



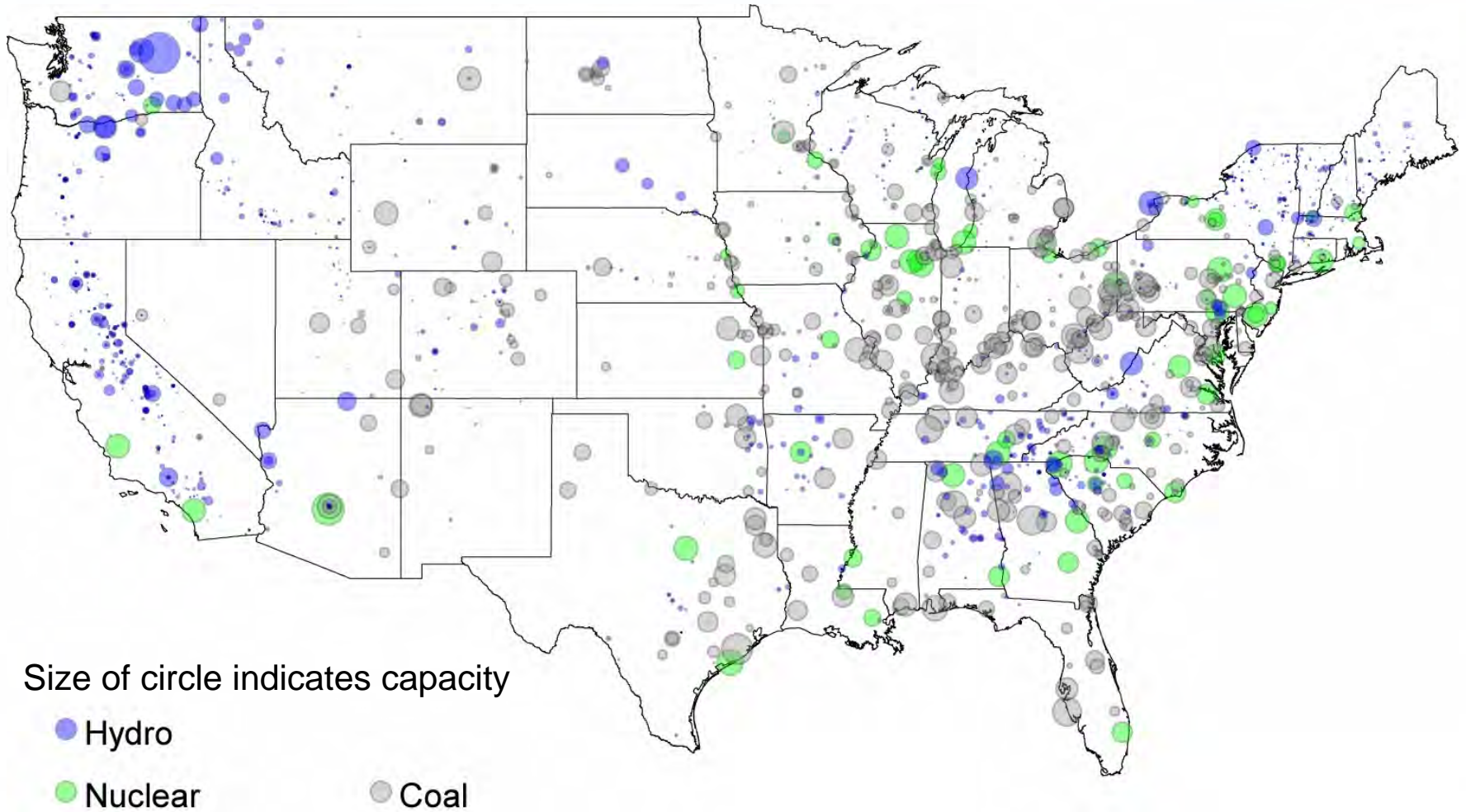
Synapse
Energy Economics, Inc.

Climate Change, Water and Risk in Electricity Planning

NARUC Portland, 2008

July 22nd, 2008
Jeremy Fisher, PhD

US power production relies on water



Source: EPA eGRID, 2006

Three years of SE drought

Florida's Electricity Picture Had Red Flags: Drought can choke power

-U.S. News and World Report (February 26, 2008)

