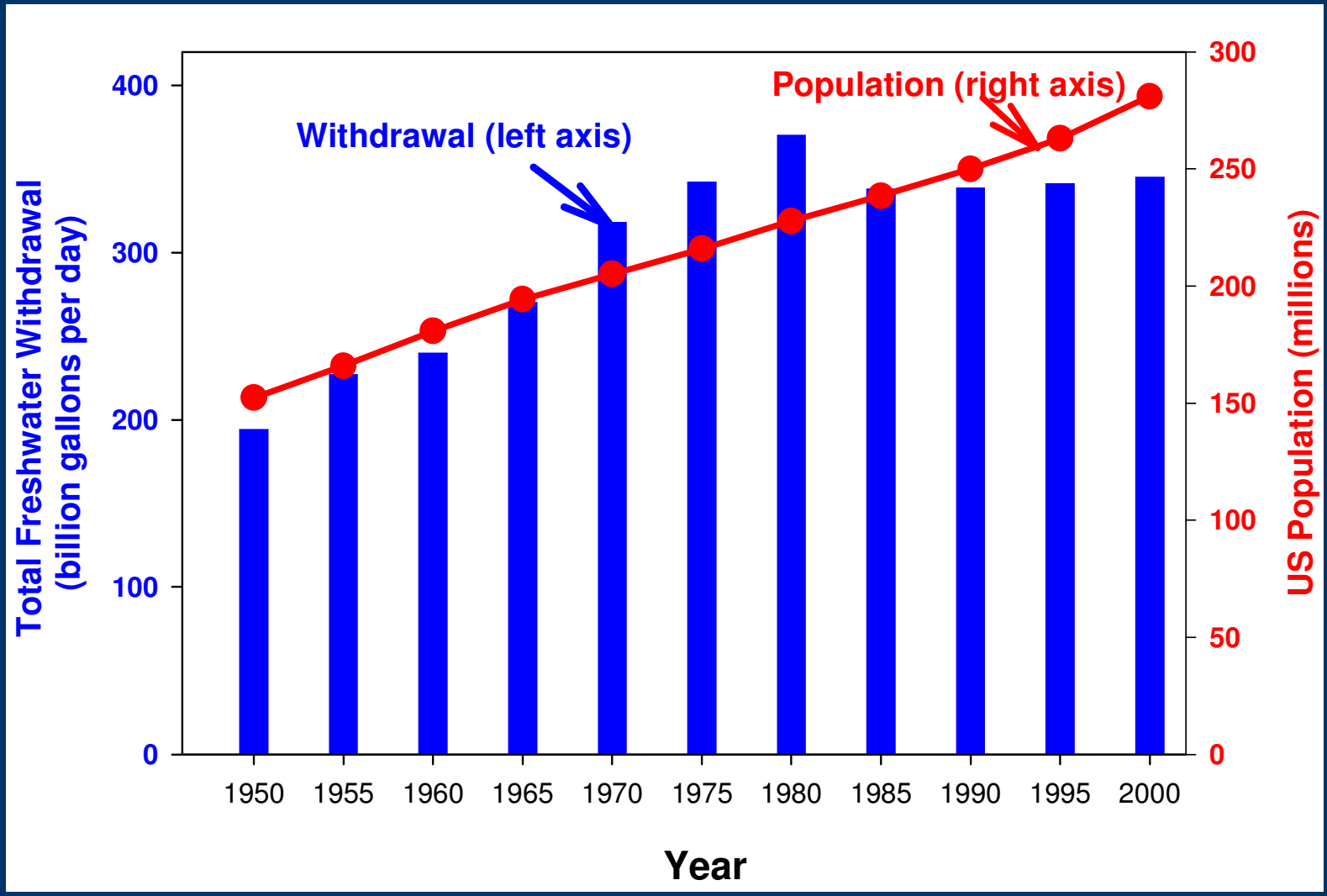
Water Sustainability in the United States With a Focus on Power Generation Cooling Water Requirements

