Synapse
Energy Economics, Inc.

The Energy-Water Nexus: Interactions, Challenges, and Policy Solutions

National Drinking Water Symposium 2009

Rachel Wilson

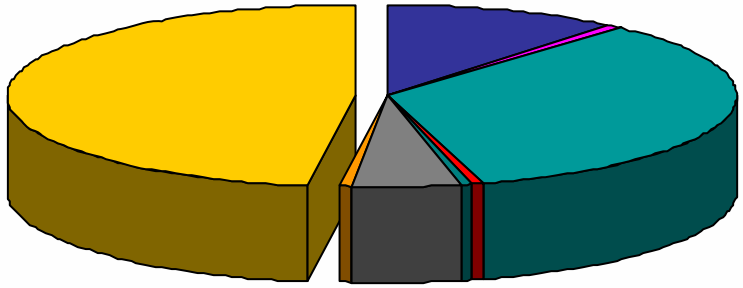
October 13, 2009

 |

The Energy-Water Nexus

- Energy is necessary to supply water
  - Collection and transport of groundwater, i.e. pumping water from underground aquifers
  - Pumping water through pipelines or canals
  - Treatment to drinking water quality standards
  - Desalination
  - Distribution to end users
  - Water heating for end uses
  - Treatment of municipal waste water

USGS Estimate of US Water Use



- **Public Supply**
- **Irrigation**
- **Aquiculture**
- **Mining**
- **Domestic**
- **Livestock**
- **Industrial**
- **Thermoelectric**

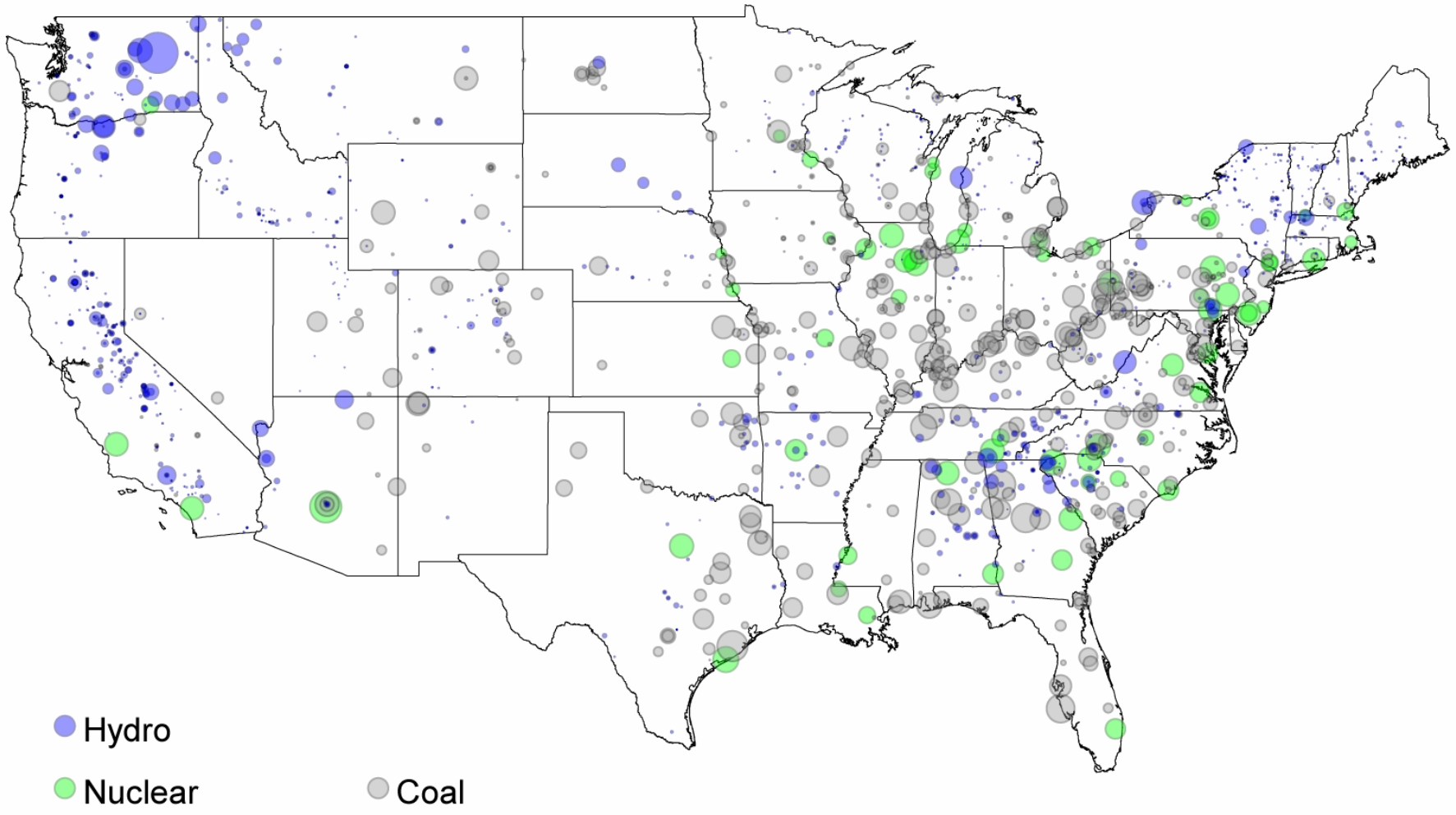
Estimated Use of Water in the United States in 2000
Hutson et al., 2004. USGS Circular 1268

