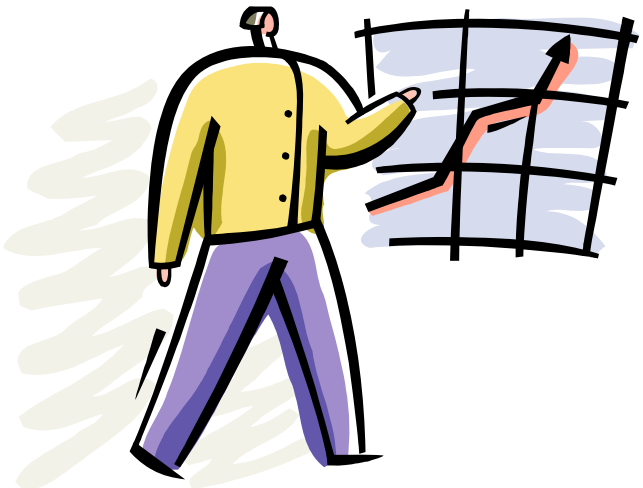
Case Descriptions

Case Description	Rationale
Case 1: Additions and retirements proportional to current water source and type of cooling system.	**Status quo scenario case.** Assumes additions and retirements follow current trends.
Case 2: All additions use freshwater and wet recirculating cooling, while retirements are proportional to current water source and cooling system.	**Regulatory-driven case.** Assumes 316(b) and future regulations dictate the use of recirculating systems for all new capacity. Retirement decisions hinge on age and operational costs rather than water source and type of cooling system.
Case 3: 90% of additions use freshwater and wet recirculating cooling, and 10% of additions use saline water and once-through cooling, while retirements are proportional to current water source and cooling system.	**Regulatory-light case.** New additions favor the use of freshwater recirculating systems, but some saline capacity is permitted. Retirement decisions remain tied to age and operational costs, tracking current source withdrawals.
Case 4: 25% of additions use dry cooling and 75% of additions use freshwater and wet recirculating cooling. Retirements are proportional to current water source and cooling system.	**Dry cooling case.** Regulatory and public pressures result in significant market penetration of dry cooling technology. Retirement decisions remain tied to age and operational costs, tracking current source withdrawals.
Case 5: Additions use freshwater and wet recirculating cooling, while retirements are proportional to current water source and cooling system. 5% of existing freshwater once-through cooling capacity retrofitted with wet recirculating cooling every 5 years starting in 2010.	**Conversion case.** Same as Case 2, except regulatory and public pressures compel state agencies to dictate the conversion of a significant amount of existing freshwater once-through cooling systems to wet recirculating.

