

A close-up photograph of a single water droplet falling into a pool of water, creating concentric ripples. The background is a soft, light blue gradient.

ENERGY-WATER *NEXUS*

USCET

Dr. Mark Bernstein

Managing Director

USC Energy Institute

Energy-water-climate and the economy

- 1. We use energy for water and water for energy**
- 2. The energy water relationship is strained**
 - 2003 heat wave in France
 - 2008 Georgia drought
- 3. And Getting worse**
 - Demand is increasing
 - Global climate change
 - Shifting towards increasing water-intensity of energy and water-intensity of energy



Graphic courtesy of Michael Webber UT Austin

Energy used in all parts of water

	Source/Treatment Type	Energy [kWh/Mgal]
Water	Surface Water	1,400
	Groundwater	1,800
	Brackish Groundwater	3,900-9,750
	Seawater	9,780-16,500
Wastewater	Trickling Filter	955
	Activated Sludge	1,300
	Advanced Treatment w/o Nitrification	1,500
	Advanced Treatment w/ Nitrification	1,900

USCEI

[Source: Stillwell, 2009]

Stats people throw around

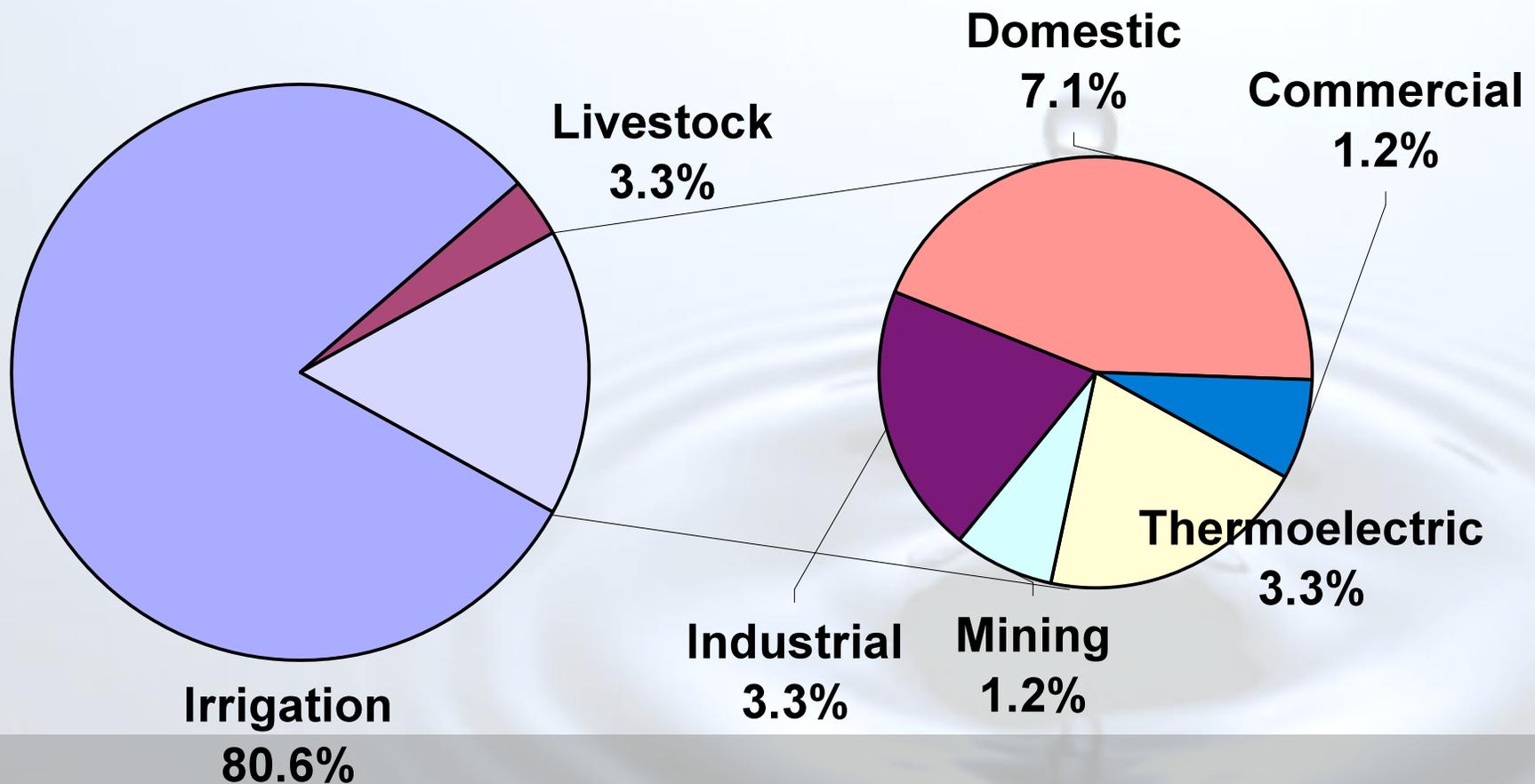
- **Almost 10% of national energy use is used for water**
- **The amount of energy used to deliver that water to residential customers in Southern California is equivalent to approximately one-third of the total average household electric use**
- **Half of a city's energy use may be associated with water**