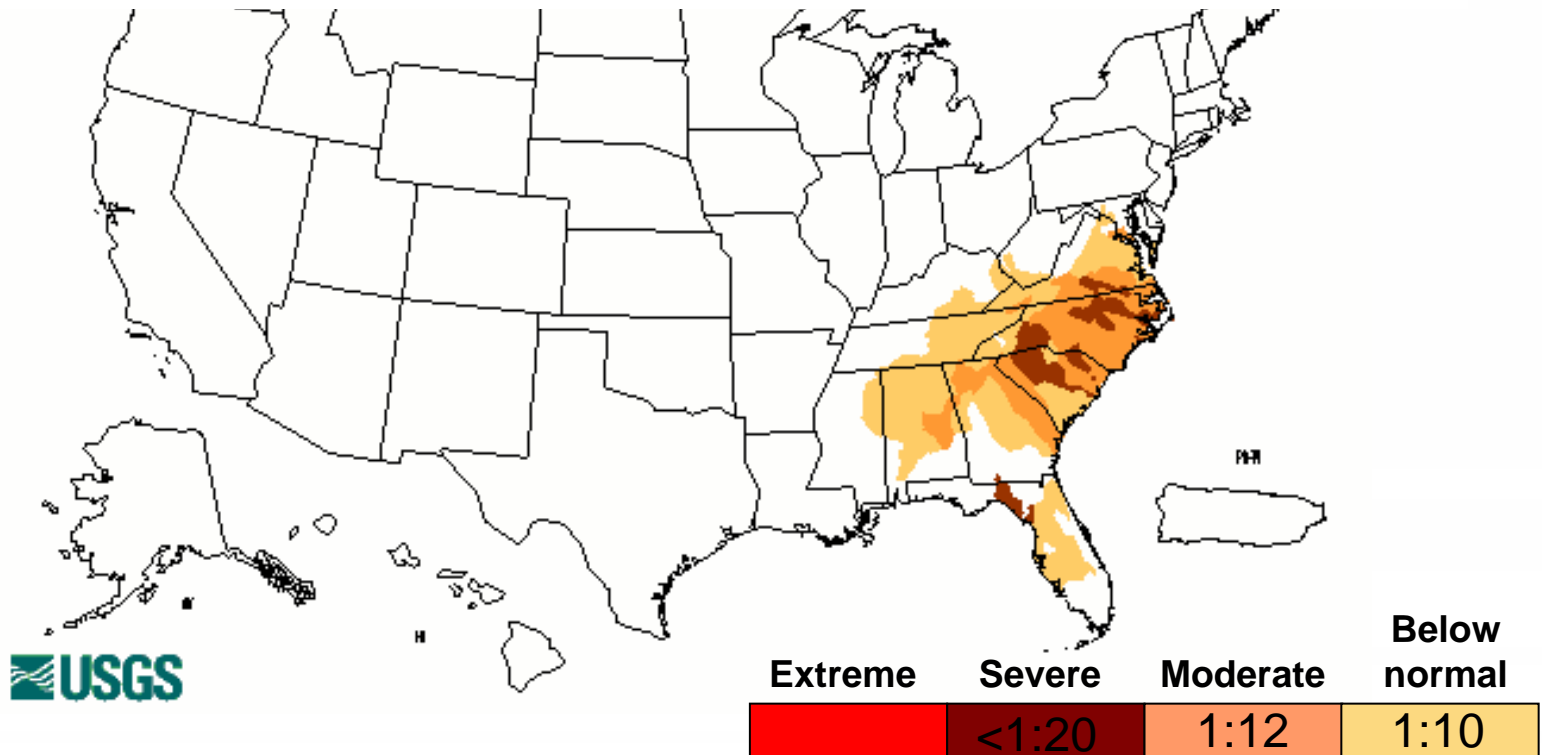
Alabama Pc

Green lawns could lead to brownouts

1 refill more

-CNMONEY.com (February 15, 2008)

-Birmingham News (November 17, 2007)



Southeast Water Dispute of 2006-2008



“The corps is sending 3.2 billion gallons of water downstream out of [the] Georgia reservoir every day. That's enough to fill three and a half Olympic-size swimming pools every minute.”

*-Georgia Governor Sunny Purdue
October 20, 2007*

The Honorable George W. Bush
President of the United States
The White House
Washington, DC 20502-0001

Dear Mr. President

Florida is strongly opposed to the request by the State of Georgia to suspend, indefinitely, the operating rules for the reservoirs on the Chattahoochee River. This request is improper as there exists no legal basis to support the action sought by Georgia. More importantly, if granted, this request would withhold water needed in Florida's Apalachicola River and would have serious, adverse effects on the River and Apalachicola Bay resulting in a profound disruption of the socioeconomic foundation in Florida's Panhandle region.

The Florida Panhandle is facing economic peril as a result of insufficient water flows. The Apalachicola River and Bay support a multi-million dollar commercial fishing industry. The total commercial fishing industry in the Apalachicola Bay is estimated to contribute \$134 million in economic output and an additional \$71 million in value added impacts. Recent data shows this industry is already being jeopardized as a result of reduced inflows. Further reductions would only hasten the decline of this important component of Florida's economy. The resulting loss of jobs will devastate a people who have relied on this industry for generations.