Sujoy Roy, Karen Summers, and Robert Goldstein

Tetra Tech Inc, Lafayette, Ca and

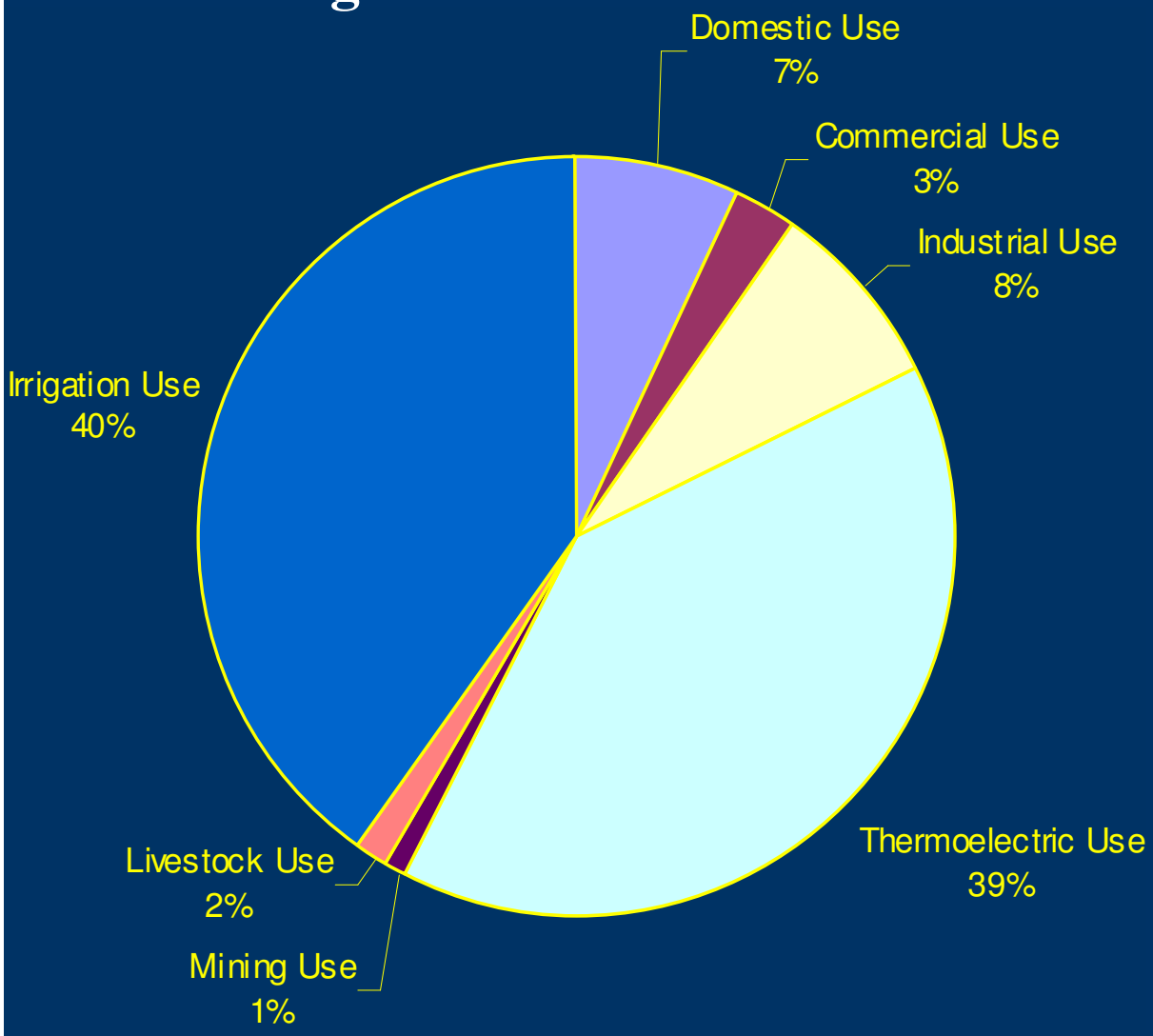
EPRI, Palo Alto Ca

US Population and Total Freshwater Withdrawal



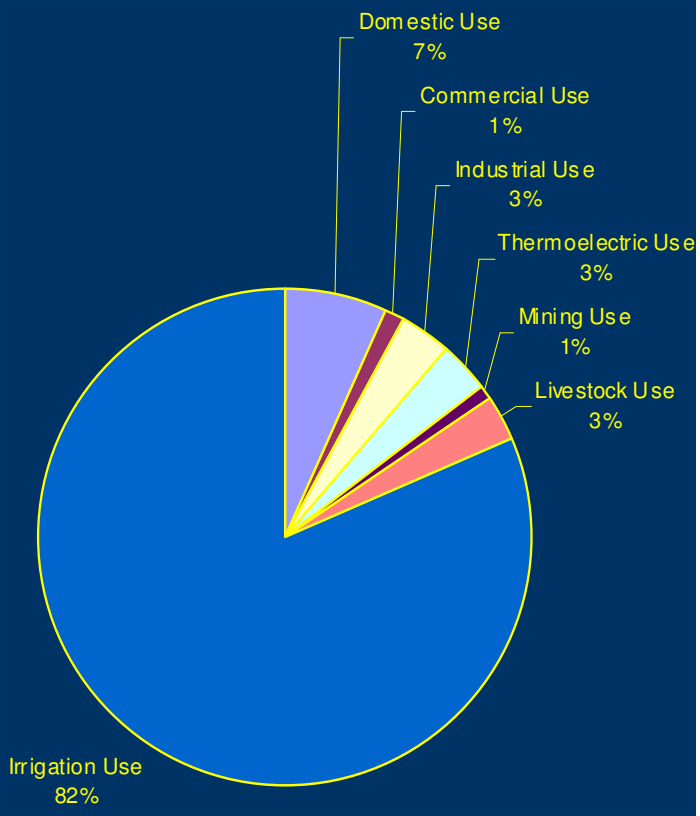
Withdrawal

342 bgd



Consumptive Use

100 bgd



Why is the Linkage Between Water and Thermoelectric Generation Important?

- Problems occur at a smaller temporal and spatial scales
- Power generation demands are often localized, with significant impacts over small areas
- In some periods of the year, and in some drought years, competition with other uses can lead to shortages (municipal, environmental, etc.)
- High population growth areas often correspond with areas for *new* electricity demand, many of which growth are among the more water-short areas in the country

Approach to Perform a National Assessment of Water Availability and Demand

I) For current conditions, use available data on

- Population (Census Bureau)
- Temperature and precipitation (NOAA)
- Water use (USGS)
- Electricity generation (EIA)
- Endangered aquatic species (EPA)

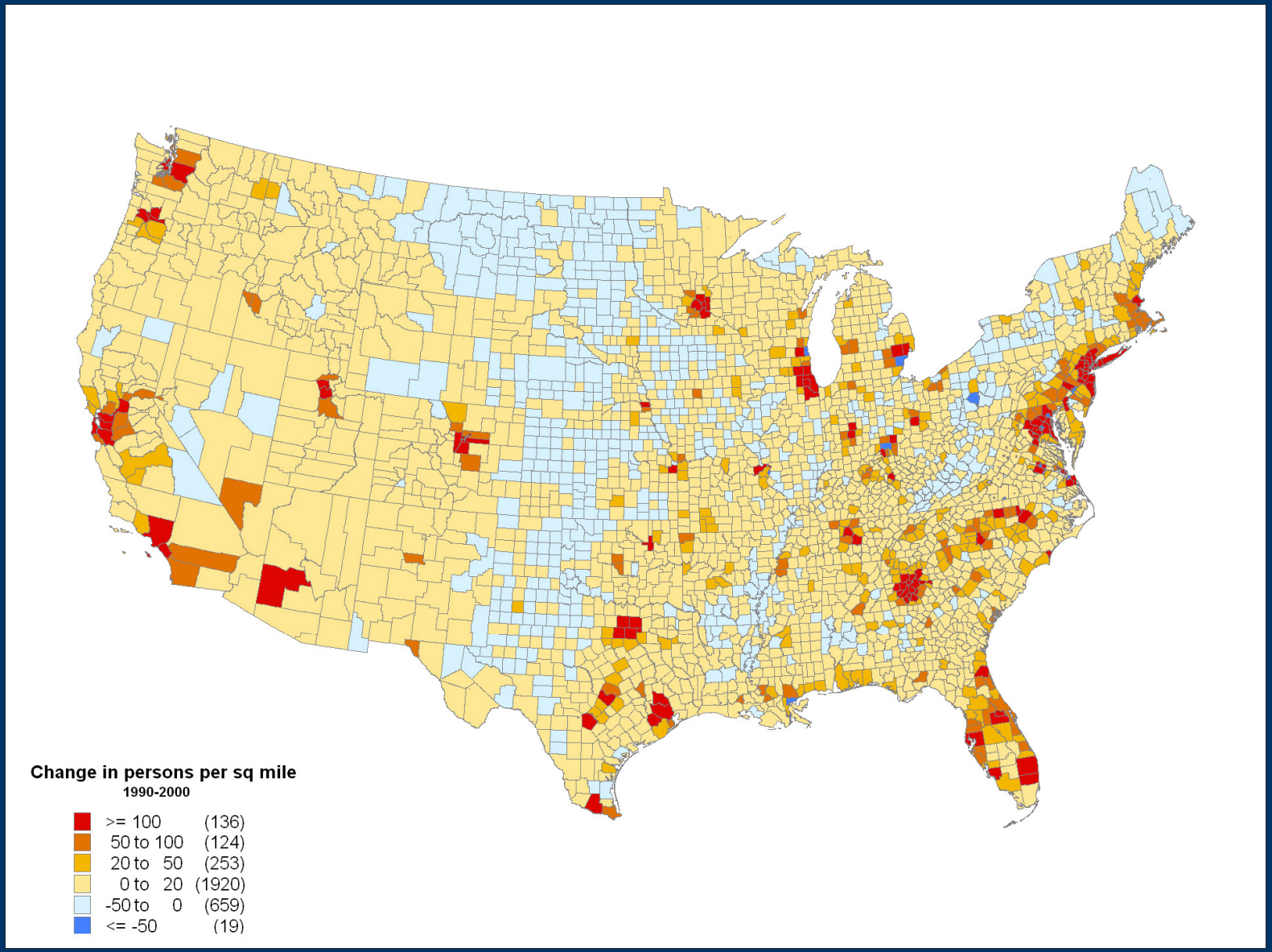
II) Estimate future conditions by in various water use sectors