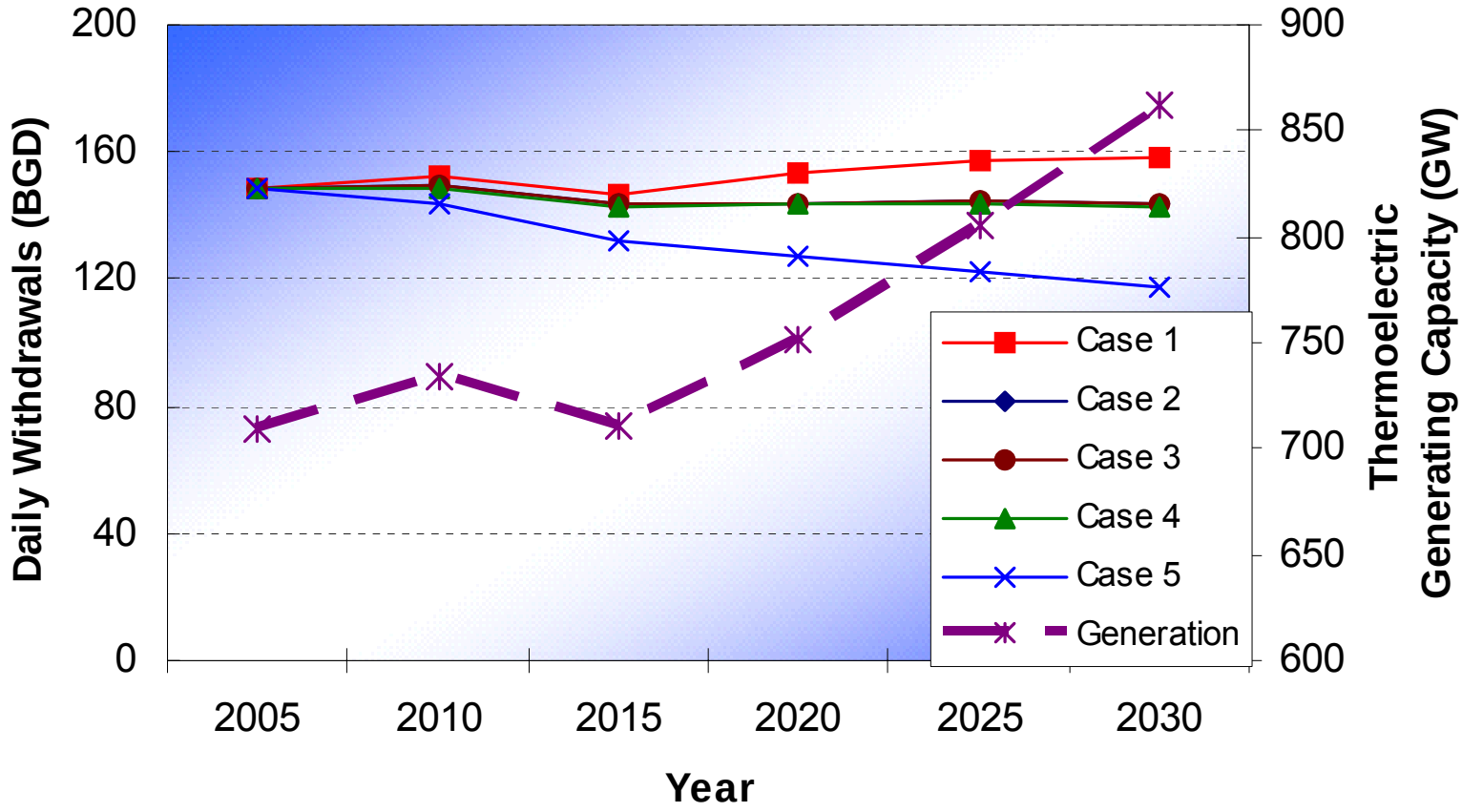
Terms and Cooling Systems



Results
Thermoelectric Water Requirements Modeling



Average Daily National Freshwater Withdrawal for Thermoelectric Power Generation