The current, and not unforeseen, crisis underscores the position Florida has taken from the beginning. Alabama, Georgia and Florida need to work together to adequately plan for and provide water for the people of Atlanta as well as the millions of residents in communities downstream. Florida, for example, has enacted comprehensive water supply legislation to ensure water is available to meet the needs of its communities, prior to development. The legislation provides the plan and funding for developing alternative water supplies such as desalinization, reuse, and conservation as well as adding new requirements for regional water supply plans to make them more useful to local governments and enhance consumptive use permitting. By ensuring water is available prior to development, Florida is, and has been, less vulnerable to periods of drought.

“Georgia ignores the fact that the Farley Nuclear Plant sits on the banks of the Chattahoochee River and requires cooling water... If Georgia obtained the presidential action it seeks, then there would likely be inadequate cooling water for the nuclear plant.”

*-Alabama Governor Bob Riley
October 22, 2007*

“The Florida Panhandle is facing economic peril as a result of insufficient water flows.”

*-Florida Governor Charlie Christ
October 24, 2007*

Southeast Water Dispute of 2006-2008

Drought-Stricken Georgia, Eyeing Tennessee River, Revives Old Border Feud

- Christian Science Monitor (February 15, 2008)



Georgia Claims a Sliver of the Tennessee River

-New York Times (February 22, 2008)

Electricity: 3.3 billion gallons H₂O consumed per day

- Generators rely on a clean, reliable source of water for:
 - Hydroelectric generation
 - Boilers
 - Cooling (condensation)
 - Fuel processing
 - Coal processing (10-50 gal / MWh)
 - Gas separation (IGCC)
 - Oil shale (100-250 gal / MWh)
 - Chemical processing
 - SO₂ (dry / wet scrubbing)
 - NO_x (SCR / SNCR)
- Water losses
 - Evaporation from reservoirs
 - Average loss of 4,500 gal / MWh
 - Total loss of 3.8 billion gallons (11,700 acre feet) per day
 - Open-loop cooling
 - 1% of water withdrawn is lost to evaporation
 - Only ~10 thermoelectric plants built open-loop since 1980
 - Cooling tower / pond
 - Draw 95% less water than open-loop
 - Loose most water to evaporation