The Energy-Water Nexus

- Water Withdrawals for Electric Power Generation
  - Used directly in hydroelectric power generation
  - Used indirectly at thermoelectric power plants
    - Fuel extraction and processing
      - Coal processing (10-50 gal / MWh)
      - Gas separation (IGCC technology) (30-60 gal / MWh)
      - Oil shale (100-250 gal / MWh)
    - Boiler efficiency
    - **Cooling (condensation)**
      - **Open-loop (13,000-42,000 gal / MWh)**
      - **Closed-loop (230-950 gal / MWh)**
    - Pollution control
      - SO_2 (dry / wet scrubbing)
      - NO_x (SCR / SNCR)

Number of gal / MWh represent withdrawals of water, as opposed to consumption.

US Power Production Relies on Water



Source: EPA eGRID, 2006

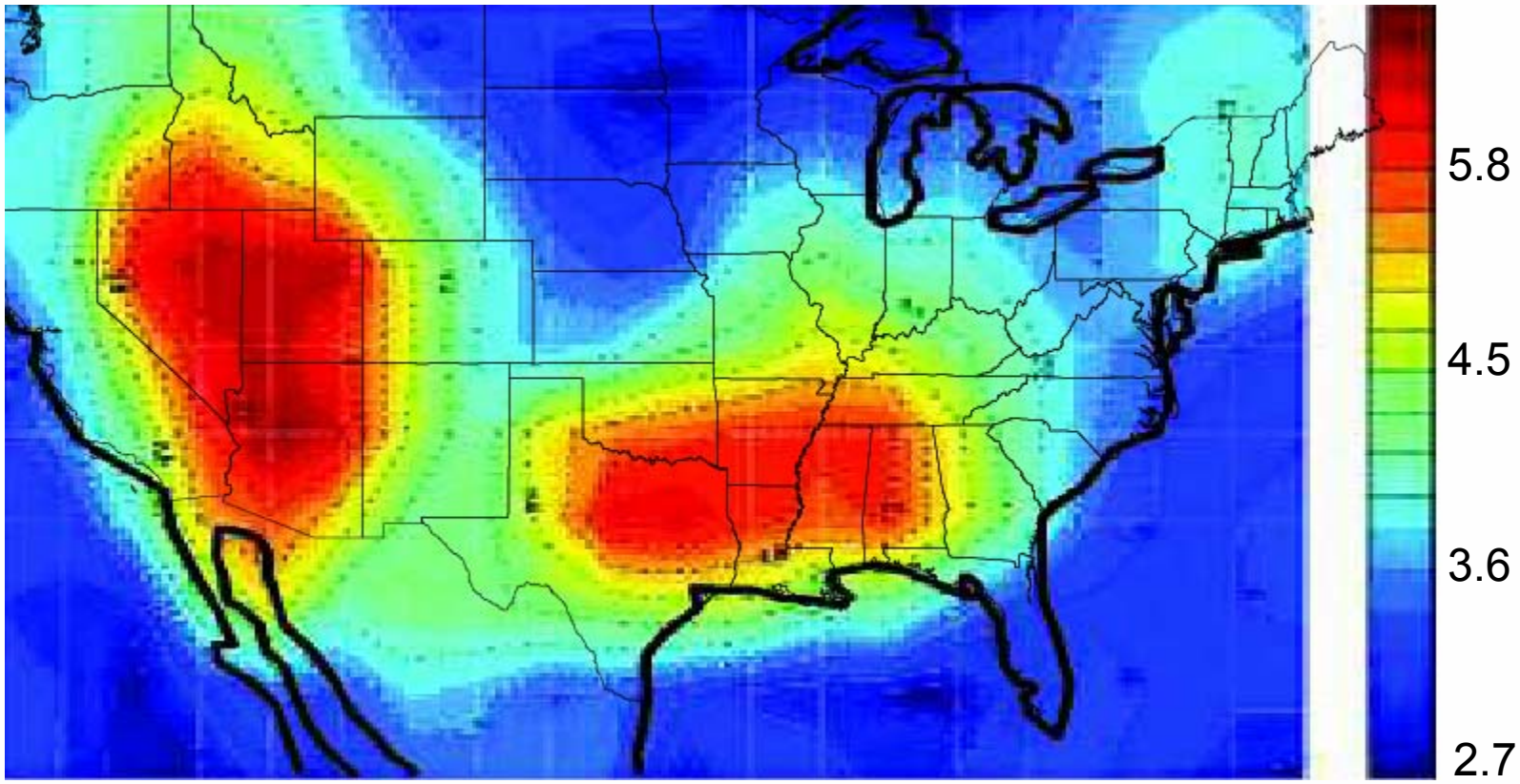
Water Wars

- Heat wave in France, 2003
- Three-year drought in the Southeastern US, 2006-2008
- Ten-year drought in Nevada, Today!

Climate Change and the Energy-Water Nexus – As Global Temperatures Rise…

- Greater intensity of heat waves increases electricity demand

Heat Wave Severity Increases (°F)