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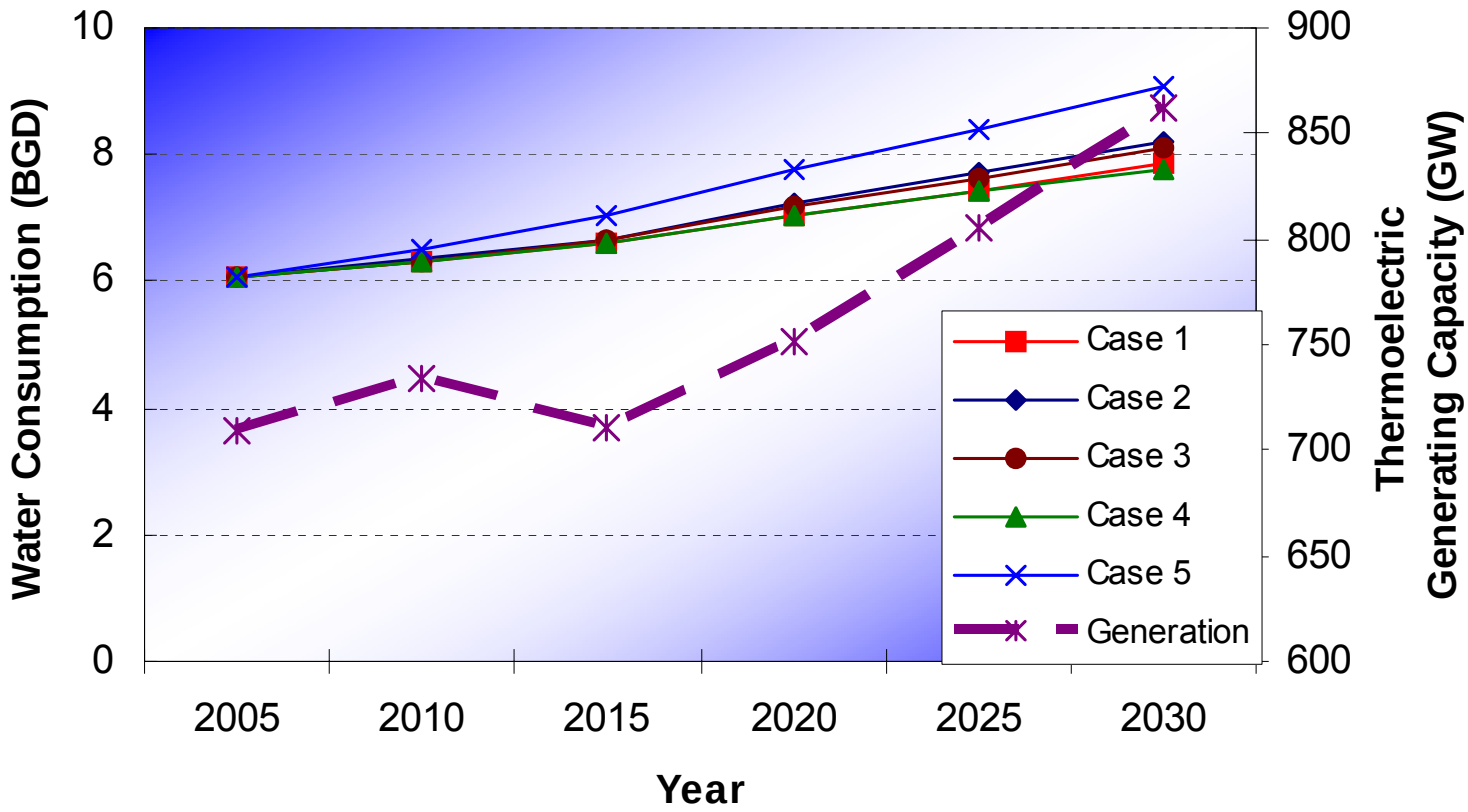
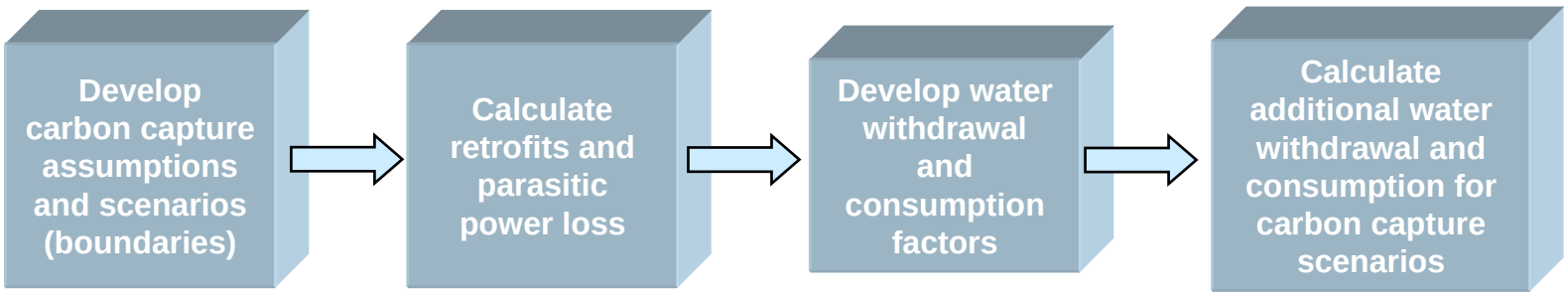
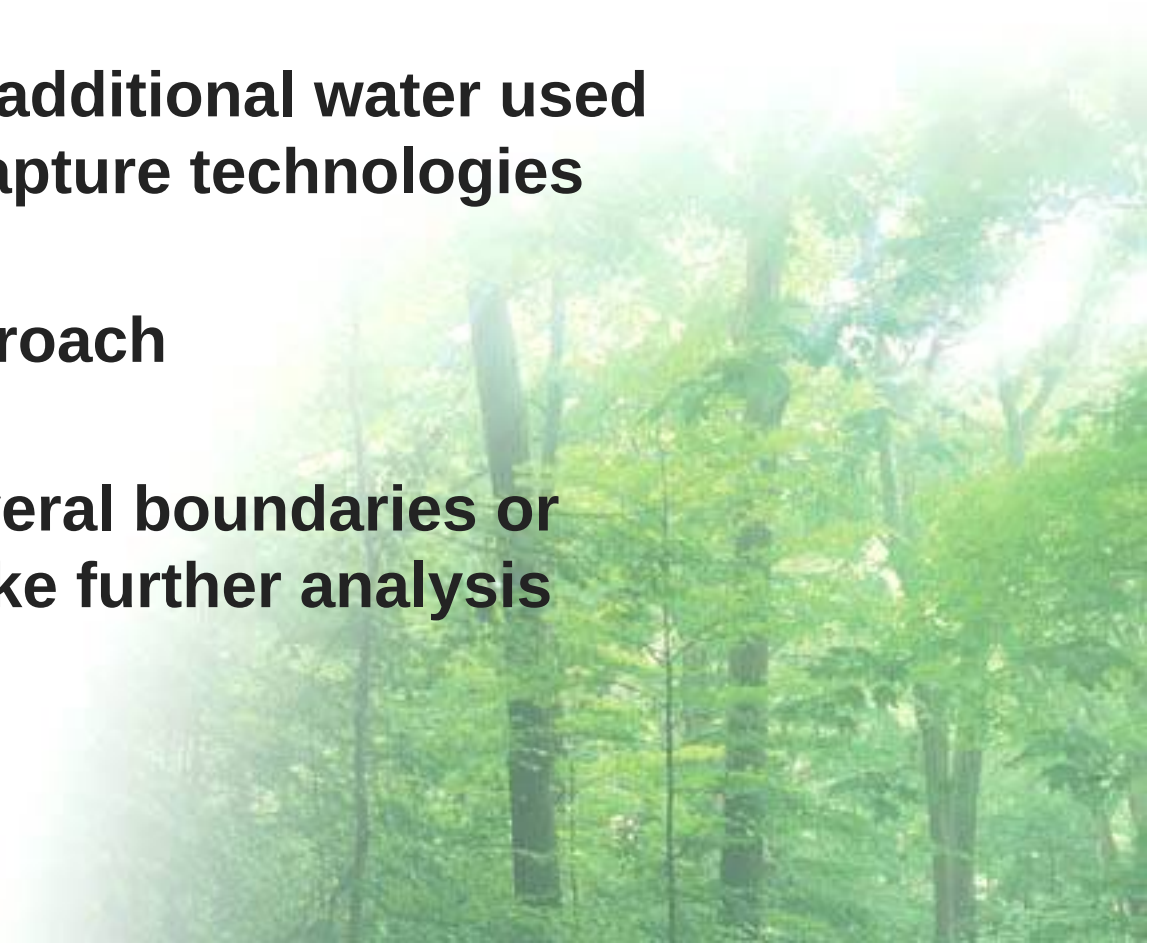