Water Overabundance



*U. Iowa Plant
2008 Flood.
Source: Flickr*

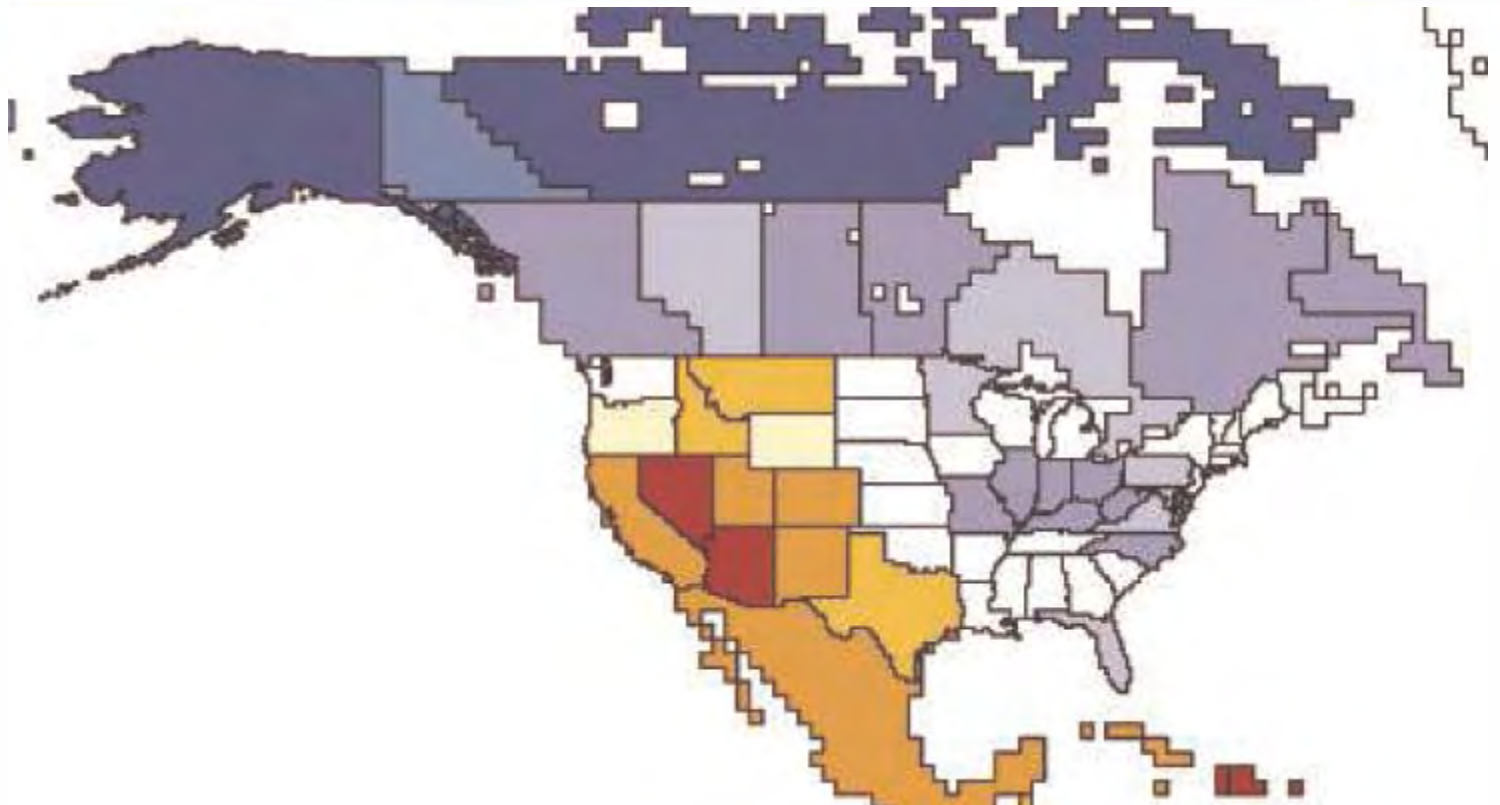


*Baxter Wilson Power Plant,
April 2008. Source: Flickr*

*1993 Missouri Flood
Source: FEMA*



Change in water availability by 2050



Percentage Change in Runoff Volume

-40 -20 -10 -5 -2 2 5 10 20 40

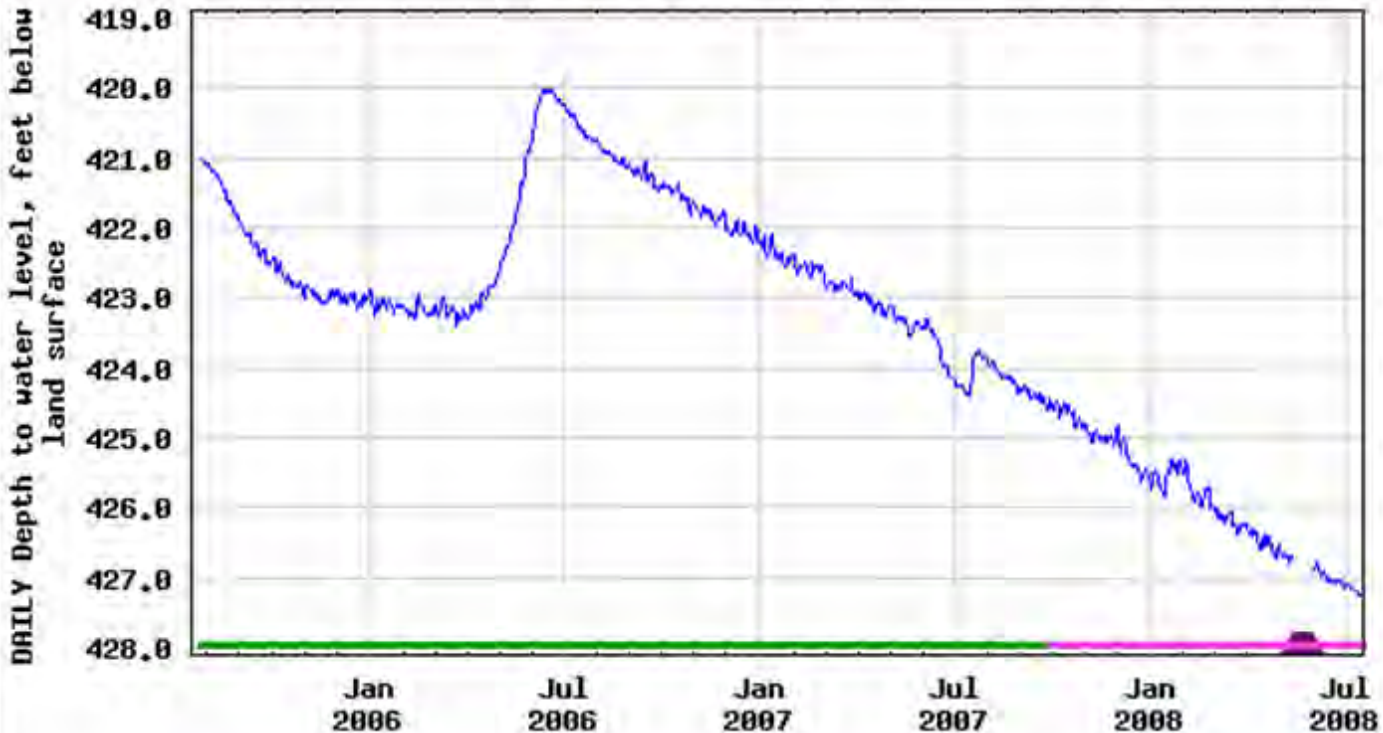
Stationarity Is Dead: Whither Water Management?
Milly et al., 2008. Science