- Using available forecasts
- Extrapolating from current rates of change
- Assuming no change in conditions

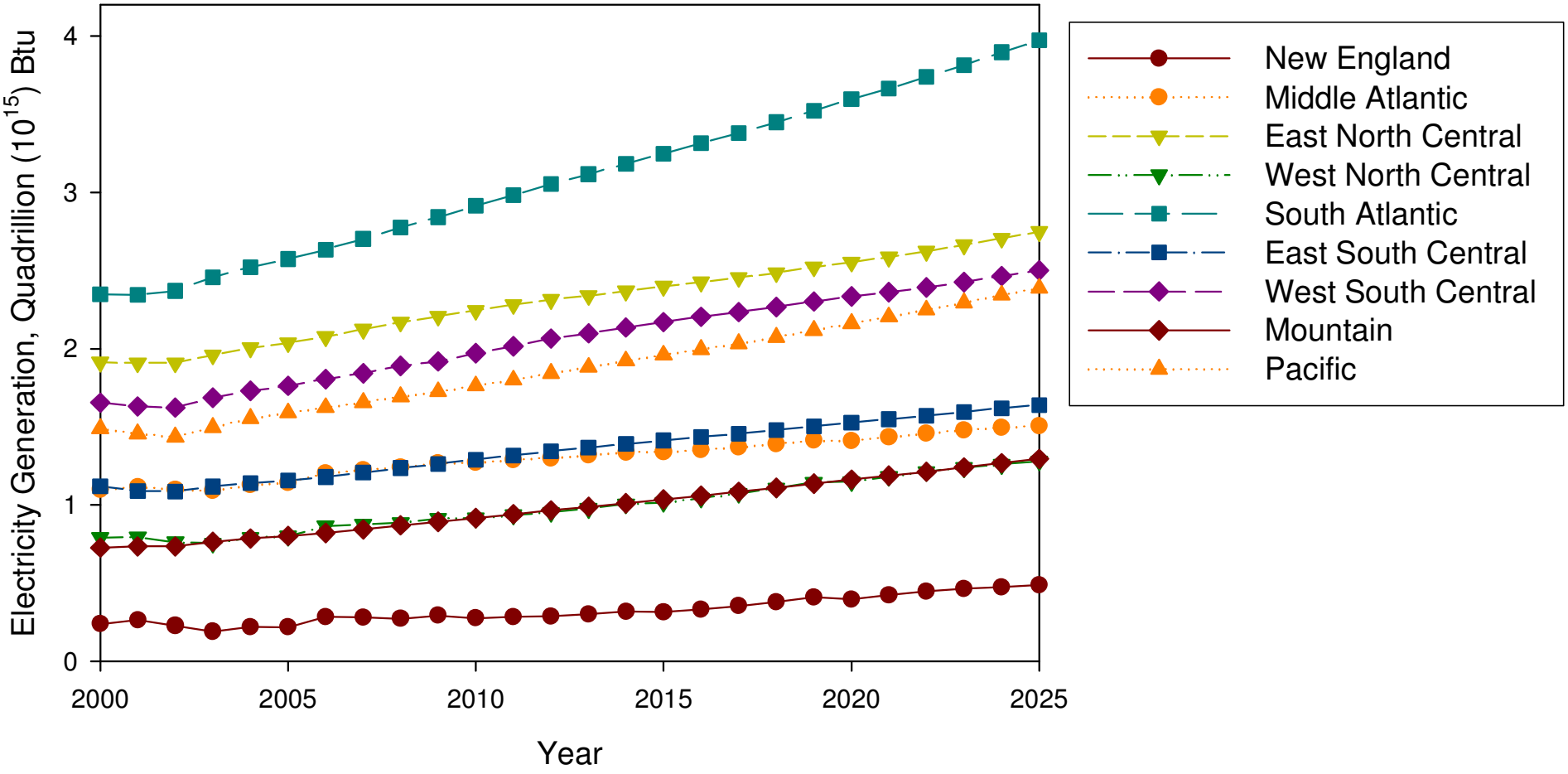
III) Future water demands based on assumption of

- Rates of water use per unit of activity (i.e., domestic water use per capita) remain at current levels
- Rates of water use exhibit improvements in efficiency over the next 25 years as they have over the last two decades