Carbon Capture Water Use Analysis



Carbon Capture Water Use Analysis

- Investigates additional water used for carbon capture technologies
- 1st order approach
- Provides several boundaries or points to make further analysis



Step 1: Develop carbon capture assumptions and scenarios

- **Assumes that carbon mitigation policies will be put in place in the near future**
- **All new and existing PC plants with scrubbers and IGCC plants would utilize carbon capture technologies by 2030**
  - PC plant w/out scrubbers are not required to capture CO_2
- **All new cooling systems will be recirculating**
- **Carbon capture technologies would remove a nominal 90% of the CO_2 that would be generated from the fuel carbon**
- **Looked at available technologies**
  - Chemical and physical absorption solvents

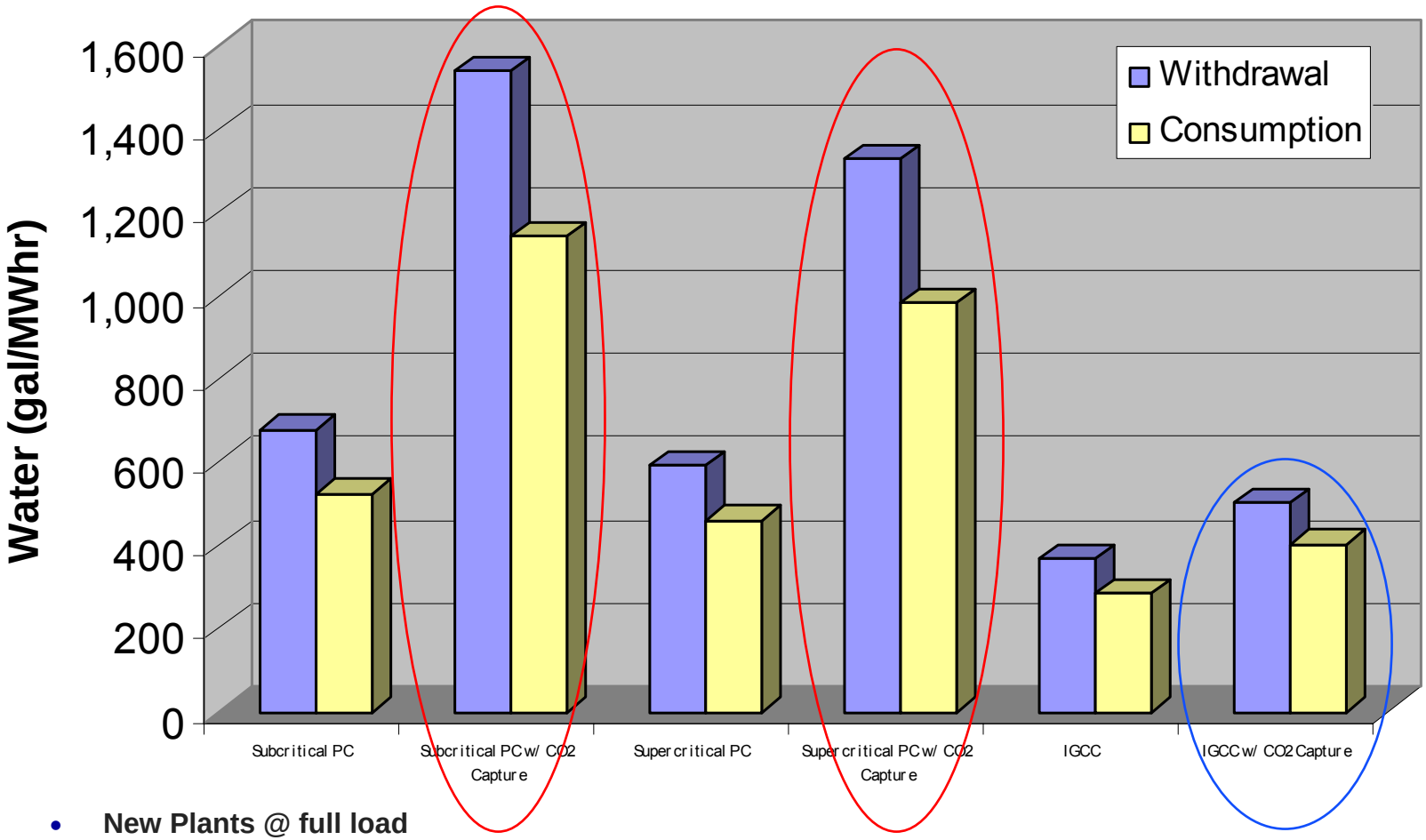
Step 1: Develop carbon capture scenarios (boundaries)

Scenario 1	Only accounts for the increased water requirements for the carbon capture technologies used for the retrofits and new builds Do not account for the reduction in capacity due to the retrofits	Reduced capacity will be replaced with some other "non-thermoelectric" generation that doesn't require cooling water
Scenario 2 Builds off of scenario 1	Additional capacity needed to make up for the parasitic loss of the retrofits are supplemented by new IGCC plants with carbon capture	All new IGCC plants required for the makeup power use recirculating cooling and include carbon capture technologies
Scenario 3 Builds off of scenario 1	Additional capacity needed to make up for the parasitic loss of the retrofits are supplemented by new supercritical plants with carbon capture	All new supercritical plants required for the makeup power use recirculating cooling and include carbon capture technologies

Step 2: Calculate retrofits and parasitic power loss

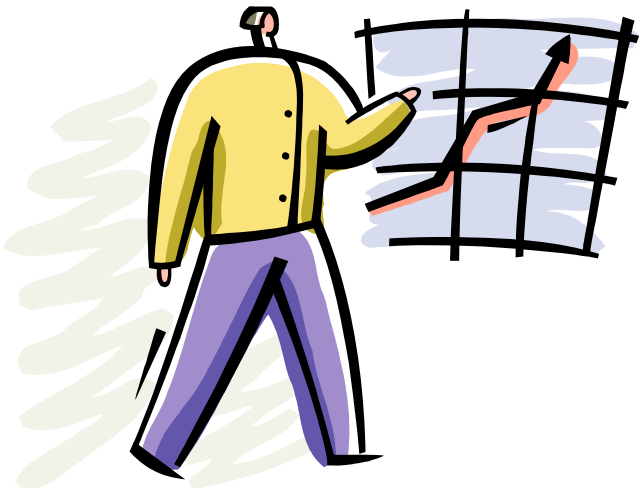
- **Used EIA 2030 forecast**
  - Existing fleet
  - Scrubbed plants
  - New additions (IGCC and PC)
  - Retirements
- **Retrofit will require 30% parasitic load**
- **Retrofits**
  - Existing – Retirements – Unscrubbed = 242 GW
- **Parasitic Power Loss** ***(build new plants to replace, Scenario dependent)***
  - Retrofits * 30% = 73 GW