White Pine County, Nevada

Las Vegas
-Ely Times



USGS 385521114503601 179 N12 E63 12AB 1 USGS - S Steptoe MX Well



— Daily mean depth to water level
— Period of approved data

▲ Equipment malfunction
— Period of provisional data

Pipe dredging
-Salt Lake Tribune

Age of water
"could be
the
-Salt Lake Tribune

Major water project
"A bid to pump water
rural Nevada
- AP, July 10

White Pine
gallon
-Ely Times

Conditions on

on



**Sunflower:
Holcomb,
Kansas**

1,980 MW
(expansion)

24,000 acre feet
(8 billion gallons)



**Toquop,
Nevada**

750 MW

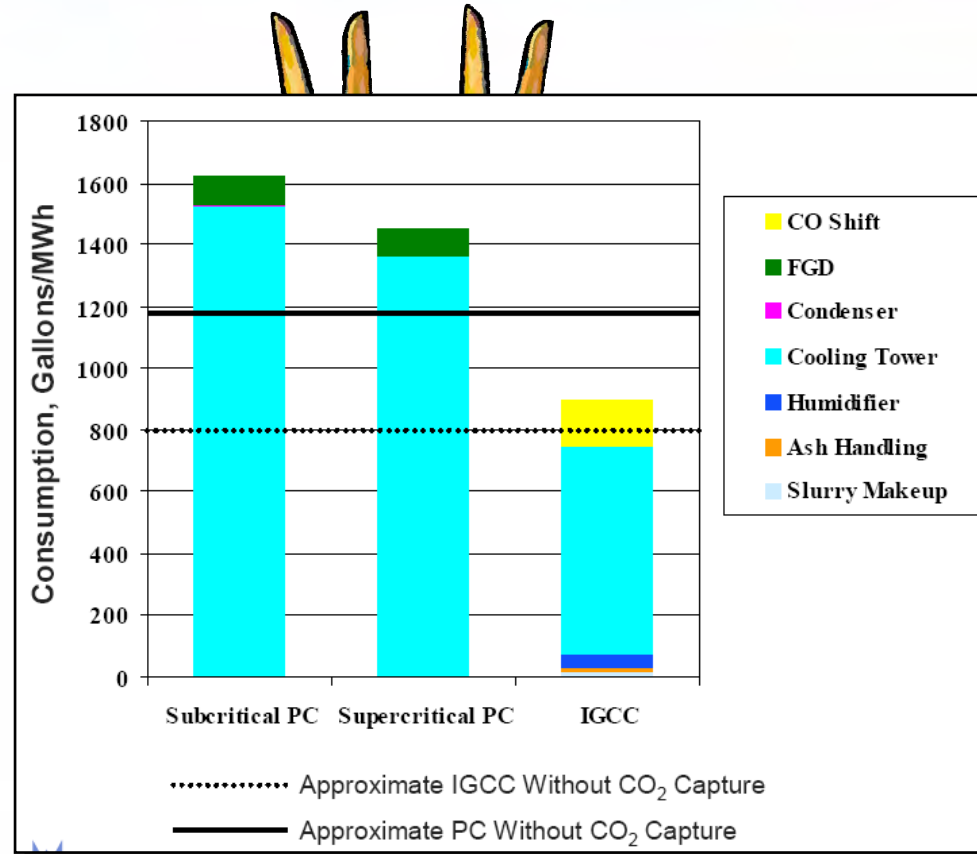
2,000 acre feet
(651 million
gallons)

Planning for Droughts and Floods

- Plans should include plausible risk of drought
 - Usually water risk is determined by a water authority, not commission
 - Economic risks associated with loss of water availability
 - What are the impacts of water availability on operations, price, and reliability?
 - Assess short and long term risks
 - Climate change – droughts, increased flooding, change in water regime?
 - All alternatives in a portfolio should be evaluated for water risk
 - Due diligence.