There's also lots of water IN energy

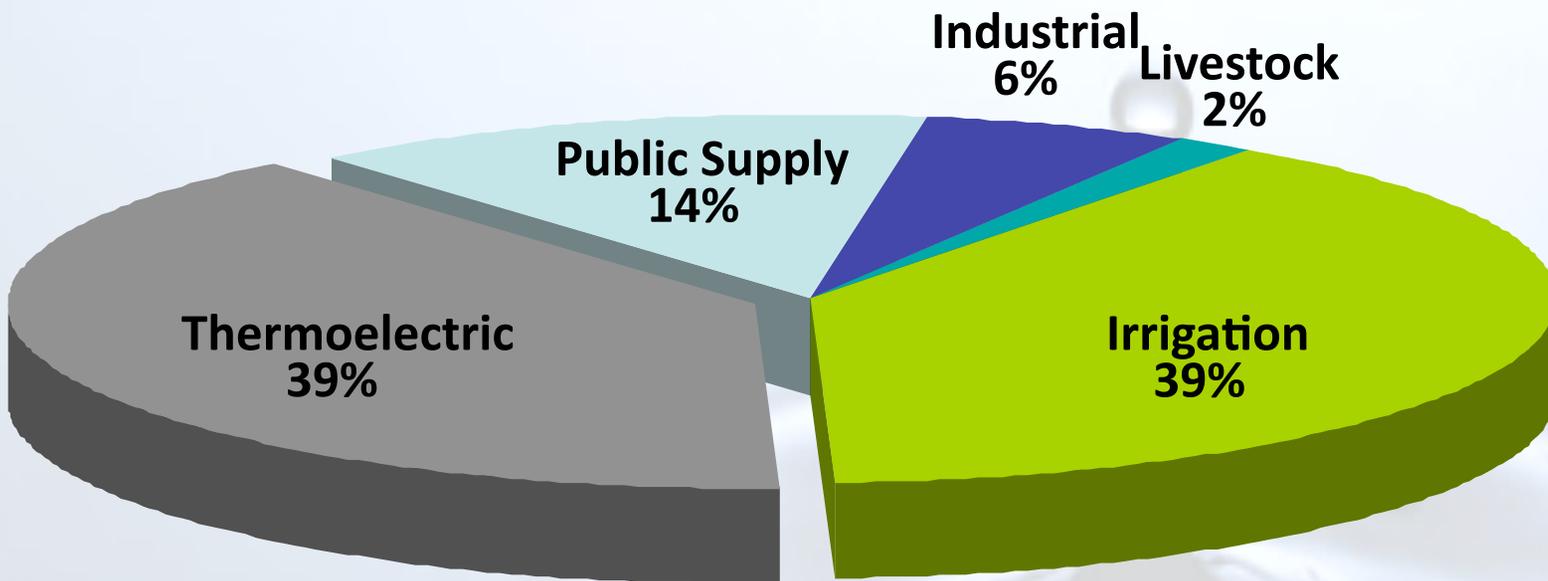
- **Oil and Gas**
 - Drilling, completion, fracturing, refining,
- **Coal**
 - Operations, tailings, drainage, slurry
- **Power plants**
 - Cooling and operations
- **Biofuels**
 - Growing, refining, distribution

Freshwater Consumption

U.S. Freshwater Consumption, 100 Bgal/day



Estimated Freshwater Withdrawals by Sector: 320 BGD



Note: Hydropower and saline water uses are not included here!