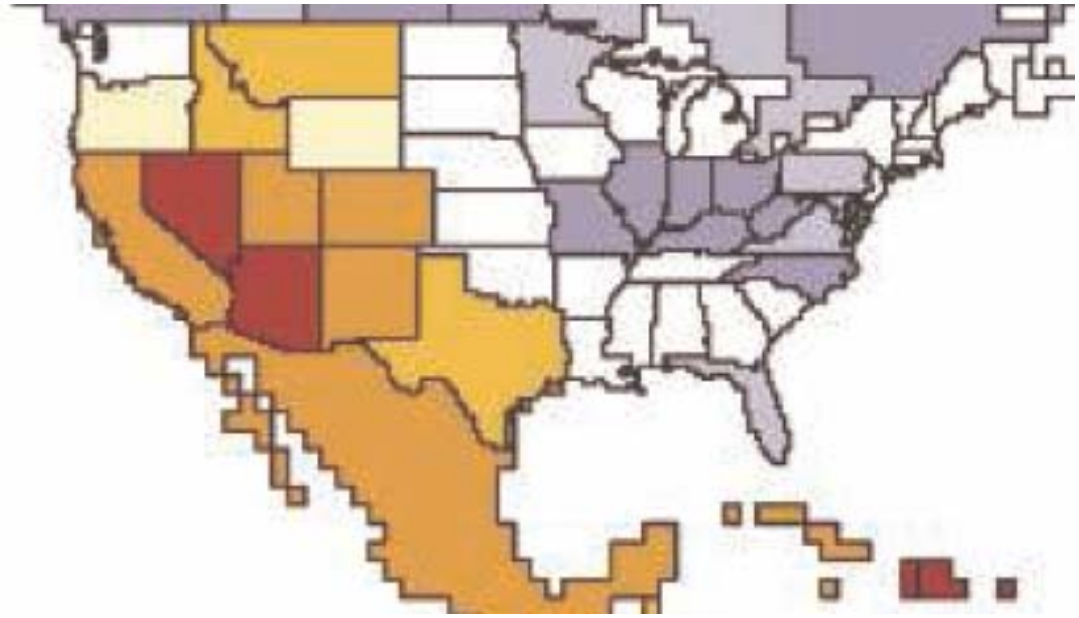


Regional Impacts of Climate Change: Four Case Studies in the United States
Ebi and Meehl. 2007. Heatwaves & Global climate change.

Climate Change and the Energy-Water Nexus – As Global Temperatures Rise…

- Water becomes increasingly scarce in the West

Change in Water Availability by 2050