Population Change

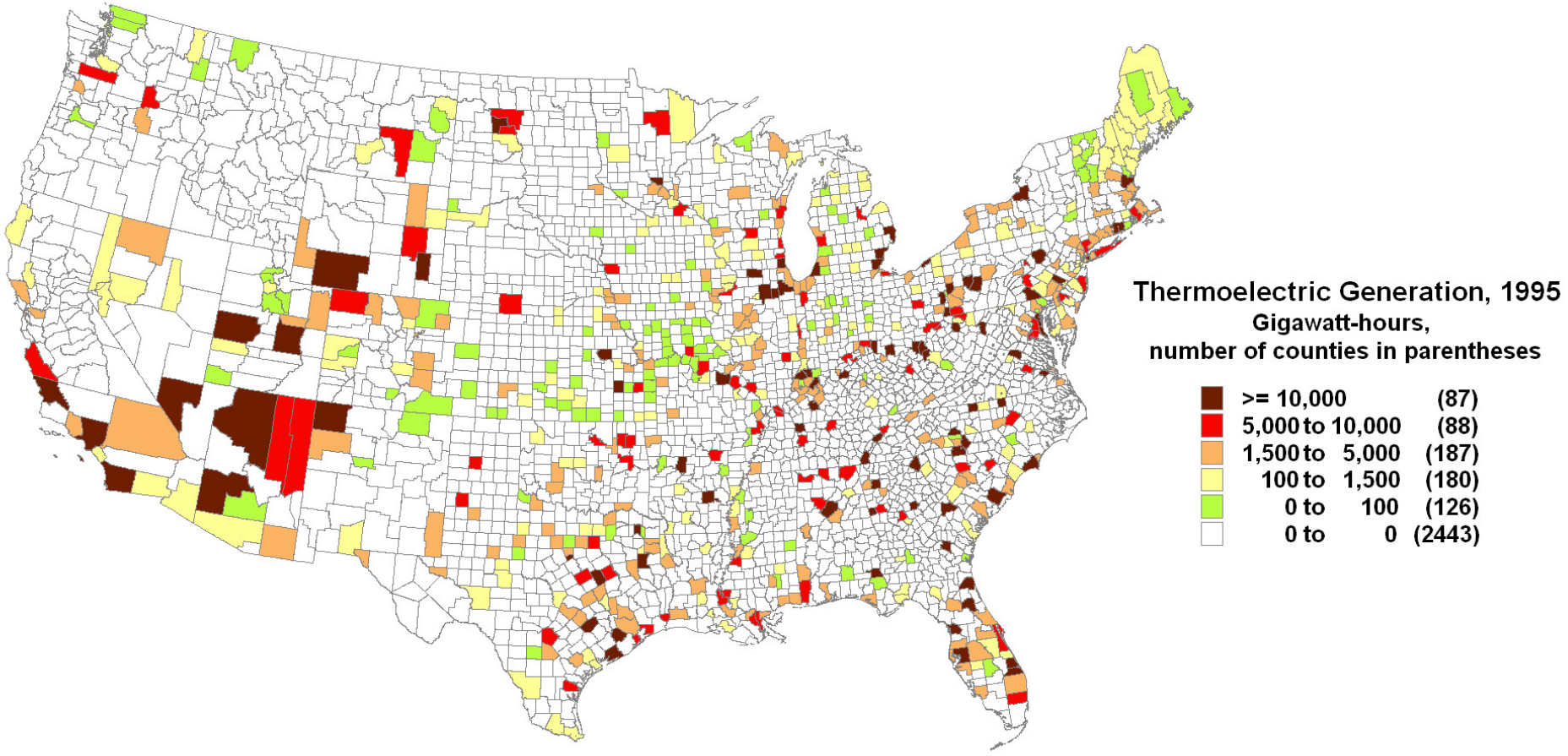


Energy demand for different census divisions of the US

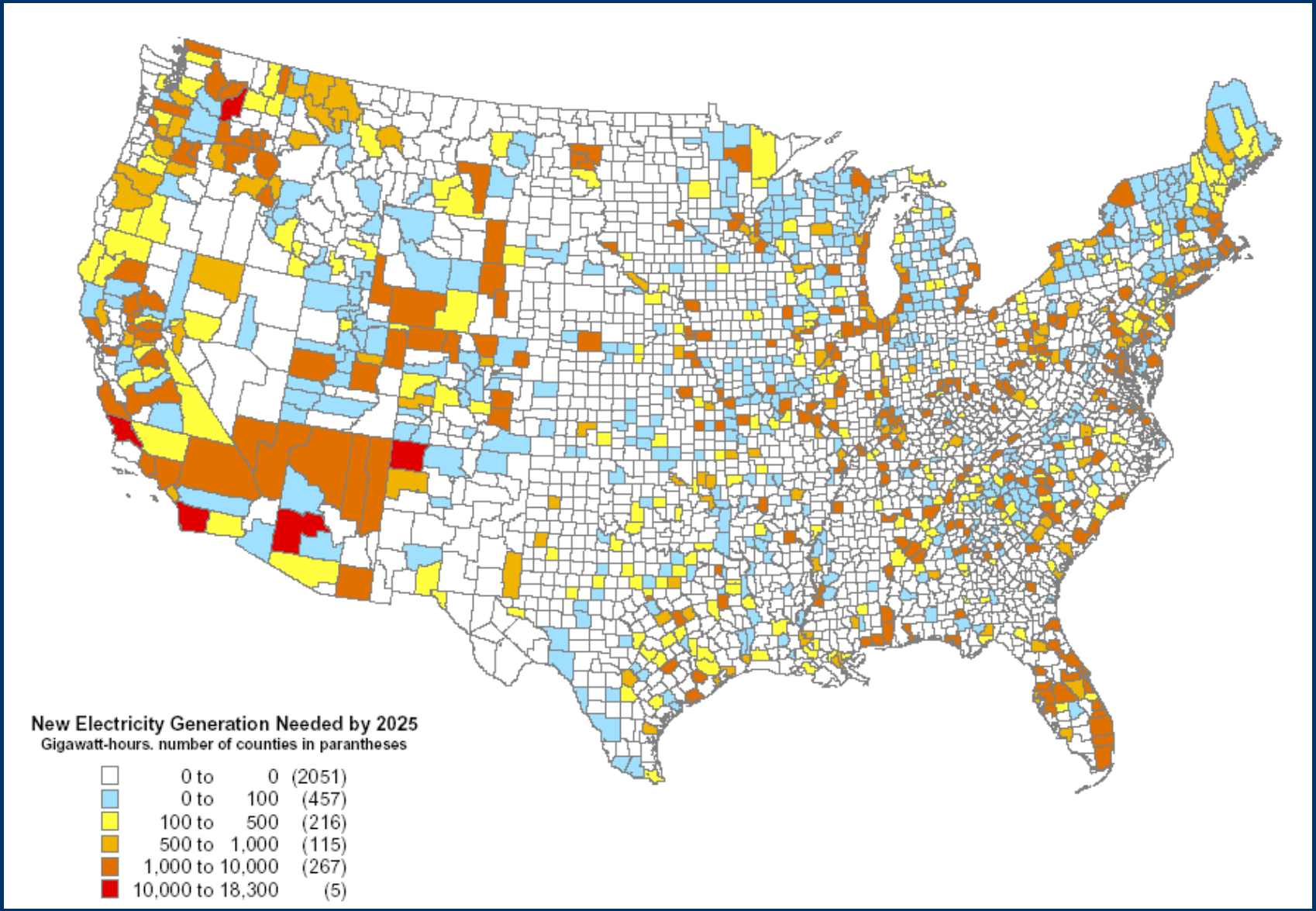


Energy demand projected by the Energy Information Administration, Department of Energy (1 quadrillion Btu = 2.398×10^5 gigawatt-hours).

