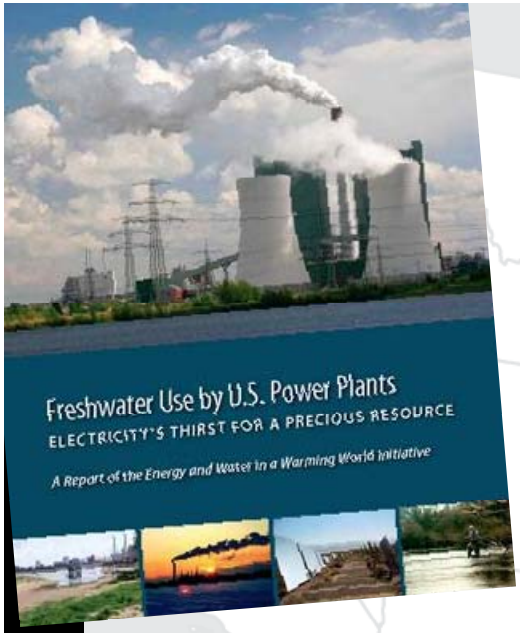
Long-term Implications of Electricity and Water in a Changing Climate

Peter C. Frumhoff
Director of Science and Policy
Union of Concerned Scientists

Energy-Water Nexus Forum
Board on Energy and Environmental Systems
National Academy of Sciences
3 April 2013