CCS: A New Wrinkle

- Carbon capture and sequestration
 - Developing technologies are water intensive
 - Gas shift in IGCC
 - Amines (cooling, liquid spray)
 - Ammonia (cooling, slurry, spray)
 - Carbonates (wet scrubbing)
 - Water use poorly characterized for emerging technologies
 - Will there be enough water to support CCS?

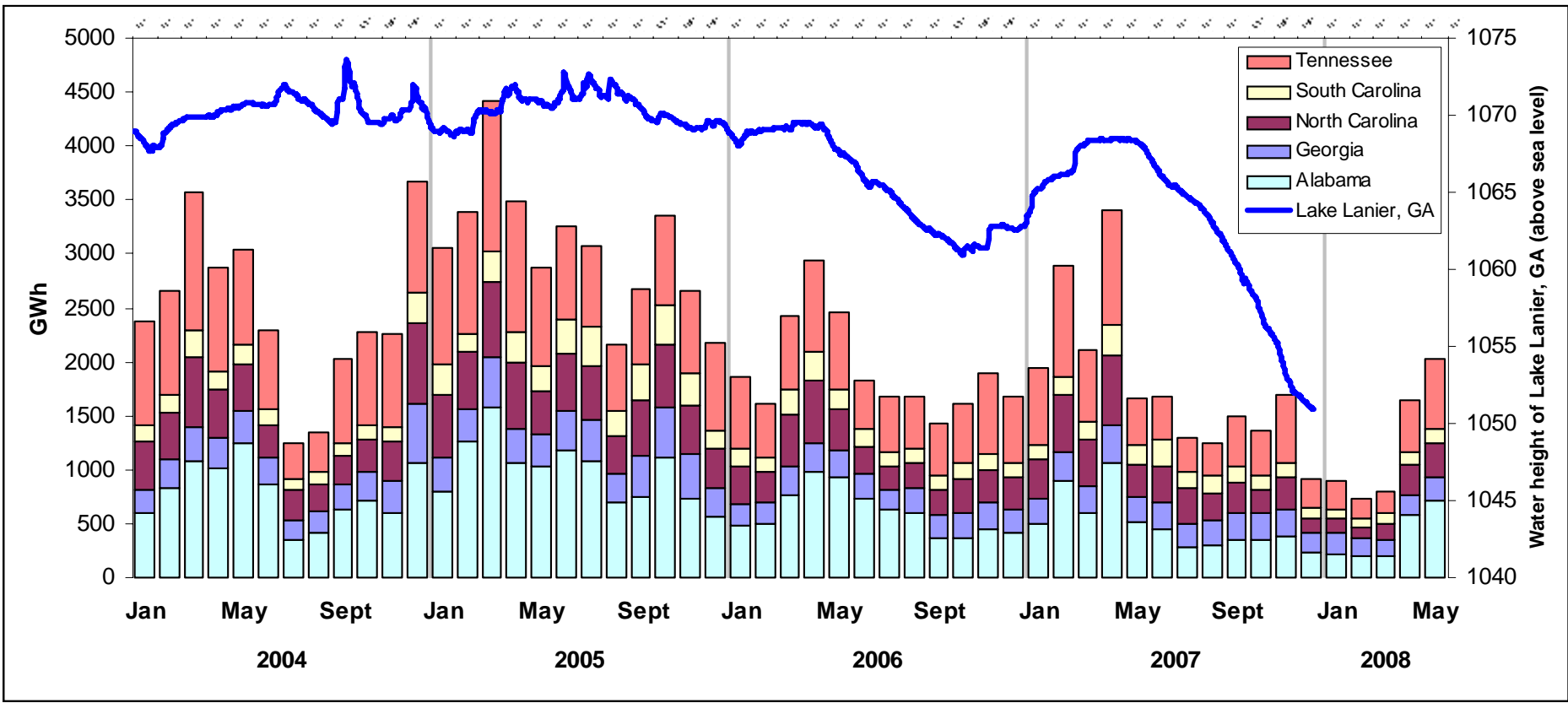


National Energy Technology Laboratory

- Climate change threatens to tighten already short water supplies: *plan for climate change*
- Thermoelectric generators are being built today without a clear understanding of future water risks
- Carbon capture and sequestration technologies are water intensive: it may be difficult to incorporate CCS in water-sparse regions
- Few, *if any*, regions of the country where water consumption does not need to be seriously evaluated in planning