Percentage Change in Runoff Volume

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

Climate Change and the Energy-Water Nexus

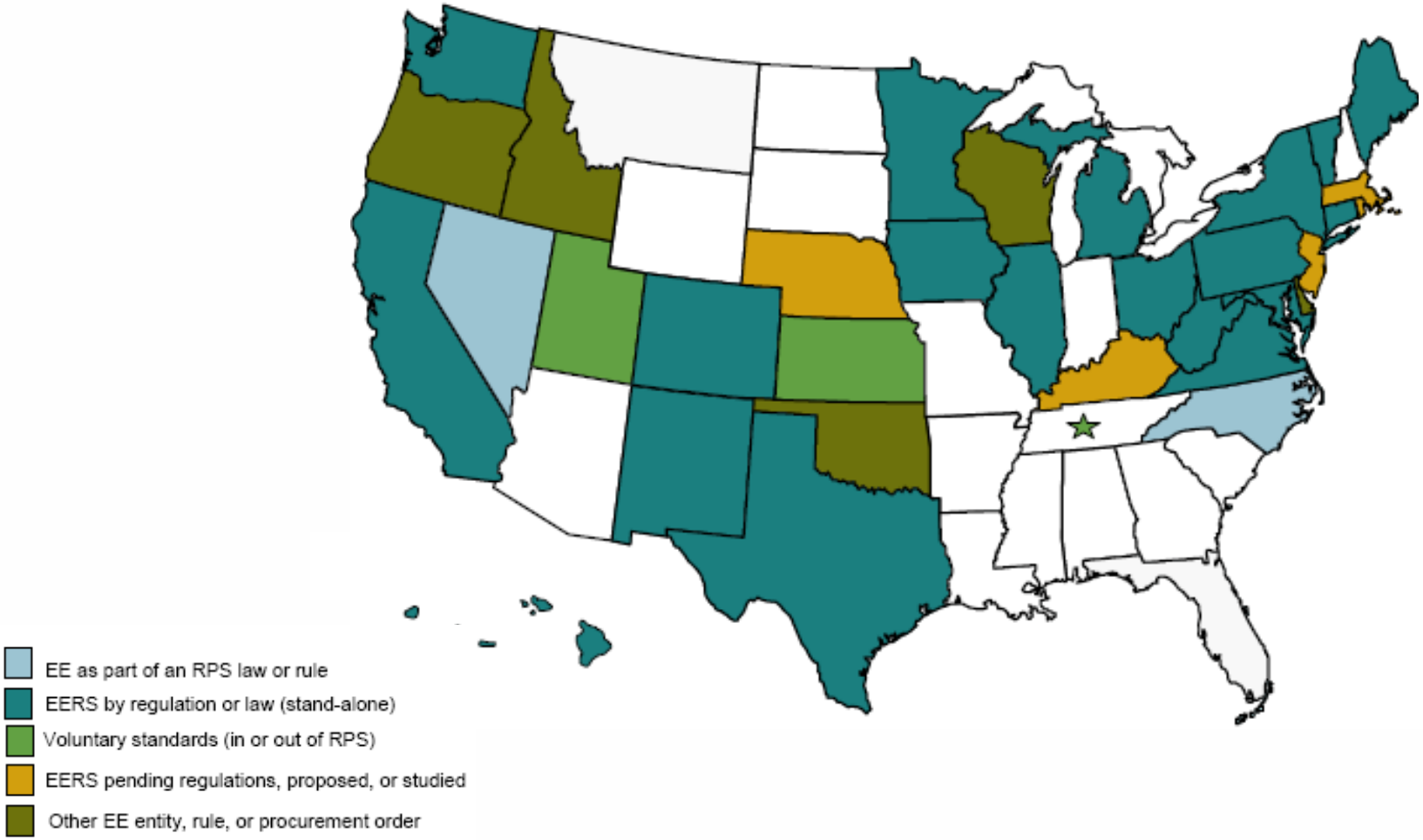
- State and federal energy policies designed to mitigate climate change:
  - Create both energy and water savings through requirements for energy efficiency and renewable energy