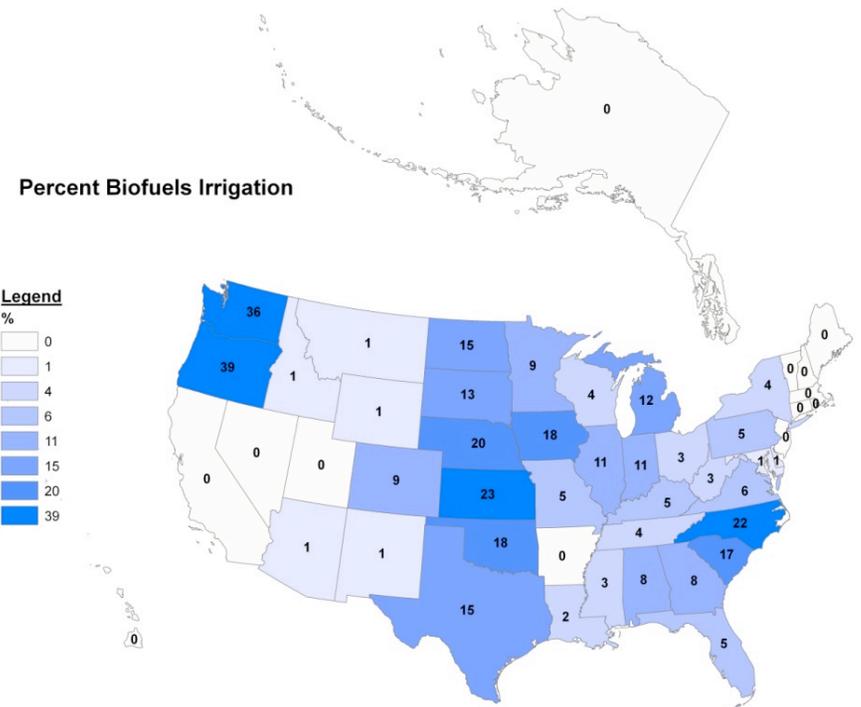
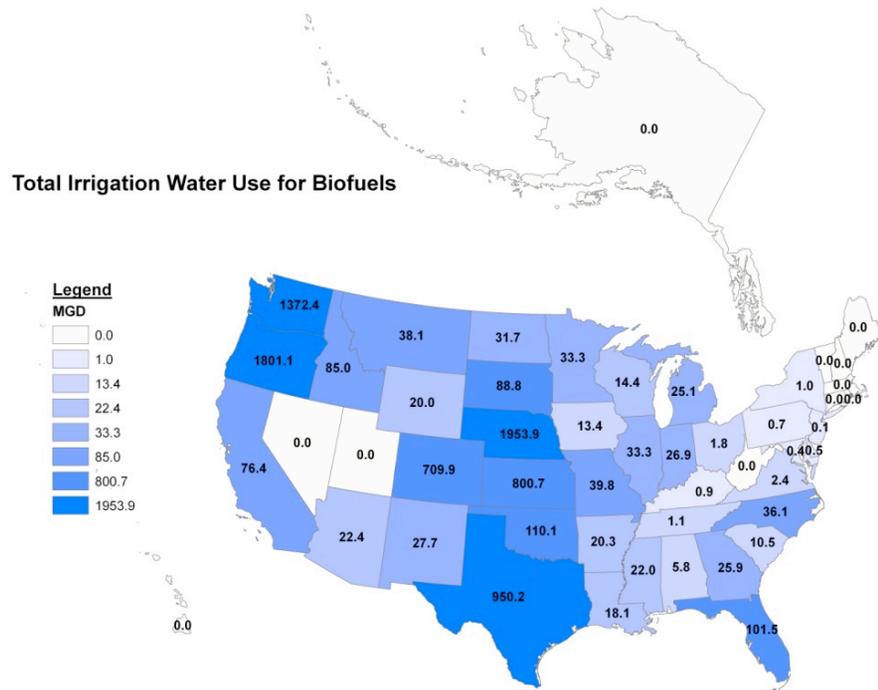
Source: USGS Circular 1268, March, 2004

If hydropower and saline water uses are included –
it rises to almost 50%

We are moving toward more water used in energy

- **Nuclear power, Solar CSP**
 - Though we are also choosing water-lean energy forms
 - Solar PV, wind, natural gas
- **Future transportation fuels may use more water**
 - **Unconventional fossil fuels (up to 4x more)**
 - **Electricity (2-3x more depending on tech)**
 - **Biofuels (2-1000x more depending on tech)**