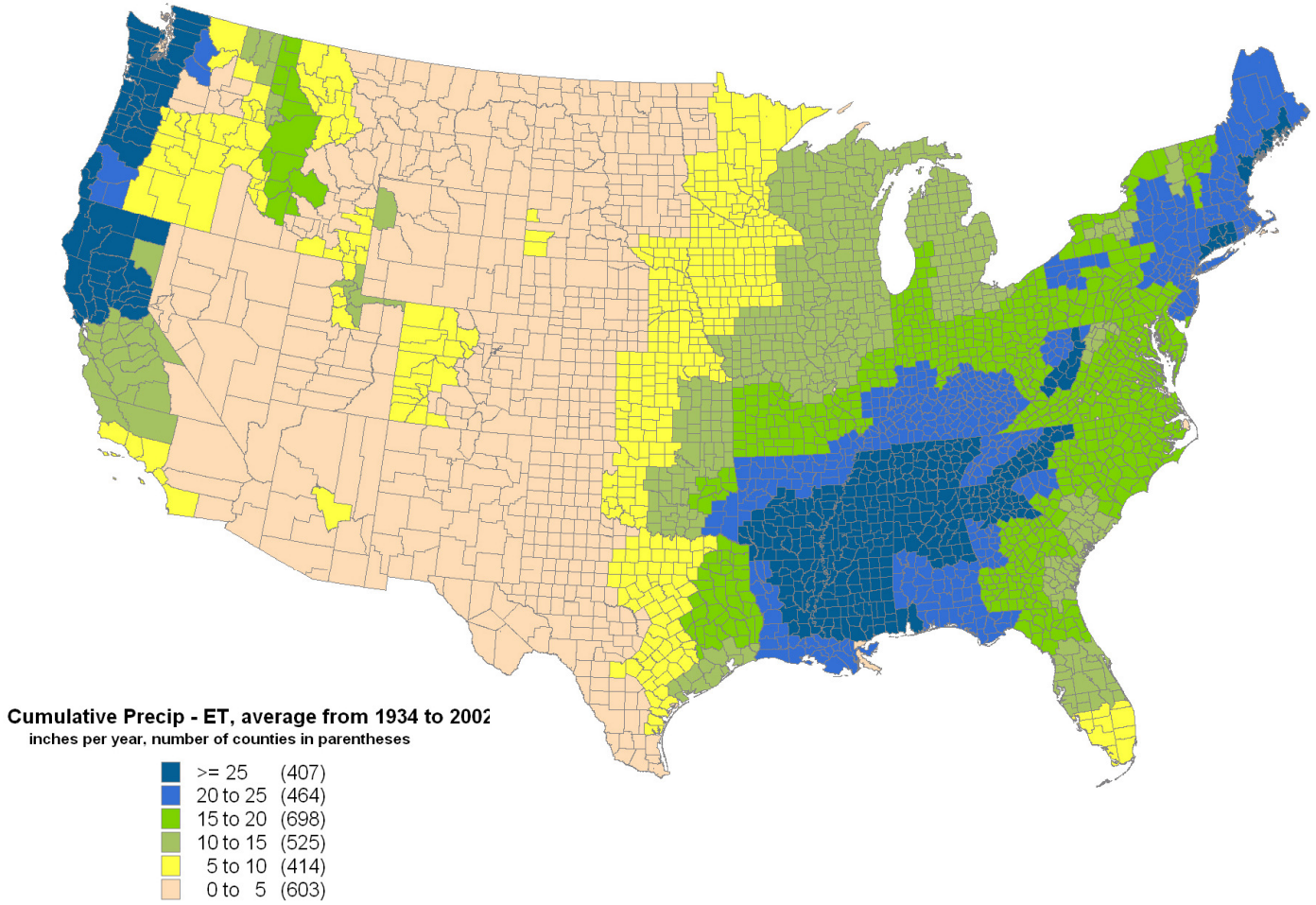
Thermoelectric Generation



New Electricity Generation Needed by 2025

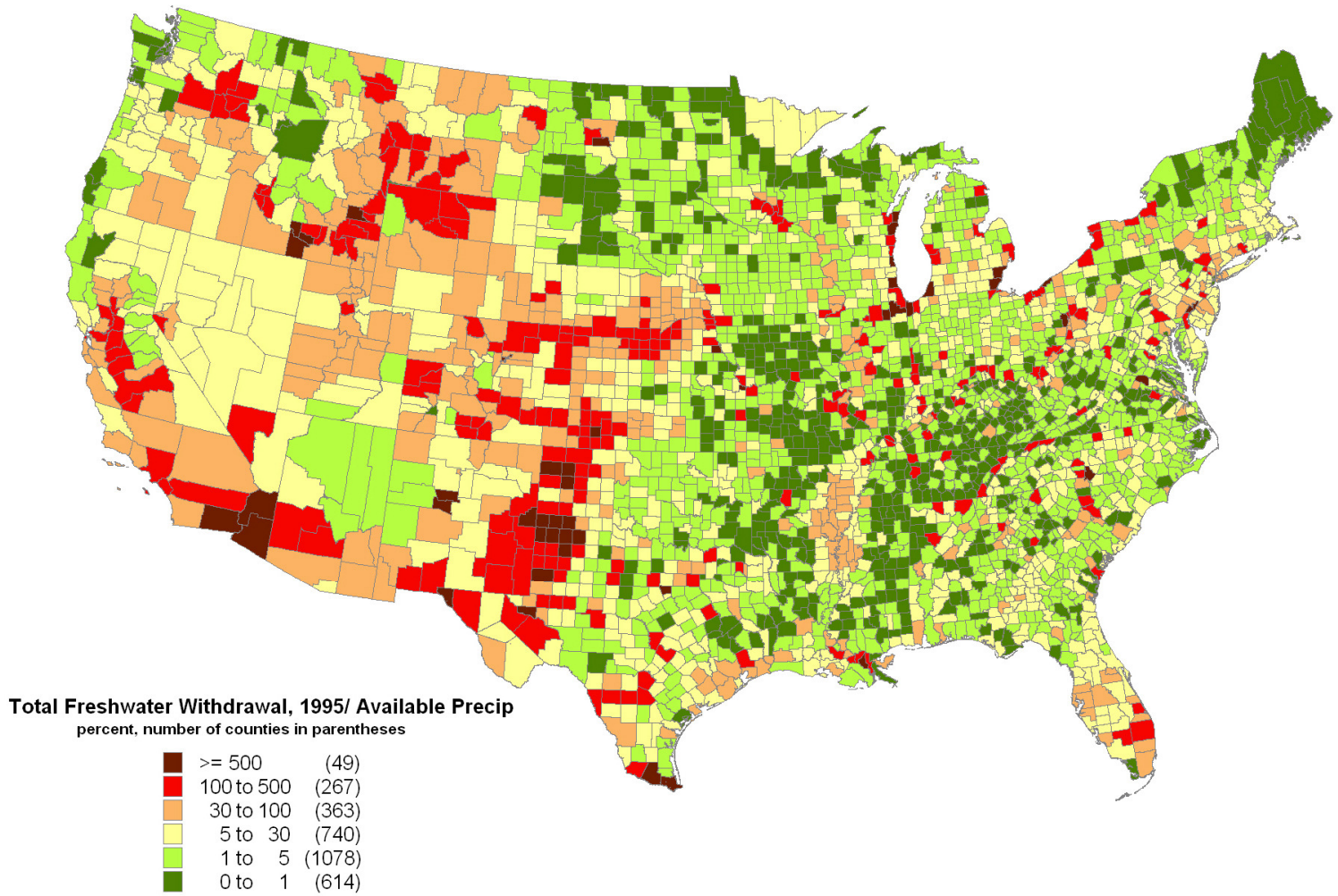


Available Precipitation*, Averaged Over 1934-2002