Additional Slides

Lake Lanier, GA



USGS Estimate of US Water Use

Public Supply, 11 percent



Irrigation, 34 percent



Aquaculture, less than 1 percent



Mining, less than 1 percent



Domestic, less than 1 percent



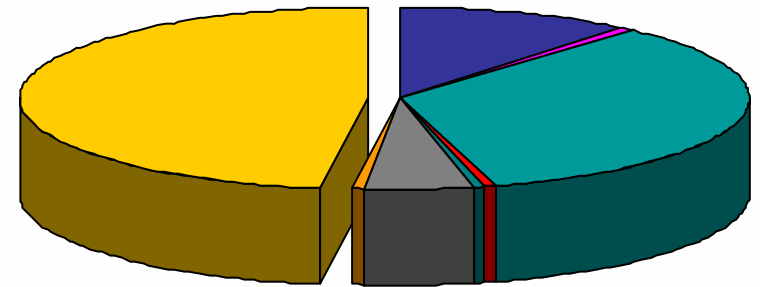
Livestock, less than 1 percent



Industrial, 5 percent



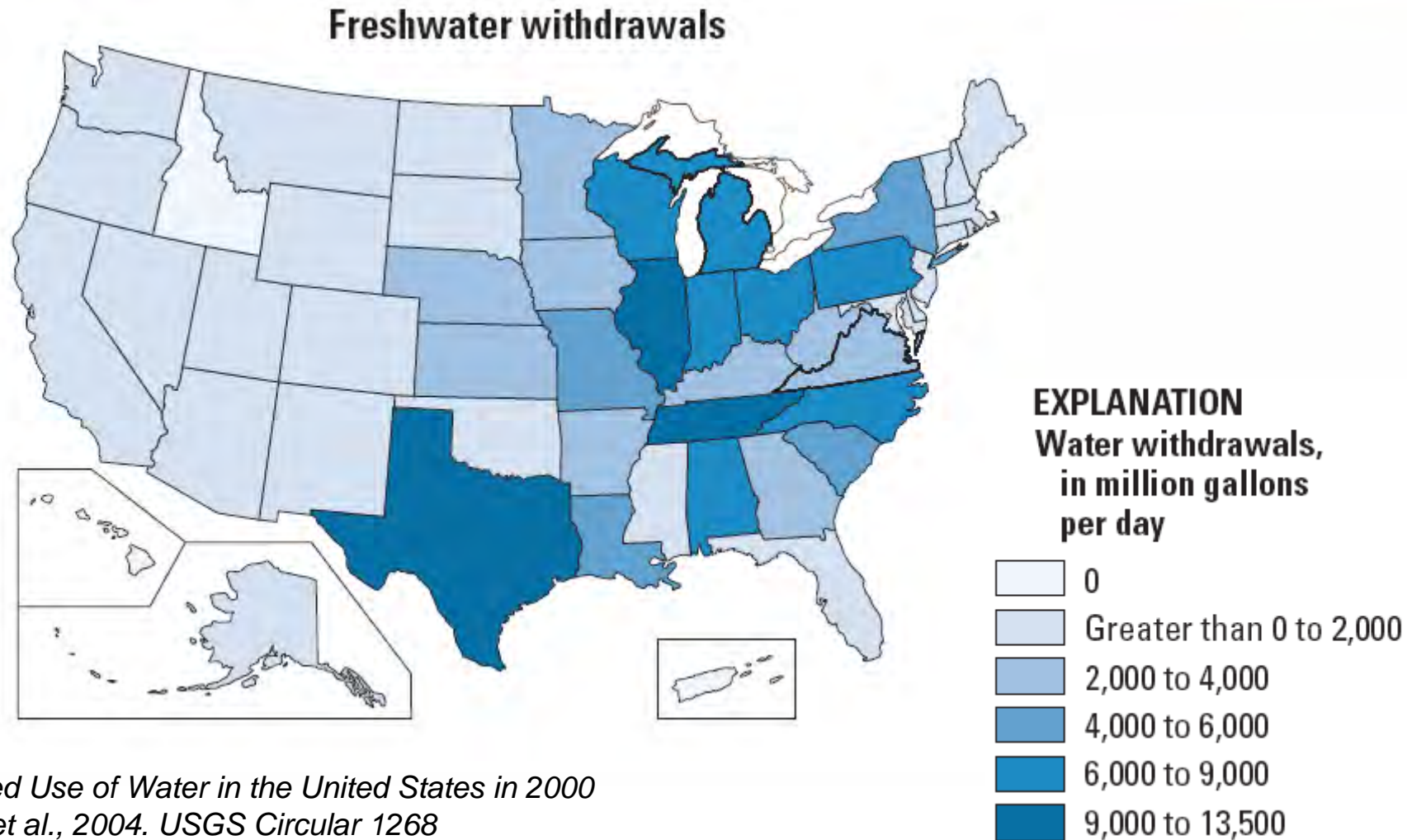
Thermoelectric Power, 48 percent



- Public Supply
- Irrigation
- Aquaculture
- Mining
- Domestic
- Livestock
- Industrial
- Thermoelectric