Water use for biofuels



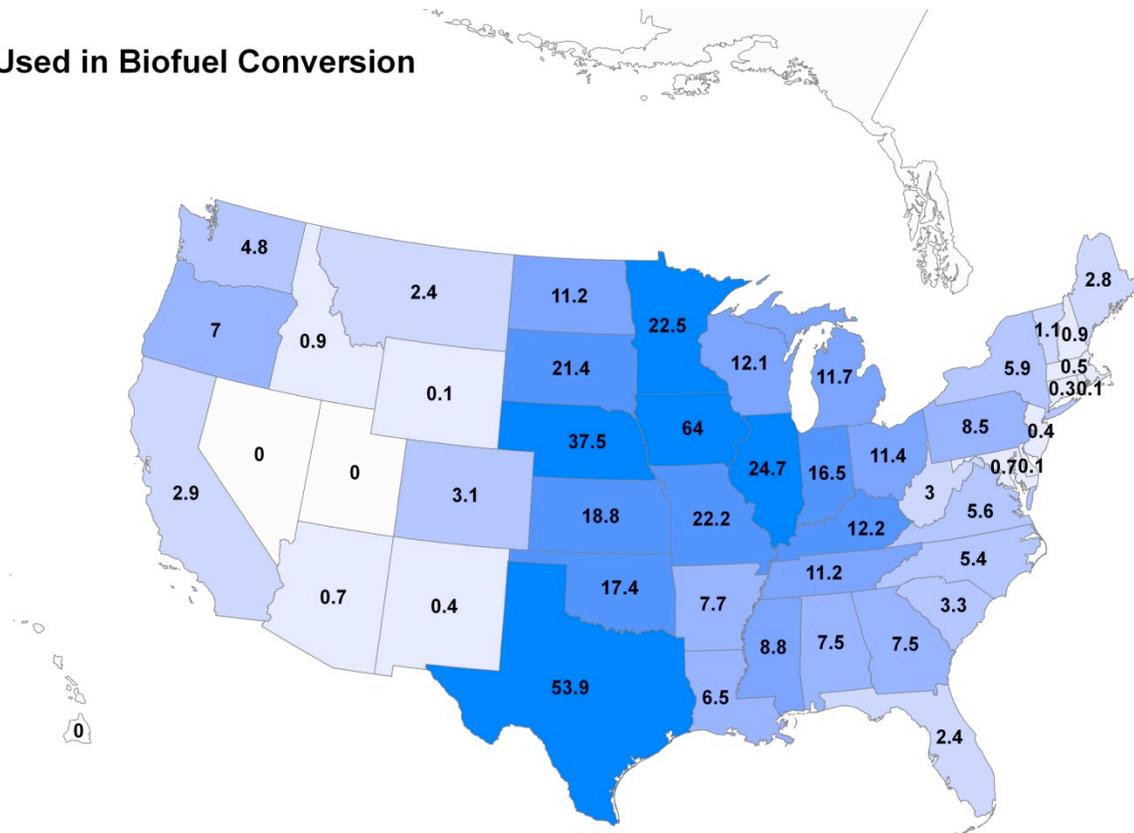
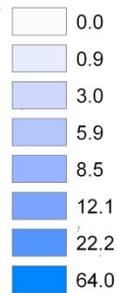
Vince Tidwell, Sandia National Lab