Energy Efficiency

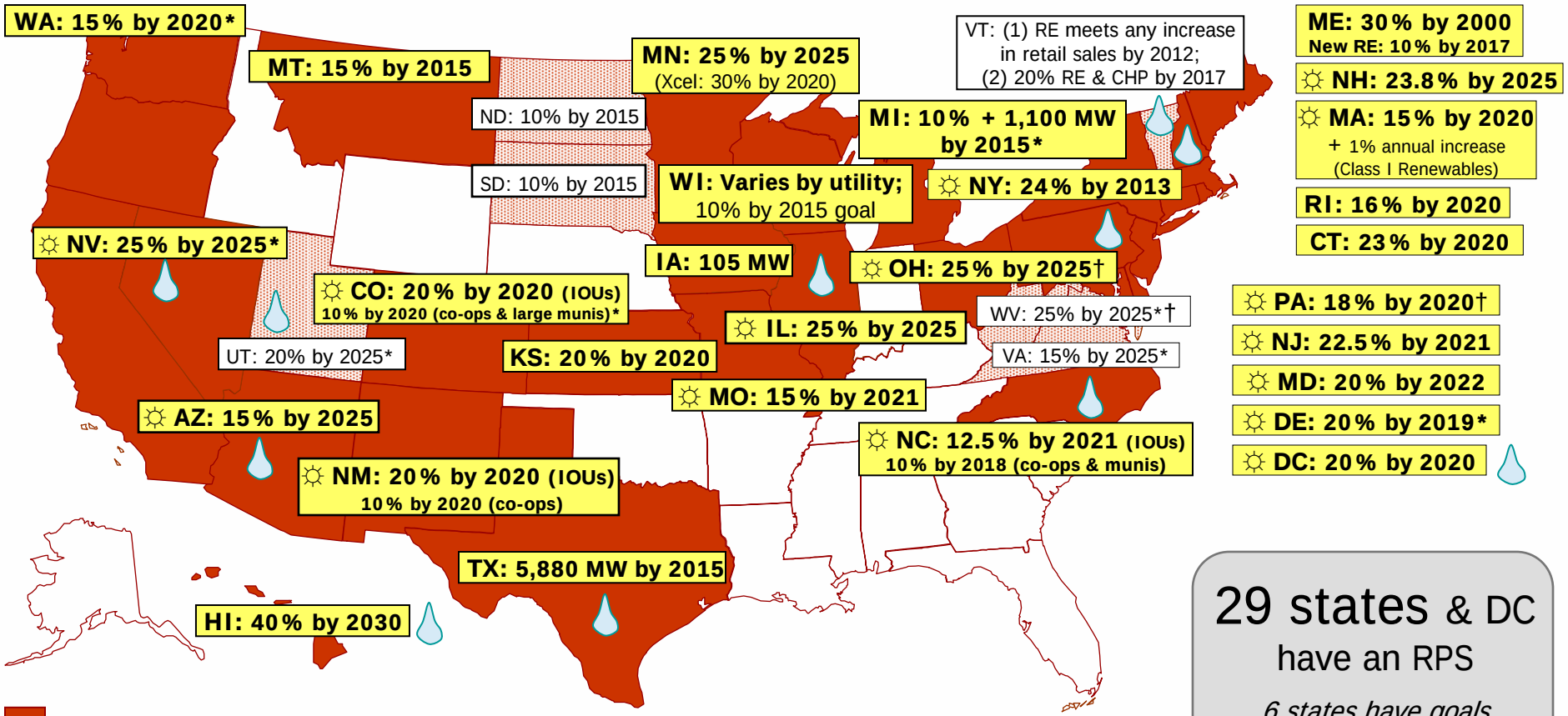
- Reducing energy demand reduces the use of cooling water at power plants
- End uses: Building codes and residential energy efficient technologies lead to energy AND water savings