Step 3: Develop water withdrawal and consumption factors

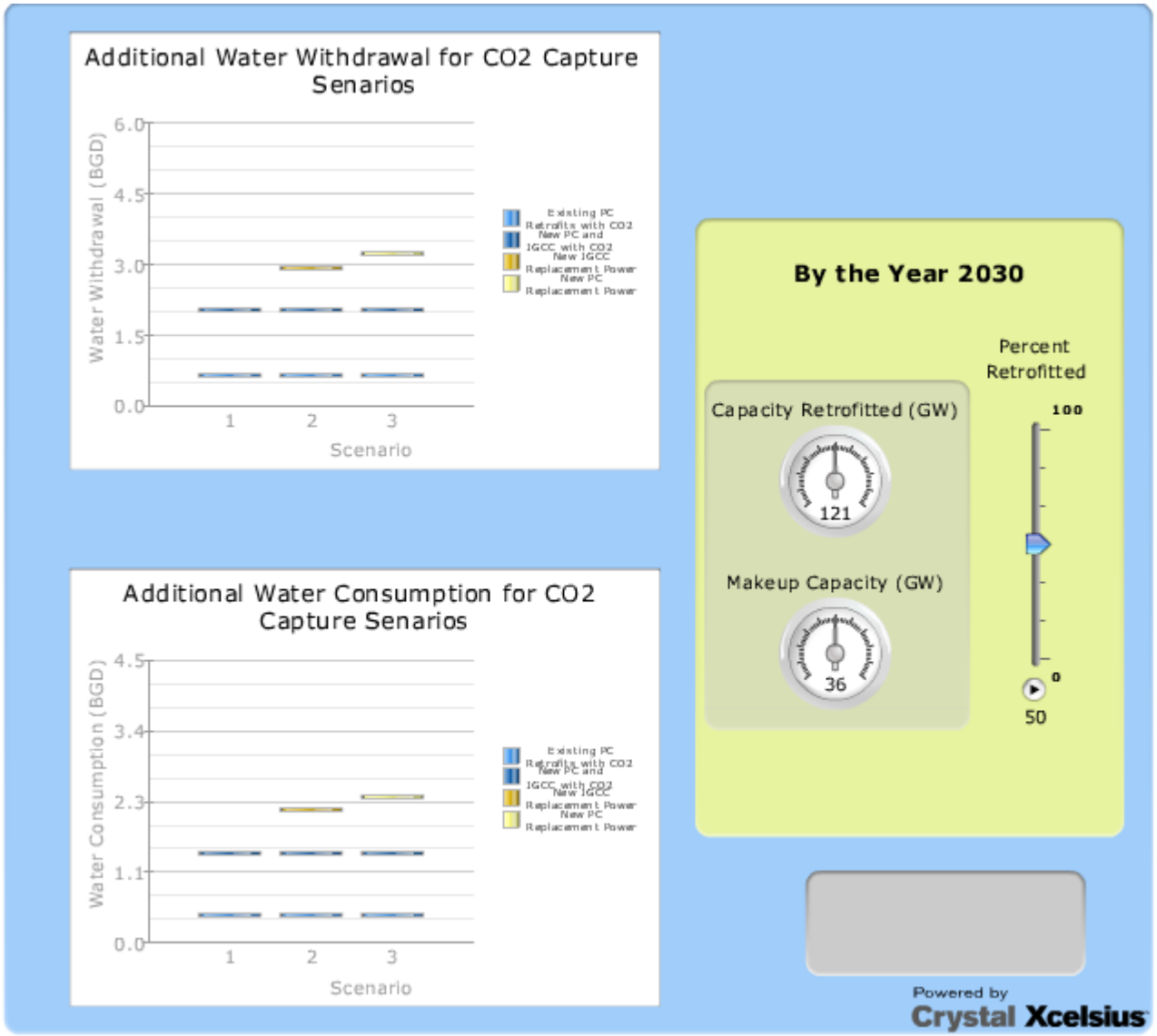


- New Plants @ full load
- IGCC average of 3 gasifier technologies
- U.S. Department of Energy, National Energy Technology Laboratory, *Cost and Performance Comparison Baseline for Fossil Energy Power Plants*, May 2007

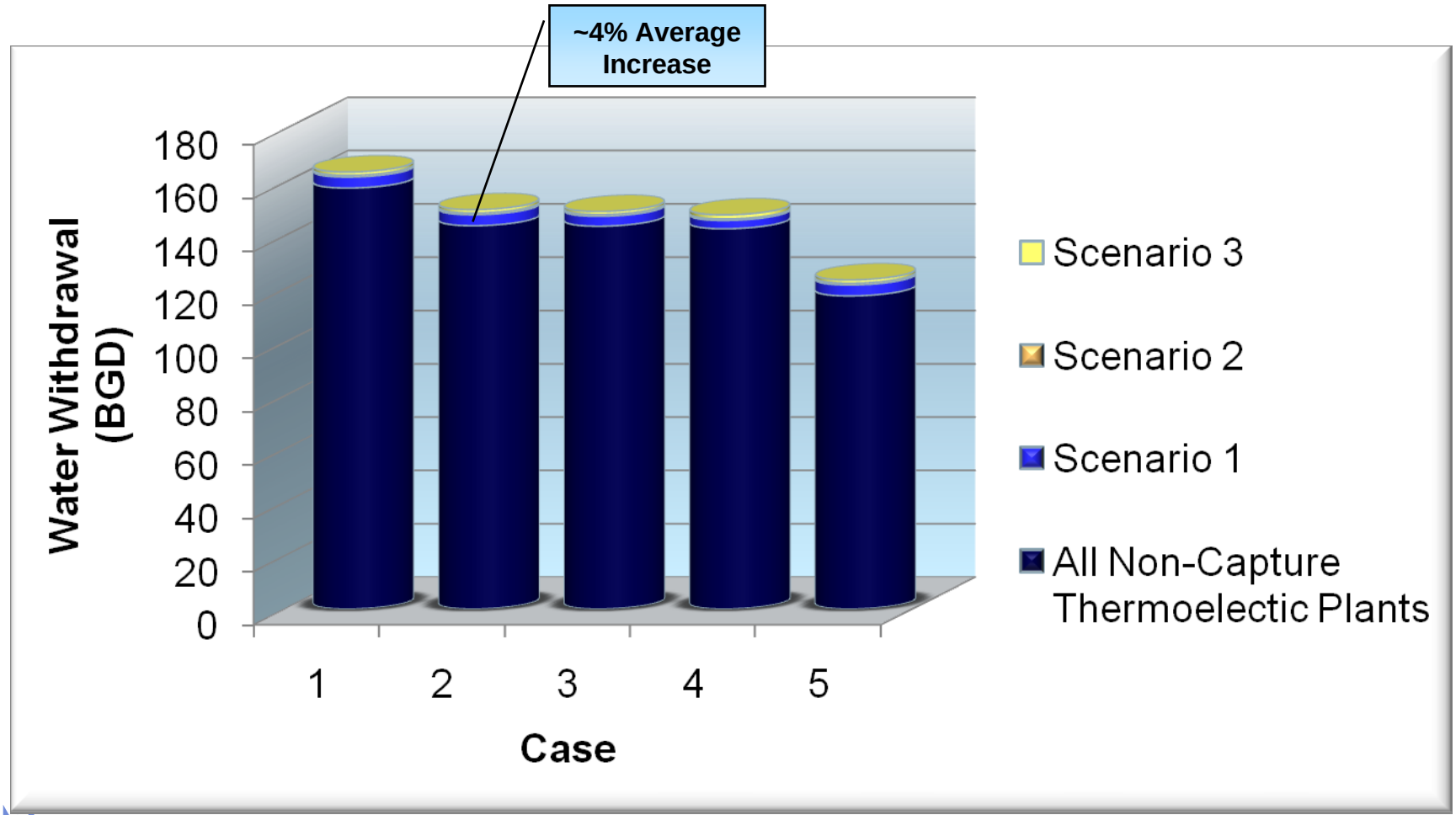
Results
Carbon Capture Water Requirements