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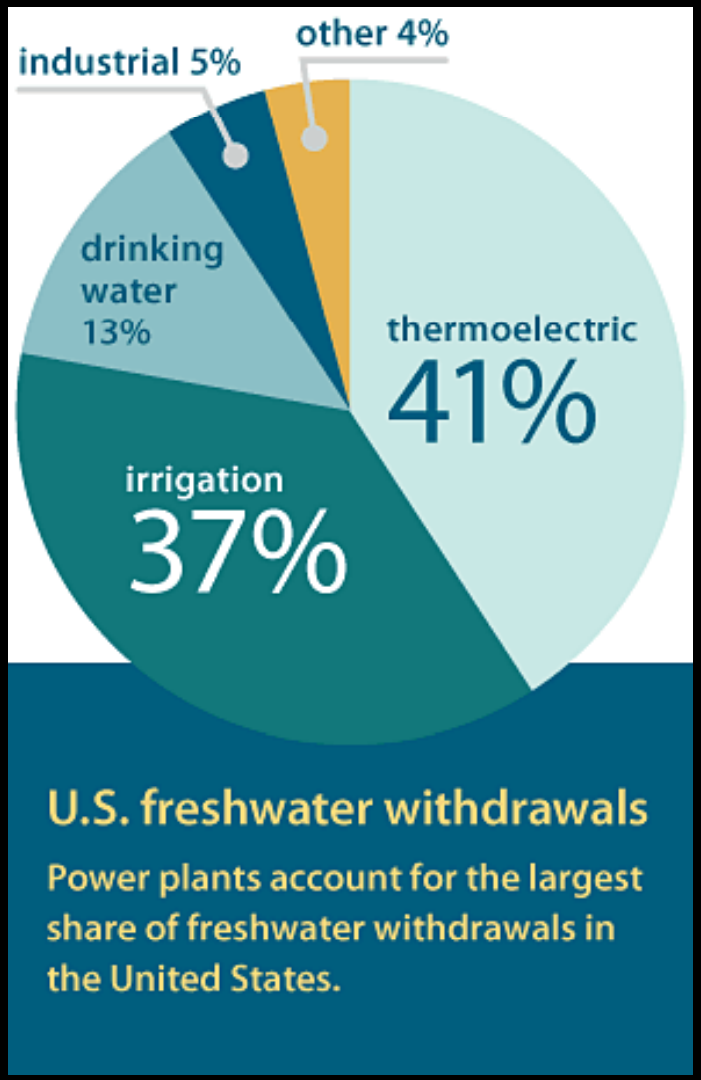
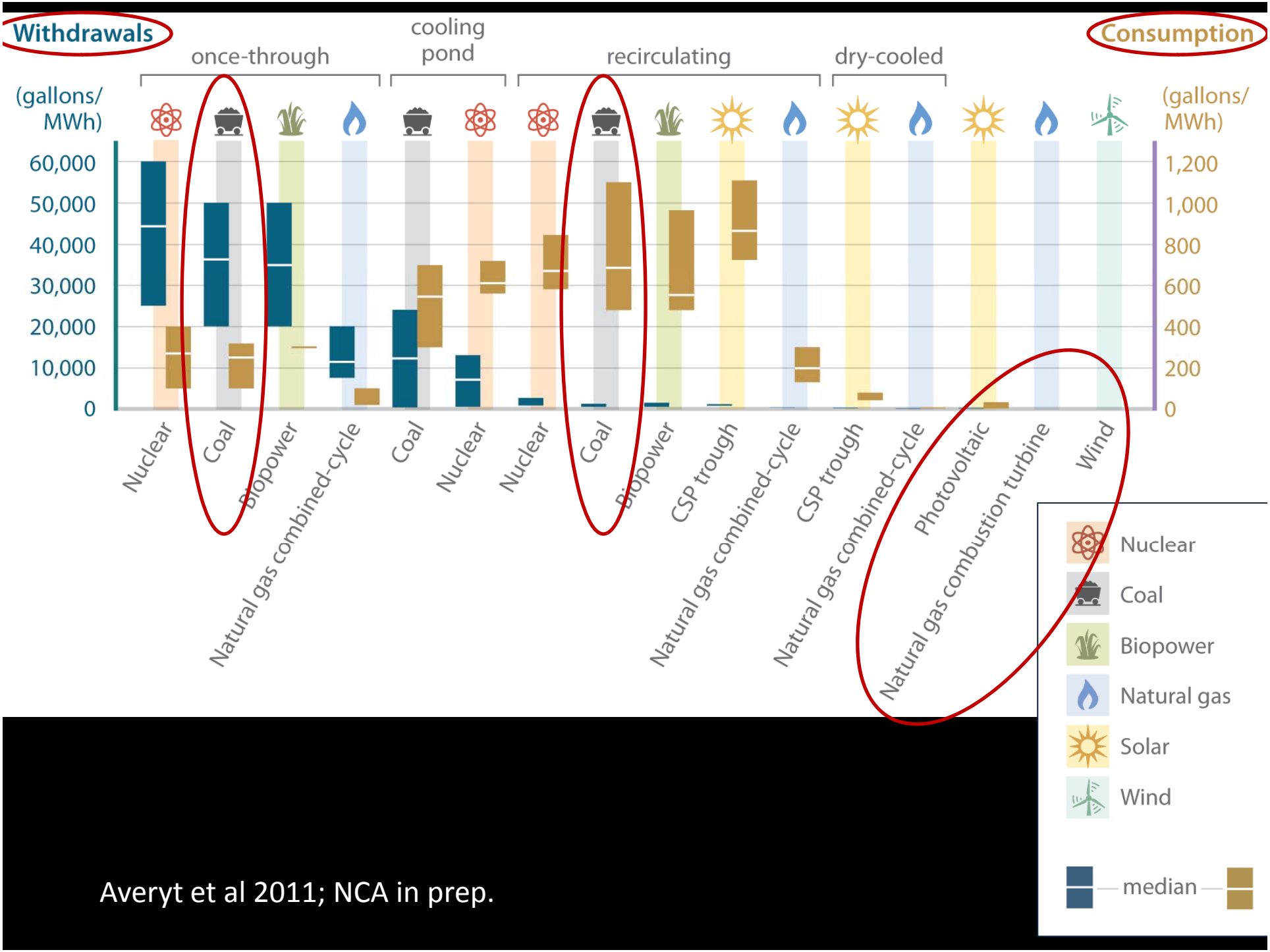
Today's Power Plants Depend On Very Large Amounts of Water For Cooling