Water used in Conversion

Total Water Used in Biofuel Conversion

Legend

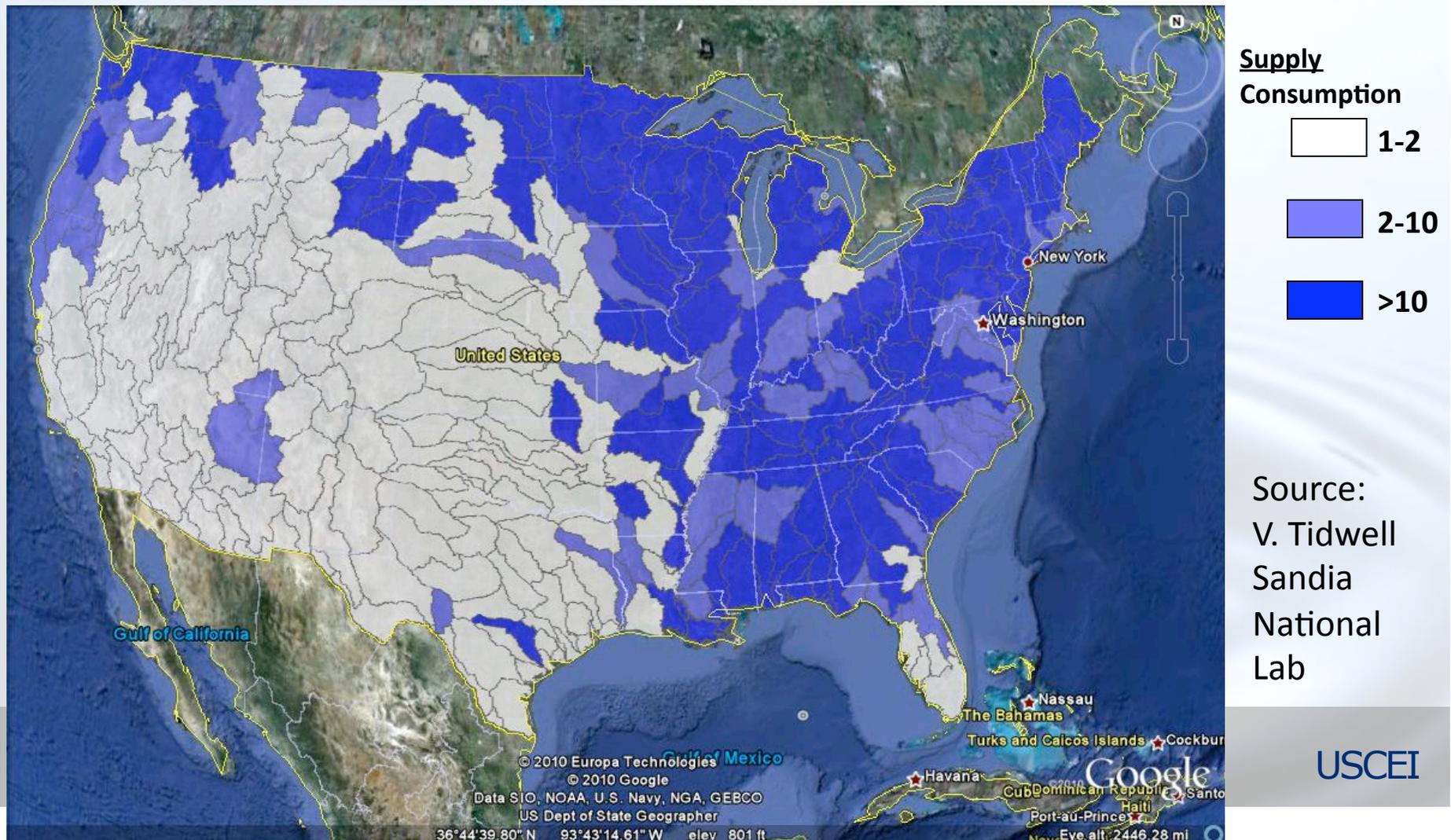
MGD



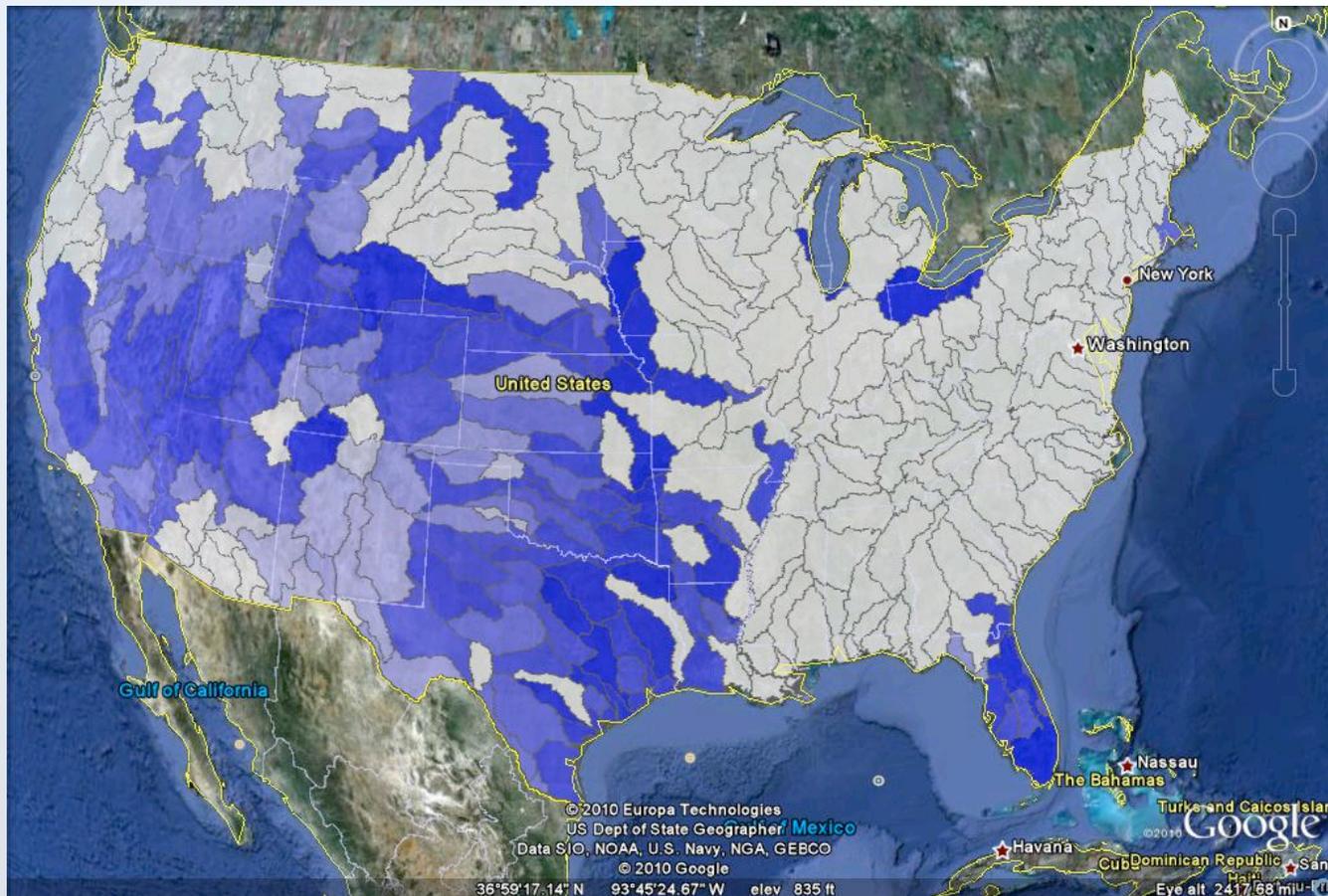
Vince Tidwell, Sandia National Lab