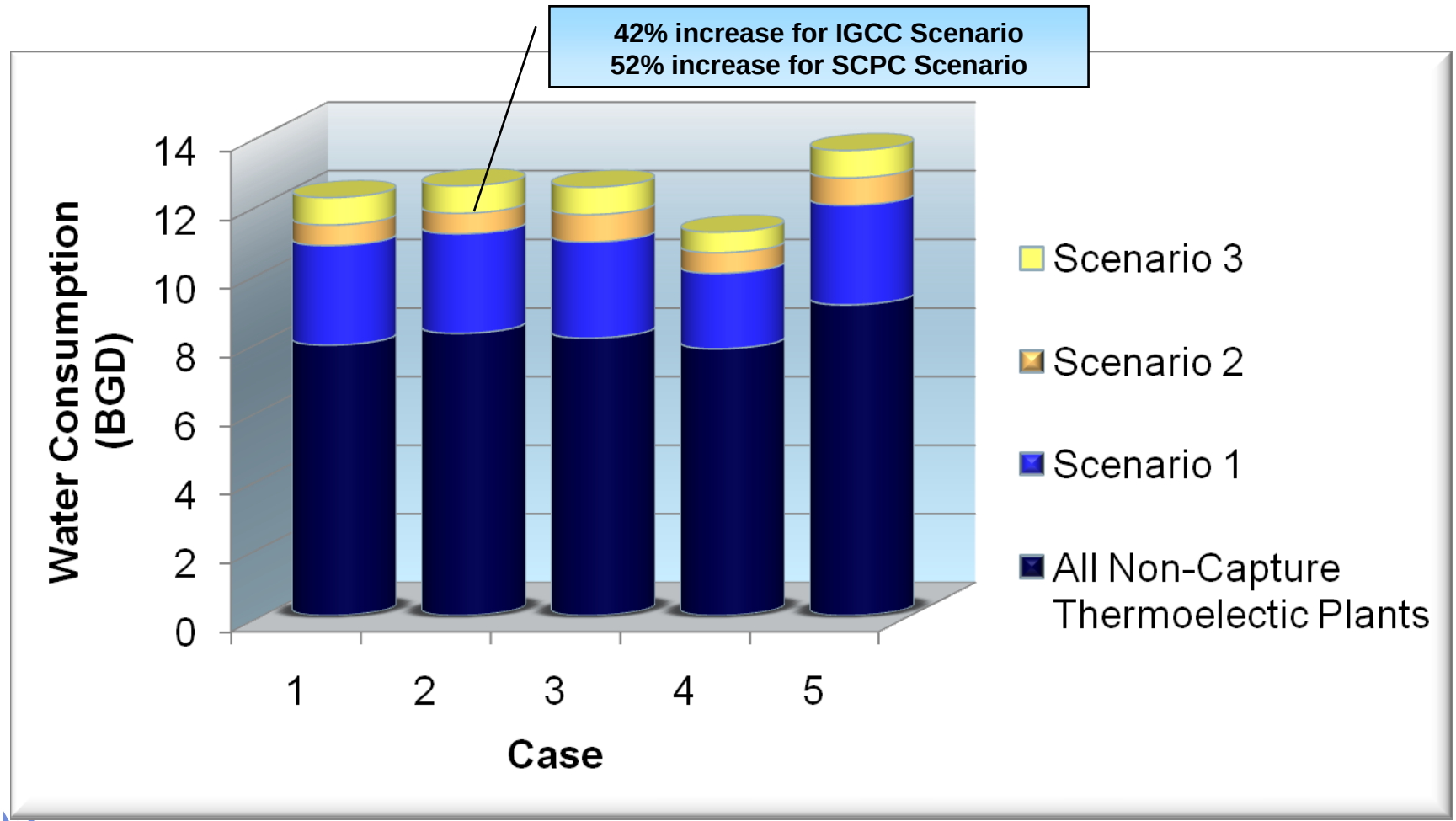
Additional Water Required for CO_2 Capture