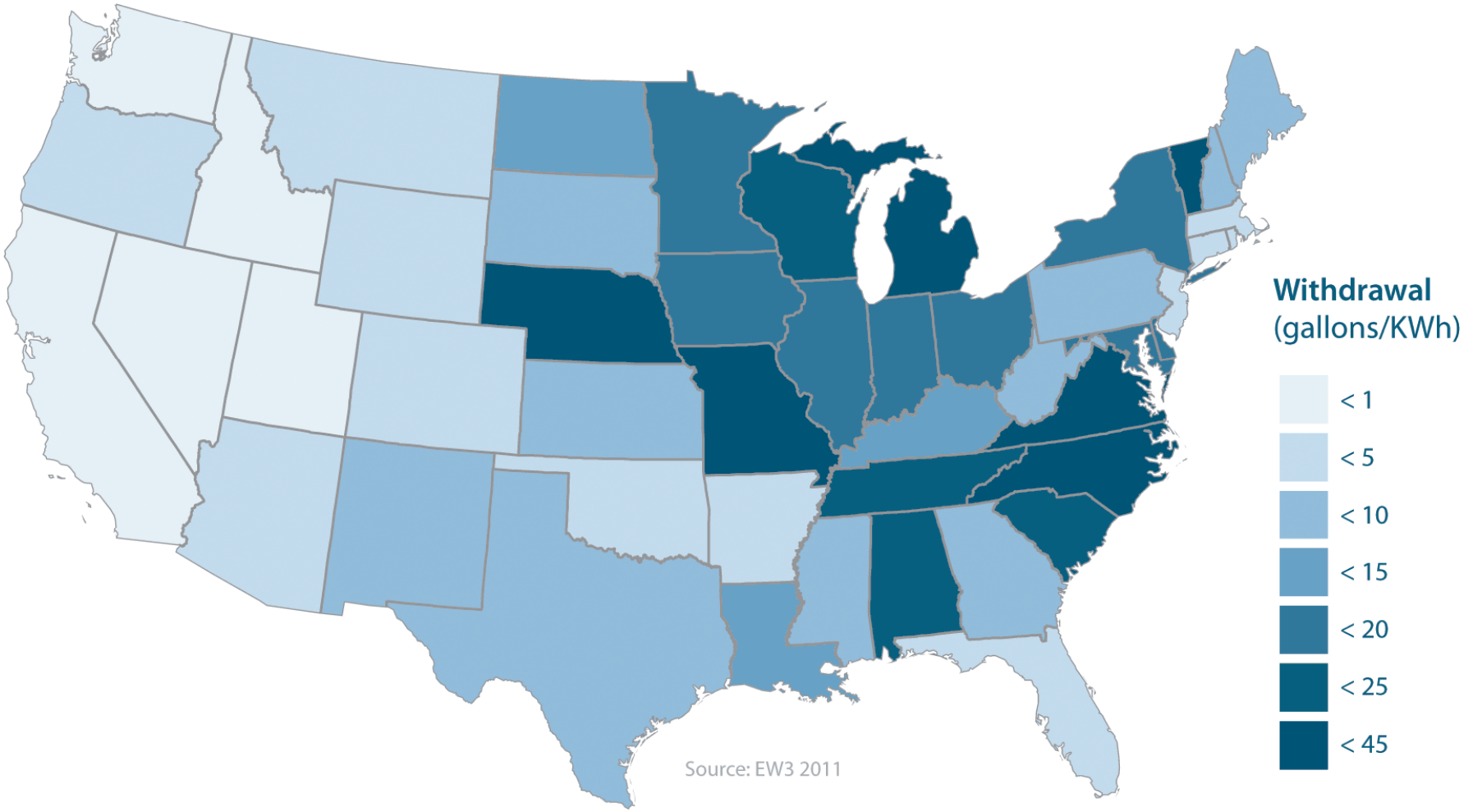
- Withdrawals: 60–170 billion gal/day
- Consumption (evaporation): 3–6 billion gal/day
- Consumption (fracking): 0.2-0.4 billion gal/day