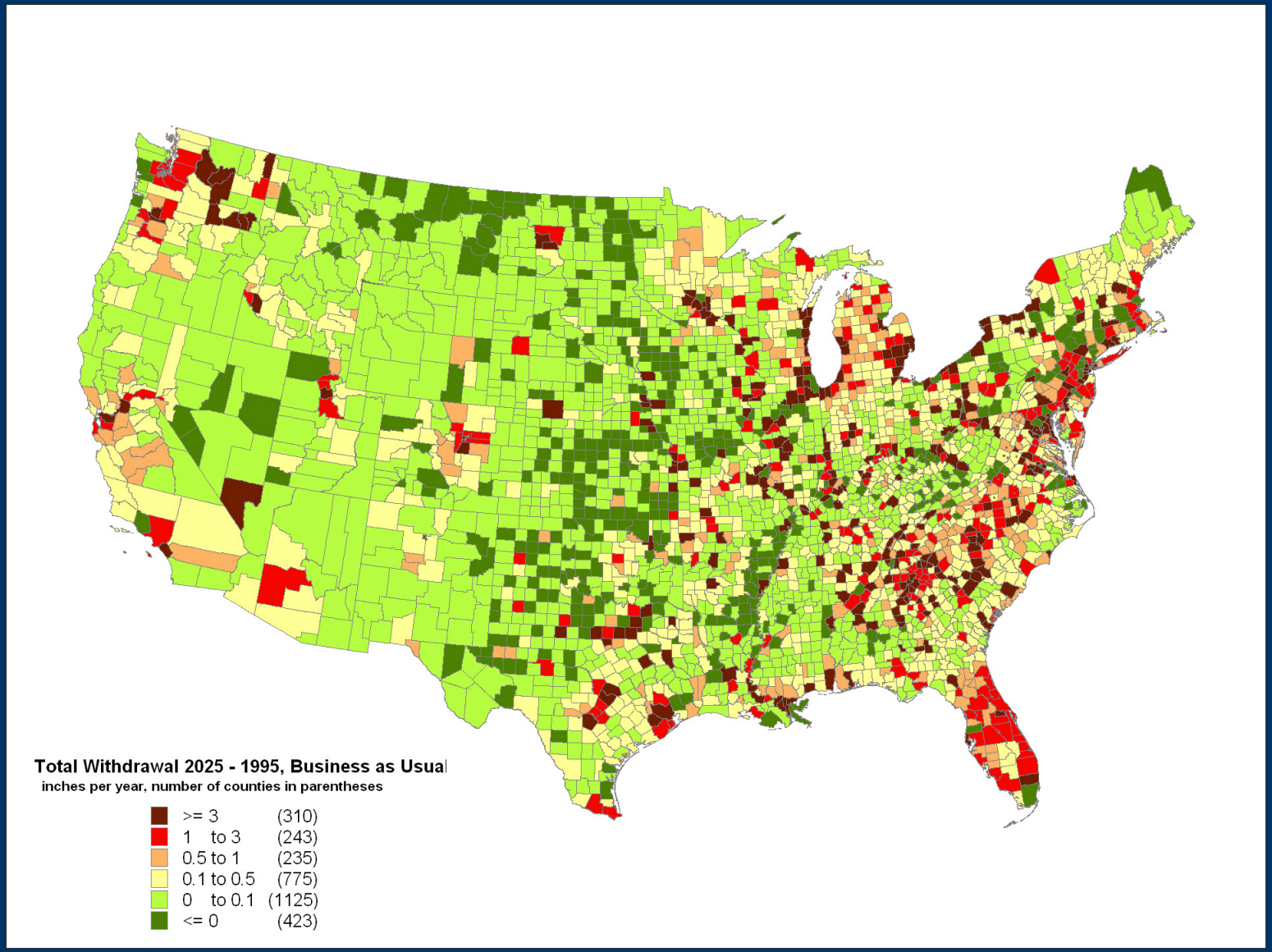


***Available precipitation is defined as the difference between monthly precipitation and potential evapotranspiration.**

Total Freshwater Withdrawal in 1995
(as a percent of available precipitation)