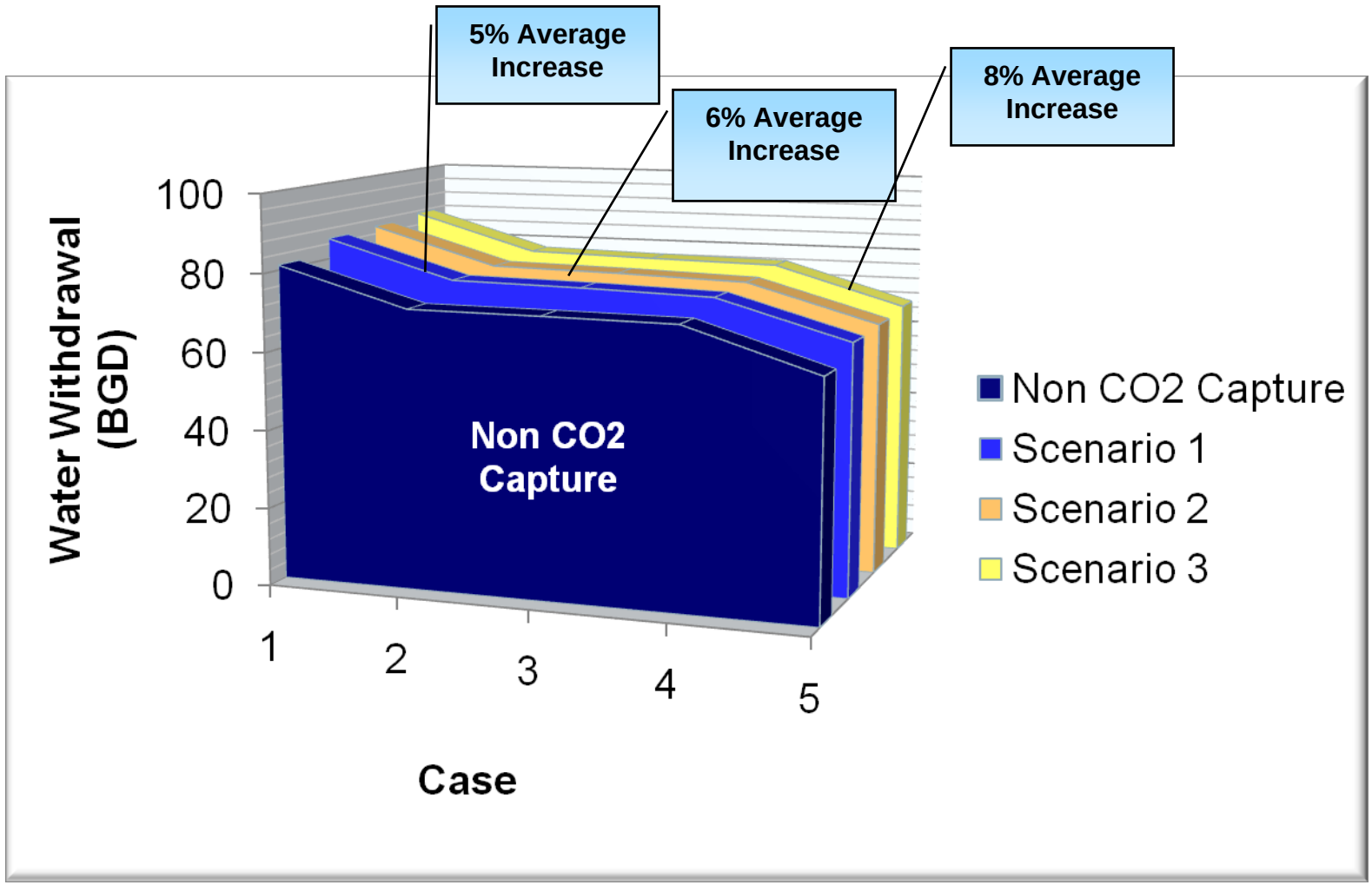
National Freshwater Withdrawal for Thermoelectric Power Generation (2030)



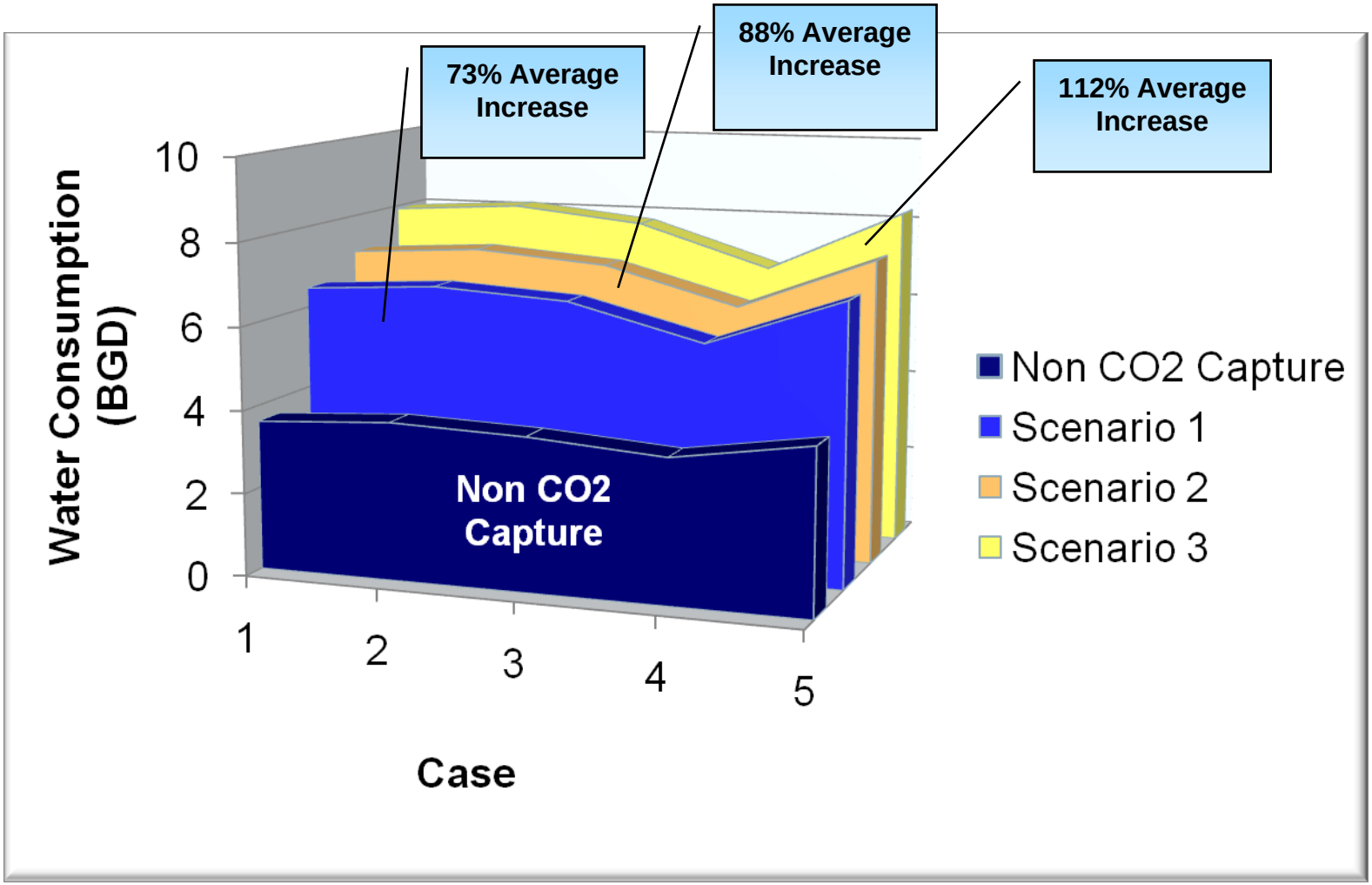
National Freshwater Consumption for Thermoelectric Power Generation (2030)