Averyt et al 2011; EPA 2011

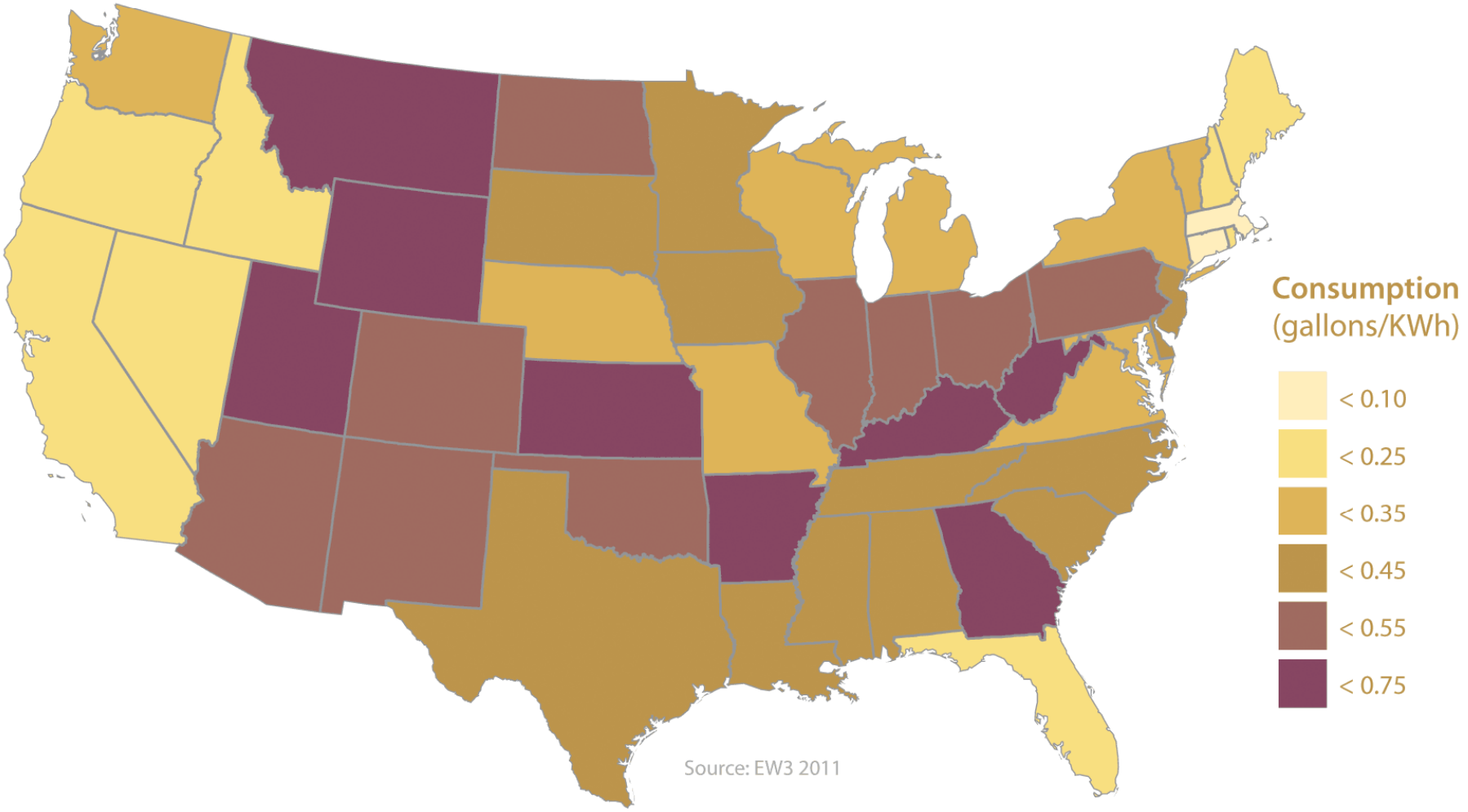


Averyt et al 2011; NCA in prep.