Water Scarce Regions

Ratio of 5th Percentile Stream Flow (Low Flow) to Total Water Consumption: 2004

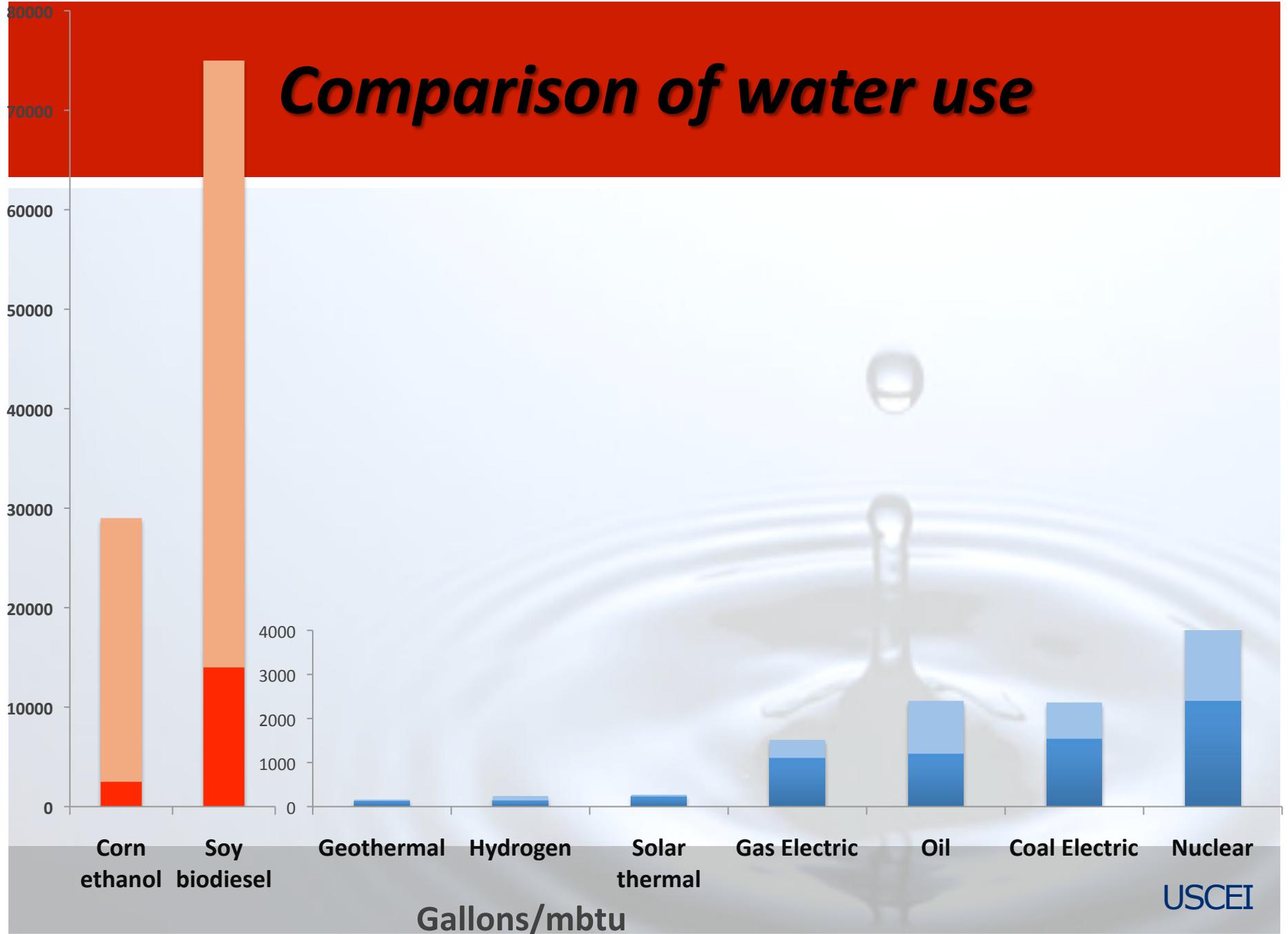


Where will we site future power plants?