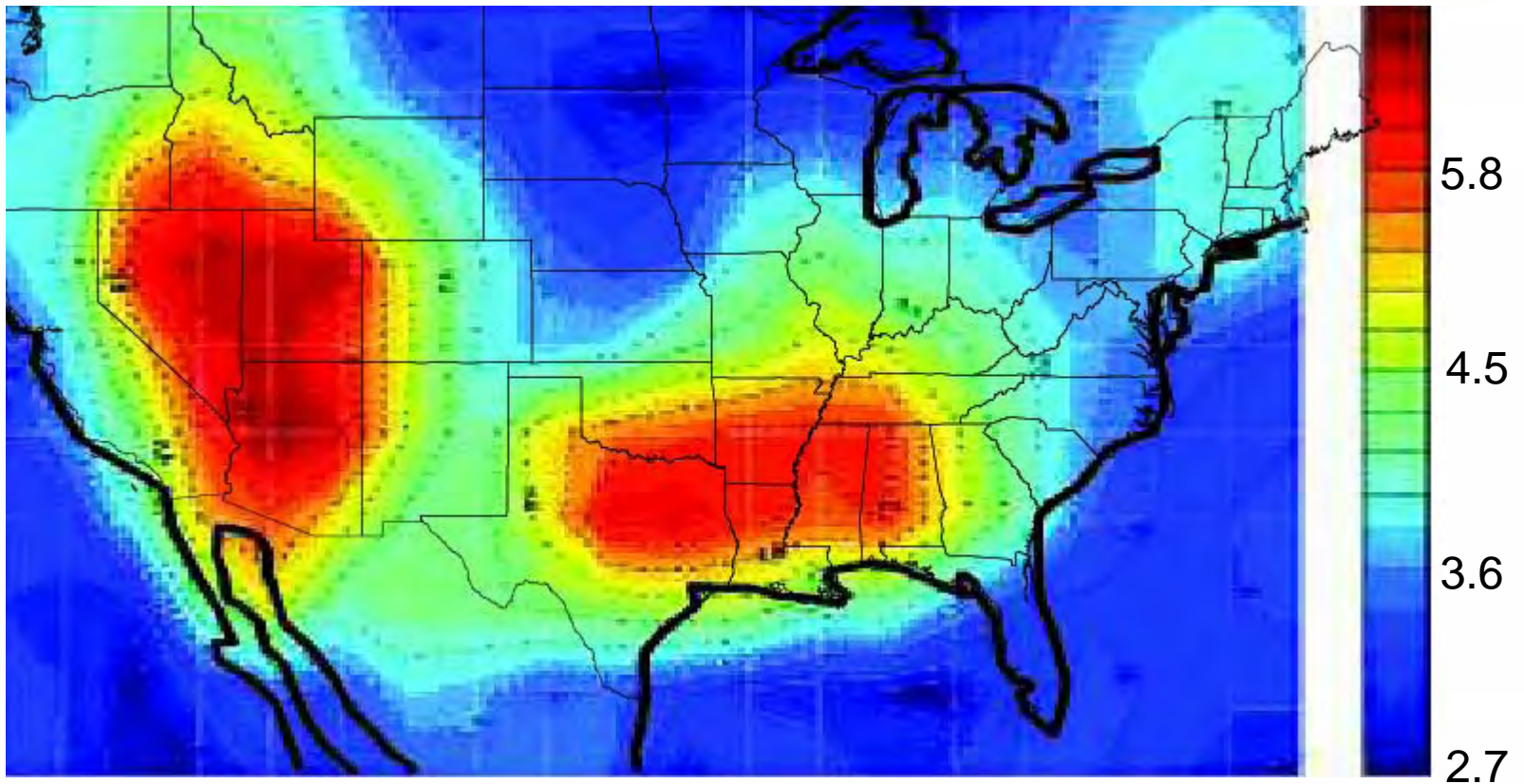
*Estimated Use of Water in the United States in 2000
Hutson et al., 2004. USGS Circular 1268*

USGS: Thermoelectric Freshwater Withdrawals



Estimated Use of Water in the United States in 2000
Hutson et al., 2004. USGS Circular 1268

Heat Wave Severity Increases (°F)



Regional Impacts of Climate Change: Four Case Studies in the United States
Ebi and Meehl. 2007. Heatwaves & Global climate change.