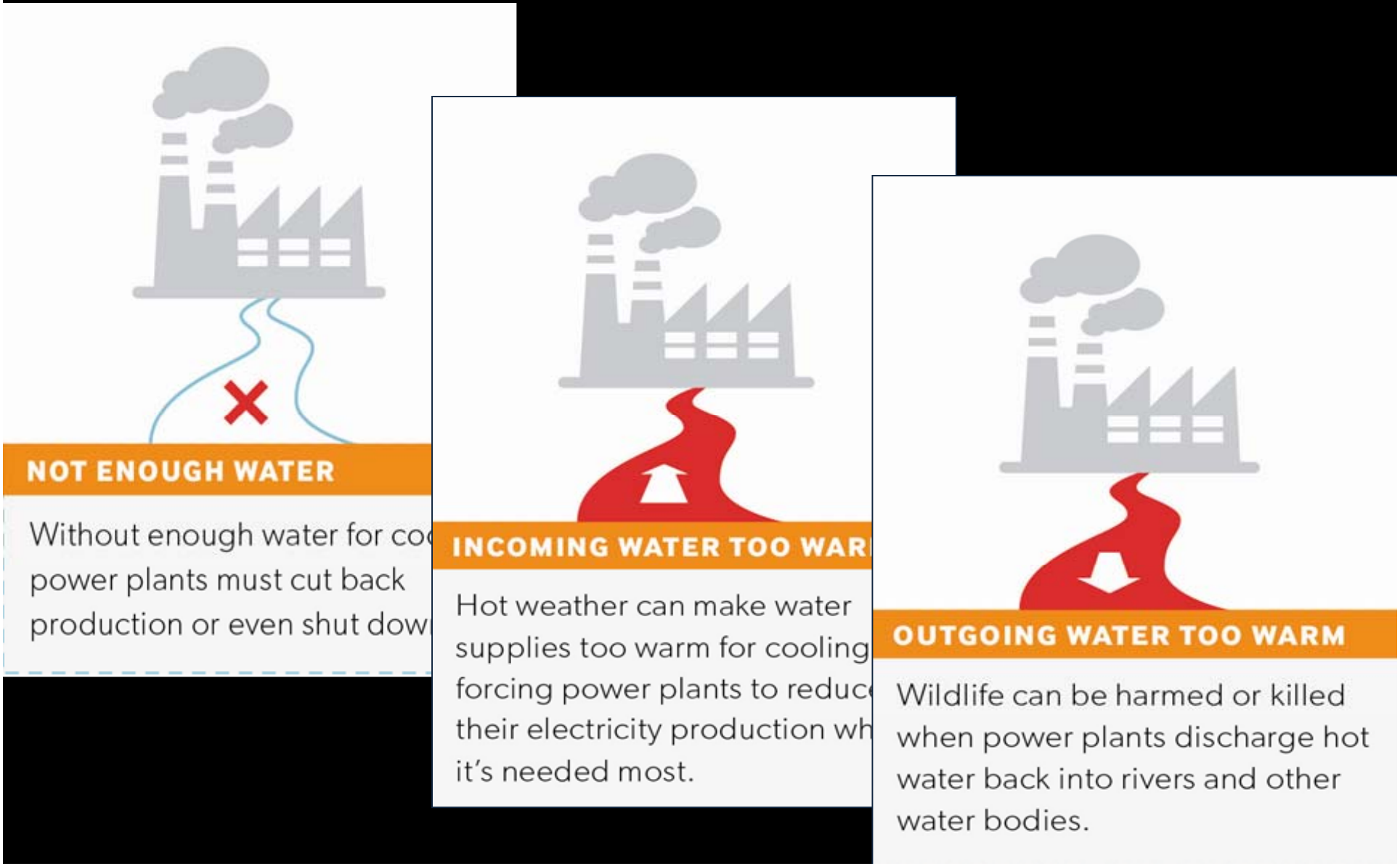
Freshwater Withdrawal Intensity



Freshwater Consumption Intensity



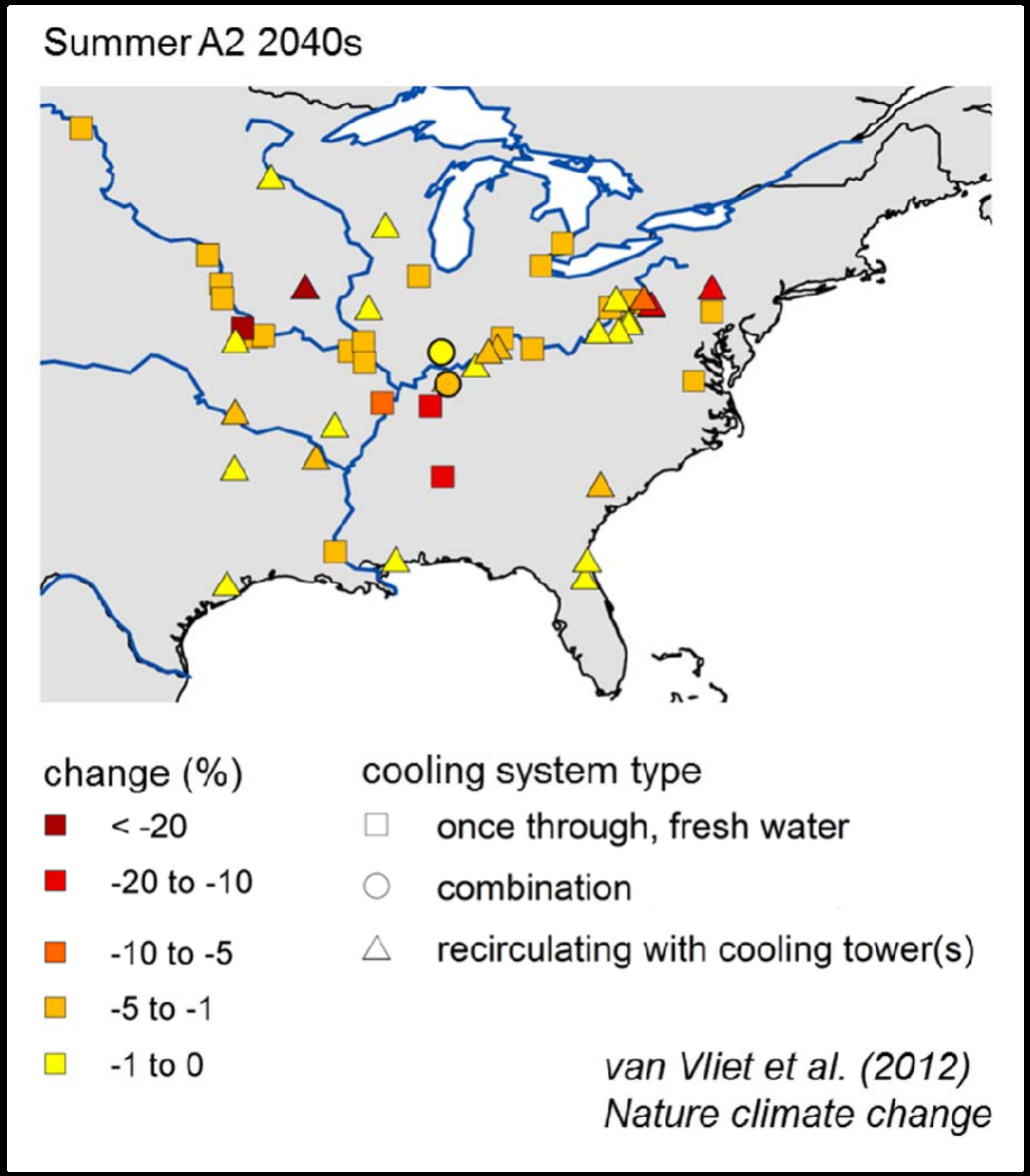
Hot, Dry Summers Put Both Electricity and Water Supplies At Risk



Heat and Drought-Related Electricity-Water Collisions (2006-2012)

Source: EW3 2012

Water-related vulnerability of US electricity sector increases with climate change