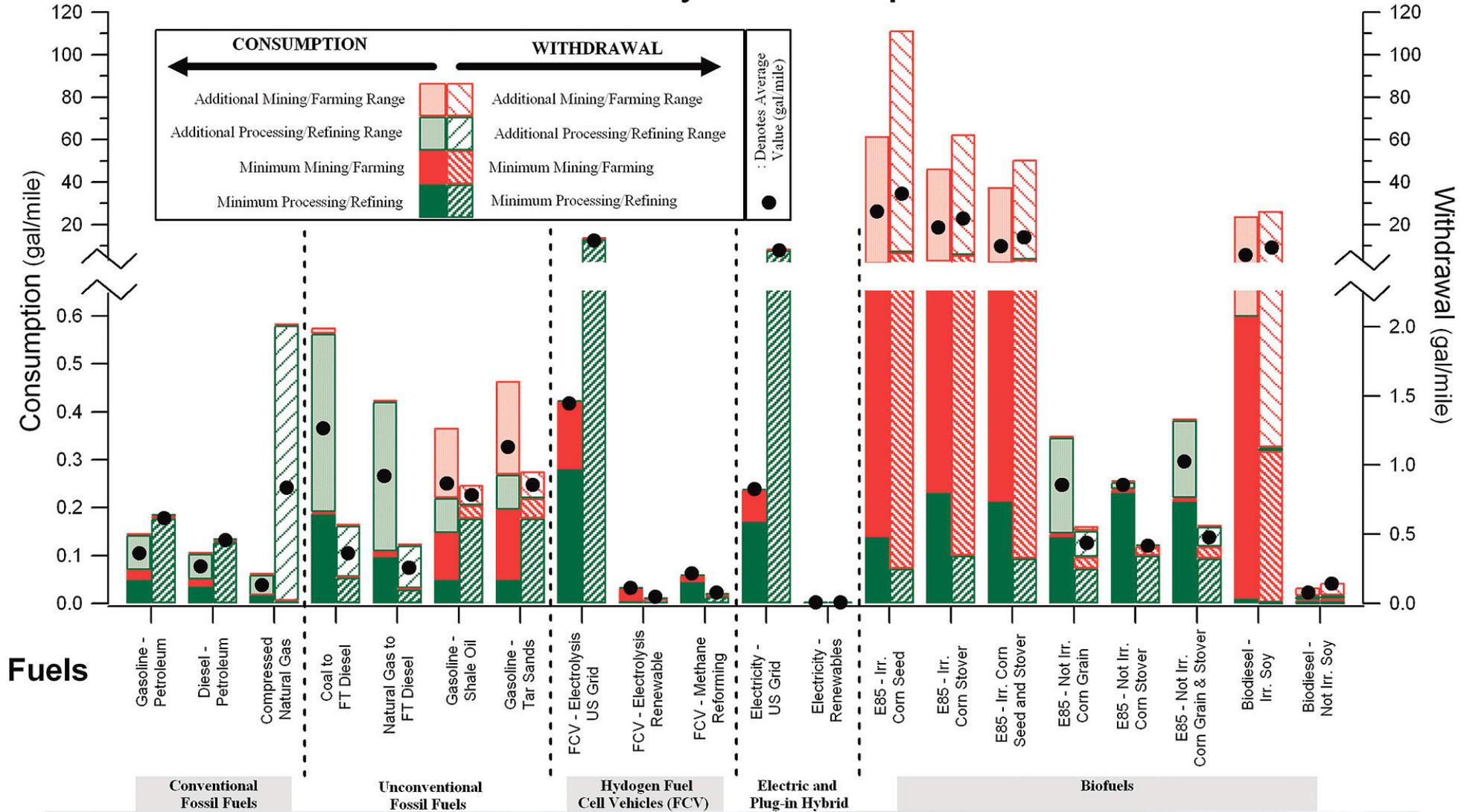


- 1316 MGD consumption at risk

Comparison of water use

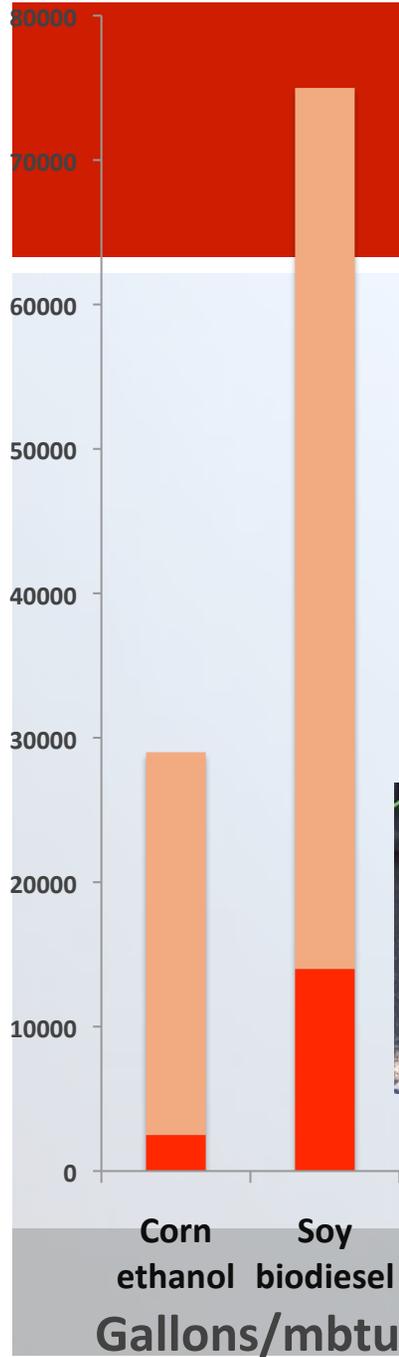


Water Intensity of Transportation



Ref: King and Webber, The Water Intensity of Transportation

Comparison of water use



Algae?