Energy Efficiency

21 States have Energy Efficiency Resource Standards



Renewable Portfolio Standards



29 states & DC have an RPS

6 states have goals

State renewable portfolio standard

State renewable portfolio goal

Solar water heating eligible

Minimum solar or customer-sited requirement

Extra credit for solar or customer-sited renewables

† Includes non-renewable alternative resources

www.dsireusa.org / October 2009

Renewable Energy Technologies and Water Use

- Wind energy ~ no water!
- Solar photovoltaic ~ 25 gal / MWh to wash panels
- Solar thermal ~ 840 gal / MWh for cooling

Climate Change and the Energy-Water Nexus

- State and federal energy policies designed to mitigate climate change:
  - Create both energy and water savings through requirements for energy efficiency and renewable energy…
  - But create new challenges for water supply due to the water-intensity of some renewable energy and pollution control technologies

Water Use of Proposed Solar Thermal Projects

- **"When push comes to shove, water could become the real throttle on renewable energy."**
  - Michael Webber, University of Texas, Austin
- Solar Millenium (NV): 1.3 billion gallons of water per year
- Abengoa Solar (AZ): 705 million gallons of water per year
- NextEra Energy Resources (CA): 521 million gallons of water per year

California, Renewable Energy, and Drinking Water

- Current CA law prohibits the use of drinking-quality water for use in power plant cooling
- CA Assembly Bill 40 proposes that "the use of potable domestic water for cooling towers that are part of a generating system that is an eligible renewable energy resource is a reasonable use of water if certain requirements are met."

Pollution Control – Carbon Capture & Storage

- Carbon capture and storage (CCS)
  - Developing technologies are water intensive
    - Amines (cooling, liquid spray)
    - Ammonia (cooling, slurry, spray)
    - Carbonates (wet scrubbing)
  - DOE estimates increased water use of 0.8 million gallons per day for a 500 MW power plant
  - Possible groundwater pollution and drinking water contamination

Dallas Morning News

Pollution Control and Drinking Water: Ignoring the Warning Signs?

- Consultants discover higher-than-normal levels of arsenic seeping from a wall along South Carolina Electric and Gas's coal ash waste pond. Residents express concern over drinking water. *Greenwire, October 5, 2009*

- TVA coal ash spill, December 22, 2008
  - "Scientists said that toxins (from the coal ash spill) were dissolving into the Emory, which feeds into two other rivers – the Tennessee and the Clinch – **and supplies municipal water treatment plants**." *The Nation, April 2, 2009*

Conclusions

- 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 storage 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
- Decisions about supplying energy and water to the public cannot be made in isolation

Recommendations

- Gather more site-specific data
- Require that power plant proposals include:
  - An analysis of water use; and
  - Determination of water availability
- Provide incentives (regulatory or financial) for use of less water-intensive cooling systems
- Improve efficiency in the use of water and energy