PC and IGCC Water Withdrawal for Carbon Capture Technologies (2030)



PC and IGCC Water Consumption for Carbon Capture Technologies (2030)



Key Points and Challenges
Summary

- **Water and energy concerns**
  - Water competition
  - Plant Siting and Operation
- **Effects of regulations and policies**
- **Impact cooling systems have on water withdrawal and consumption**
- **Deployment of solvent based Carbon Capture systems and water regulations could noticeably increase water consumption**
- **CO_2 legislation needs to assess full plant impact (not just decrease in CO_2 emissions)**

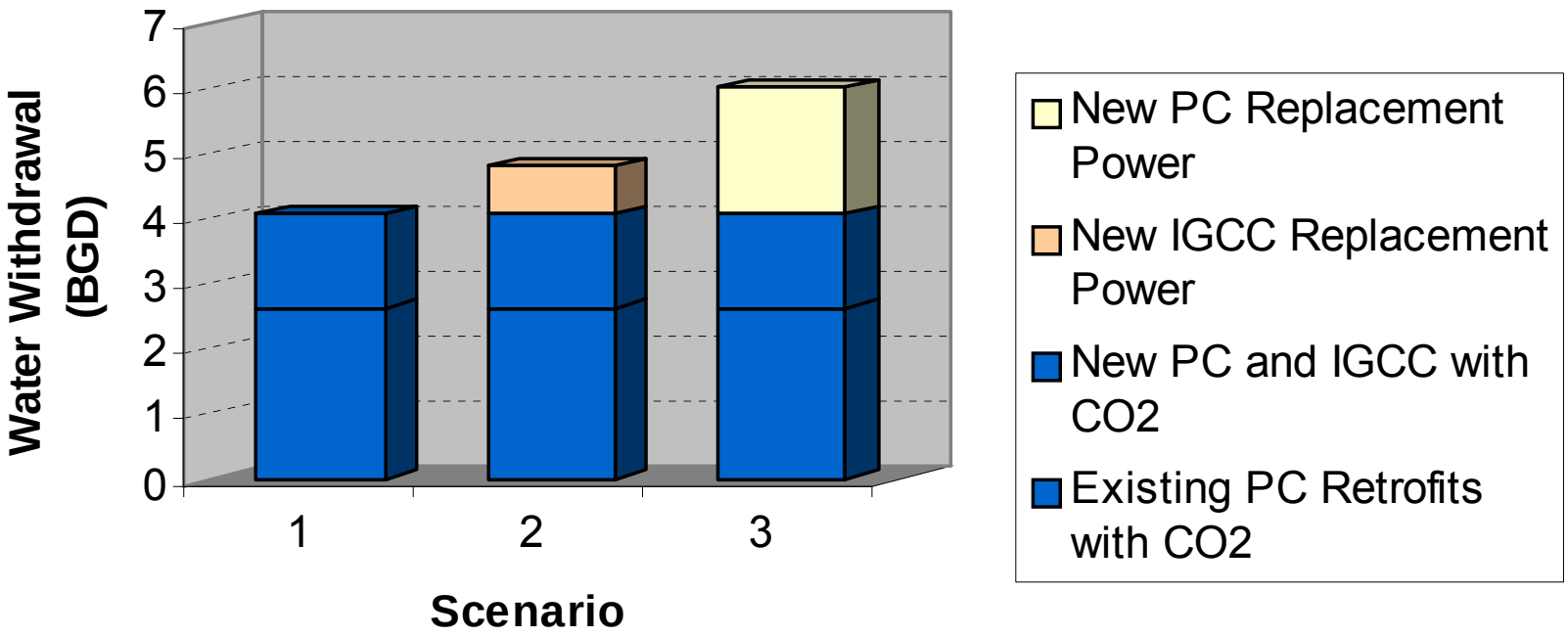
Considerations for 2008 Analysis

- **Update Model/Report with EIA 2008 data**
- **Carbon capture at a regional level**
- **More granularity (deployment by years)**
  - Technologies
  - Carbon capture deployment
- **Introduce late nuclear scenario to carbon capture analysis**
- **No new coal case (EIA analysis of McCain-Lieberman Bill)**
- **Oxyfuel Technologies for carbon capture**

Thank you.

Questions?

Additional Water Withdrawal for CO_2 Capture Scenarios



- **Scenario 1 – Retrofits (no Parasitic make-up power)**
- **Scenario 2 – Retrofits + IGCC make-up**
- **Scenario 3 – Retrofits + Supercritical make-up**

Additional Water Consumption for CO_2 Capture Scenarios