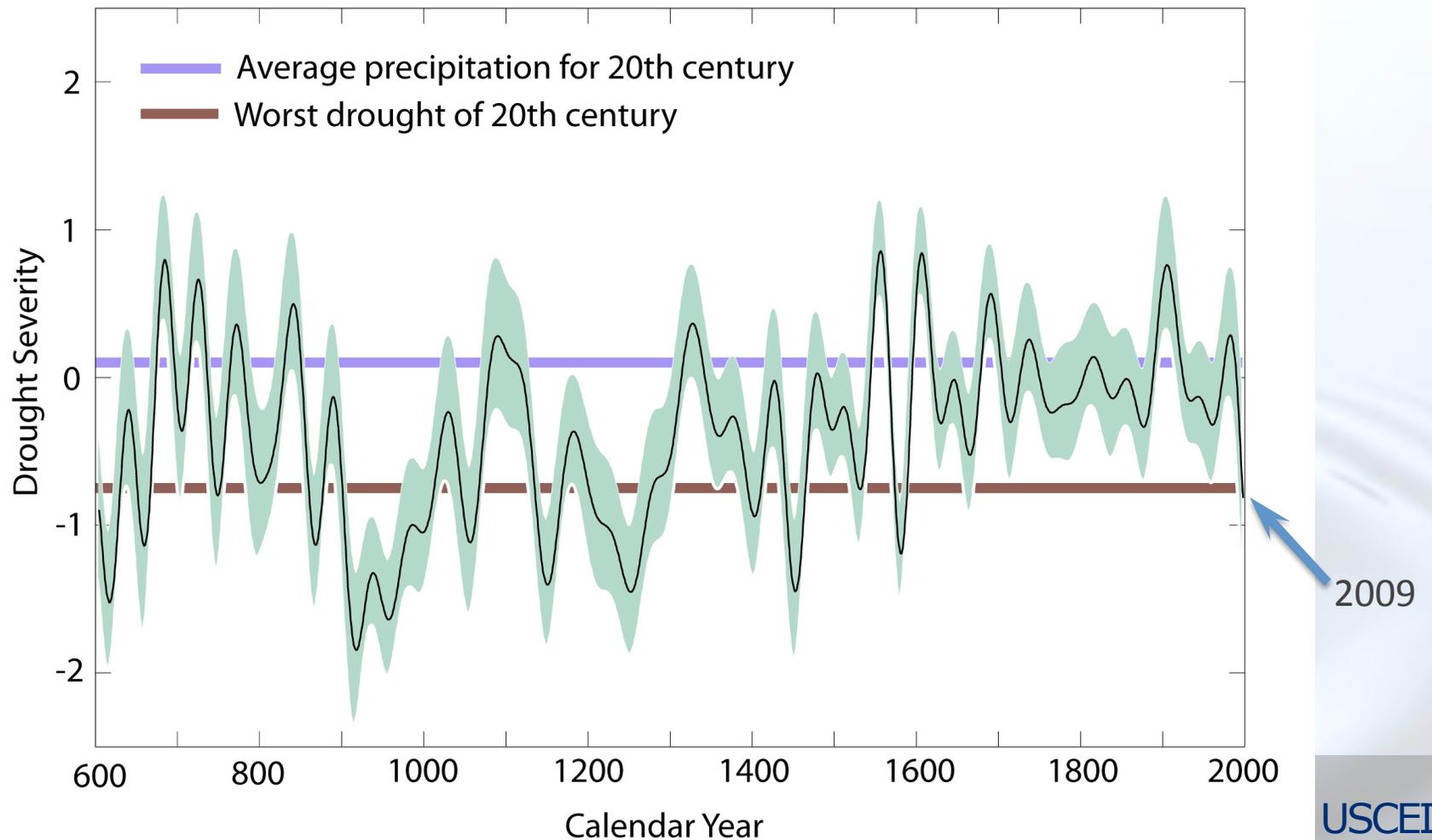
Jatropha?



Waste?

Other?

Implications for CA – Future of water



USCEI

Implications for CA: Water use

- **Agriculture is still highest water use**
- **Water issues will increase in intensity**
- **Reshaping water relationships will be necessary**
- **It will be contentious**
- **Biofuels could be impacted:**
 - **Unlikely that CA will be a large producer of biofuel crops**
 - **CA can be a biofuel converter**
 - **Can use reclaimed water**

We can break the cycle

- **Increase efficiency of water and energy use – i.e. reduce demand**
- **Reduce energy intensity of water by increasing efficiency**
- **Recognize the value of water and the consequences**
- **Reduce water intensity of energy by**
 - **Using low water technologies like solar and wind**
 - **Develop technologies to reduce water in other new technologies**

Thanks

Mark Bernstein

mabernst@usc.edu

www.usc.edu/energy