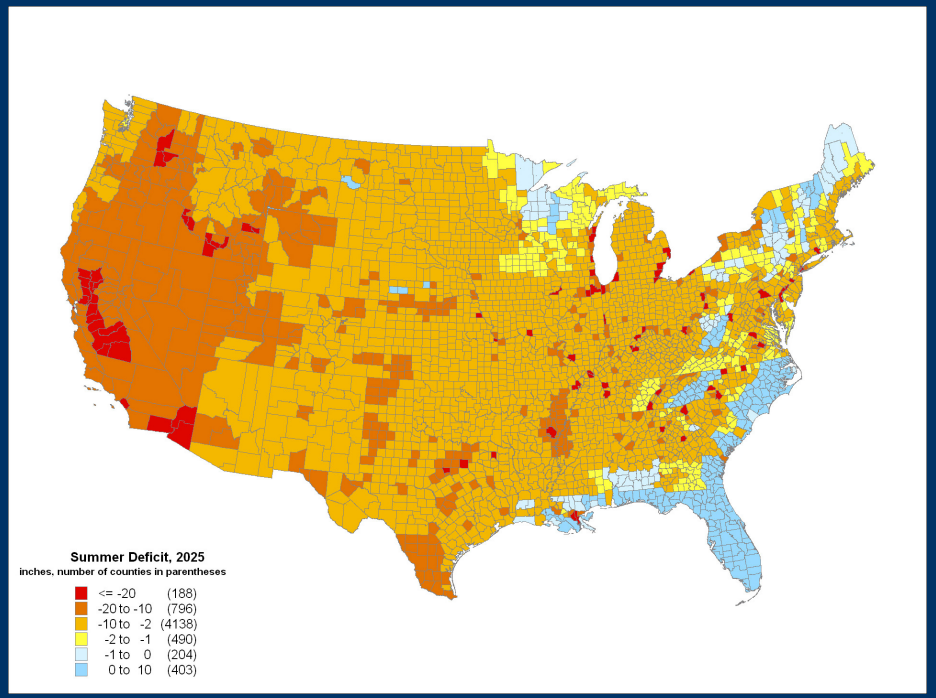


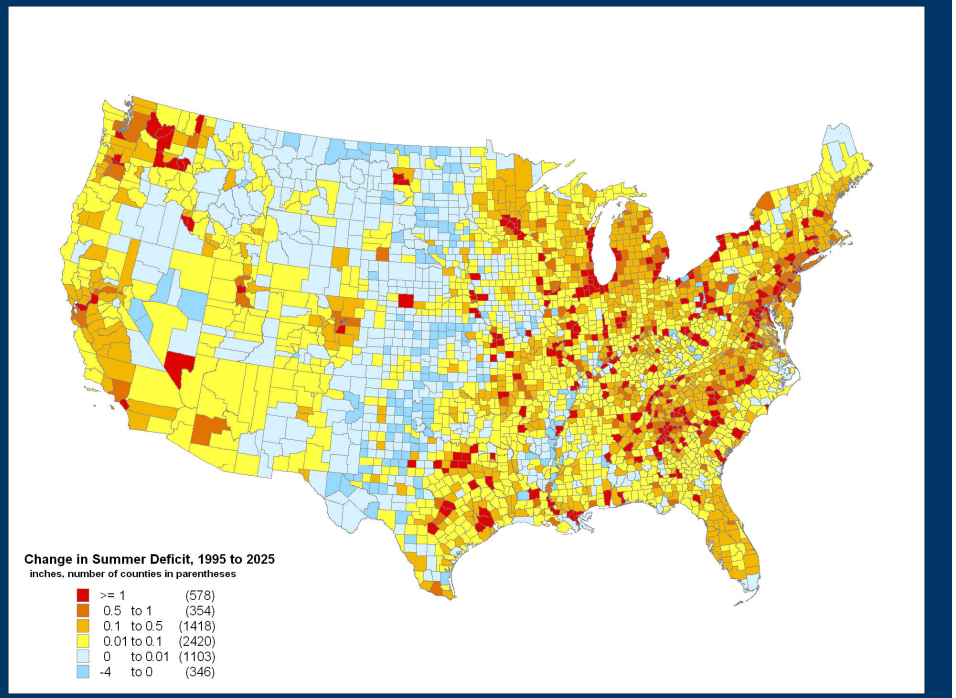
Change in water withdrawal requirements from 1995 to 2025, in inches per year, for the business-as-usual scenario



Storage Infrastructure Requirements

Summer deficit in 2025 and the change in summer deficit from 1995 to 2025, in inches per year, for the business-as-usual scenario





A Proposed Index of Water Sustainability

Each of the Following is Scored 0 or 1

2 = slightly, 3 = moderately, and 4 = highly susceptible

1) Extent of development of available renewable water:

- Greater than 25% of available precipitation currently used

2) Sustainable groundwater use:

- Ratio of groundwater withdrawal to available precipitation is greater than 50%.

3) Environmental regulatory limits on freshwater withdrawals:

- Presence of two or more endangered aquatic species.

4) Susceptibility to drought:

- Difference between water withdrawal during the three driest months of the year (July, August, September) and available precipitation is greater than 10 inches, where the lowest 3-year average rolling precipitation, based on data from 1934-2002 is considered.

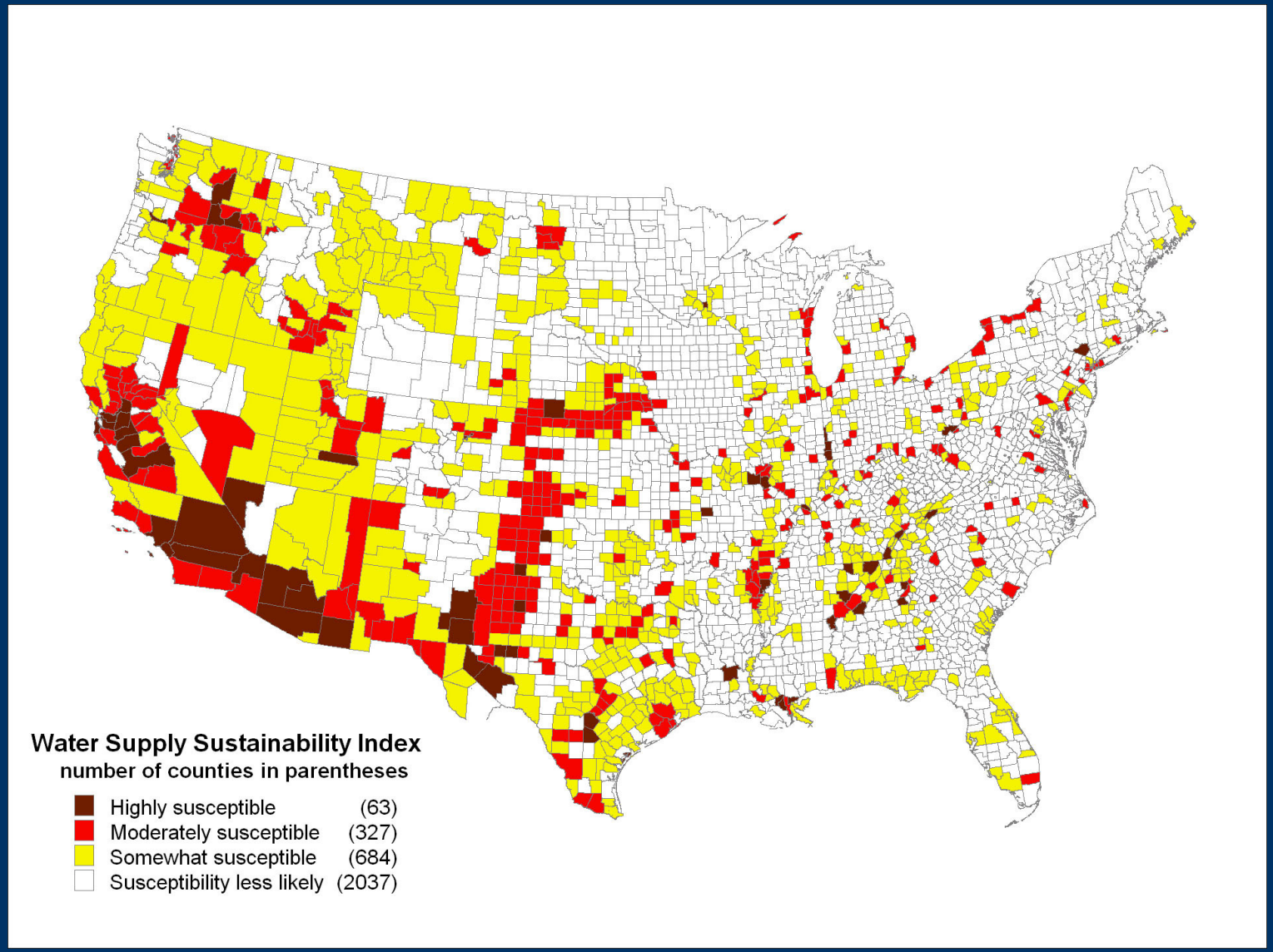
5) Growth of Water Use:

- Business as usual requirements to 2025 increase current freshwater withdrawal by more than 20%.

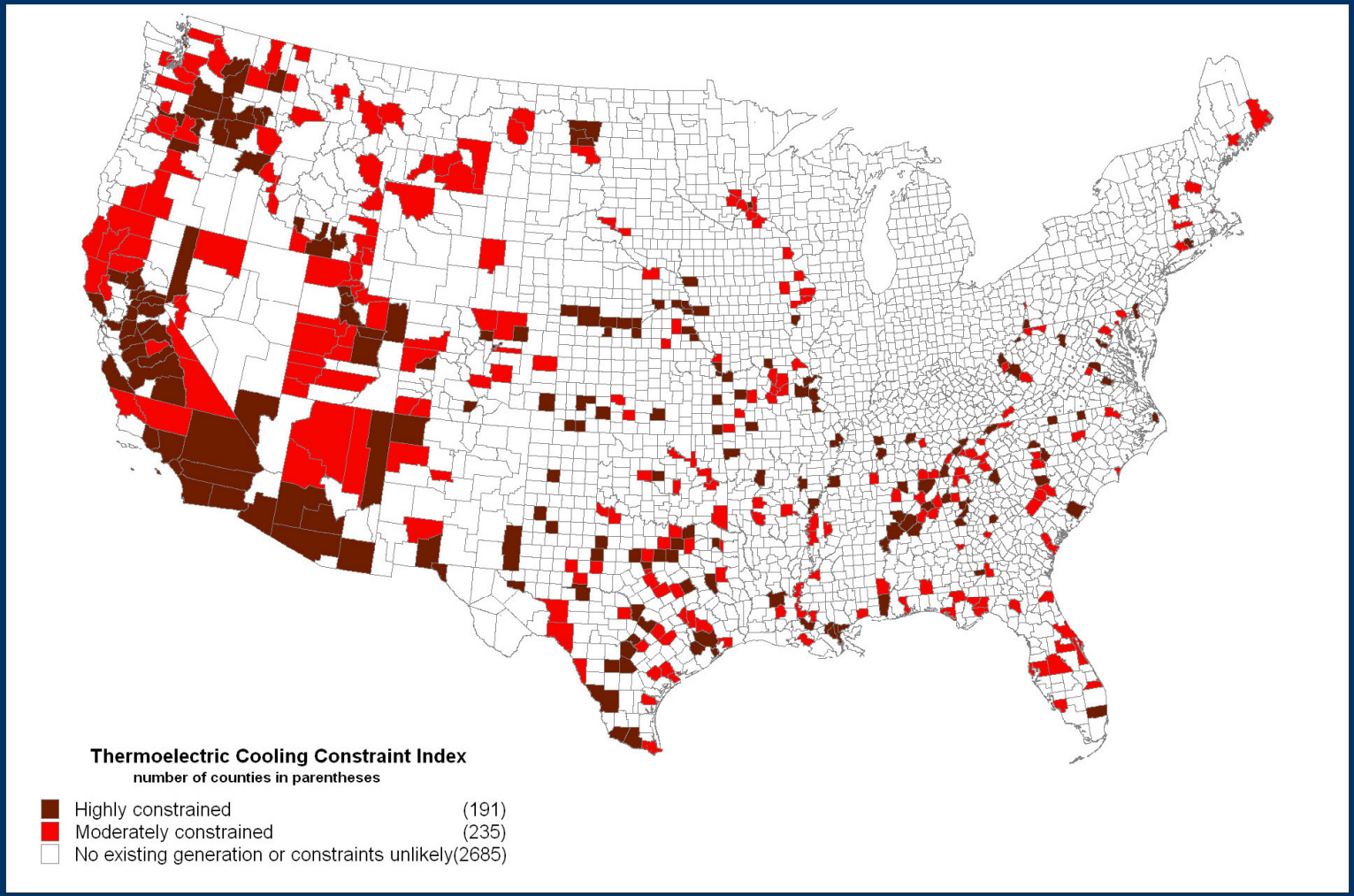
6) New requirements for storage or withdrawal from storage:

- Summer deficit (difference between withdrawal and available precipitation in an average year) increases more than 1 inch over 1995-2025.

Water Supply Sustainability Index



Thermoelectric Cooling Constraint Index



Highly constrained: Generation growth > 50%, WSSI >= 3
Moderately constrained: Generation growth > 50%, WSSI >= 2

Findings/Next Steps

- Publicly available data provide a basis to evaluate sustainable water use and highlight regions that need more study and/or data; not all water supply/storage limitations are in the Western U.S.
- Consider different assumptions for growth, including more sophisticated representations of future water use by different sectors of the economy
- Consideration of climate change
- Some data needs:
  - A better representation of regulatory limits on water withdrawals, or an estimate of environmental flow requirements, are needed
  - Data on intra-annual use could be important in highlighting scarcity in the driest months of the year
  - More uniform assessment of water quality impairment