Decrease in power plant usable capacity

% decrease from 1970 – 2000 baseline

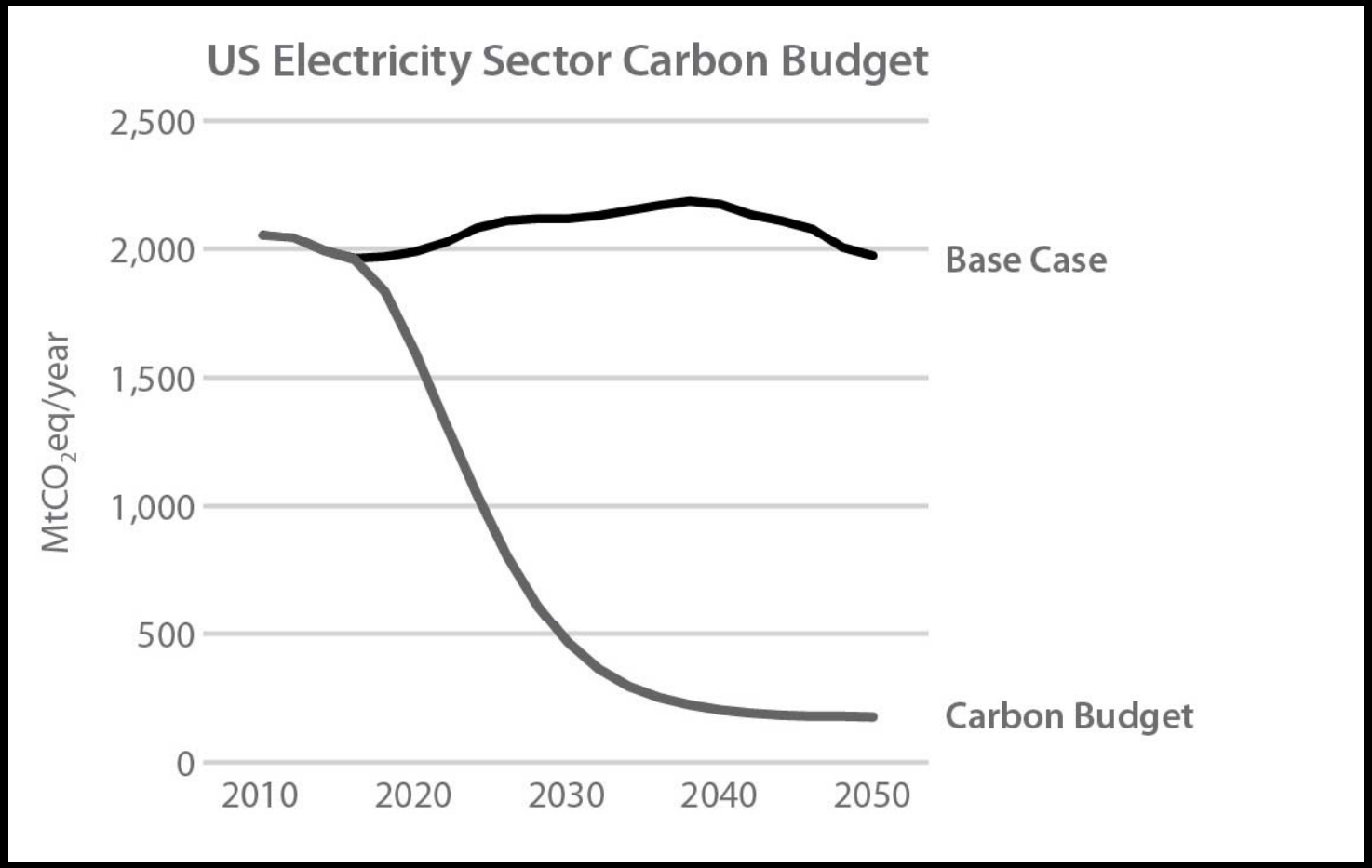
Trade-offs and Synergies Between Mitigation and Adaptation Electricity-Water-Climate Nexus

Possible Action	Impact on Carbon Emissions	Impact on Water Resources	
		Withdrawal	Consumption
Switch a Coal Plant from Once-Through to Recirculating Cooling			

Trade-offs and Synergies Between Mitigation & Adaptation: Electricity-Water-Climate Nexus

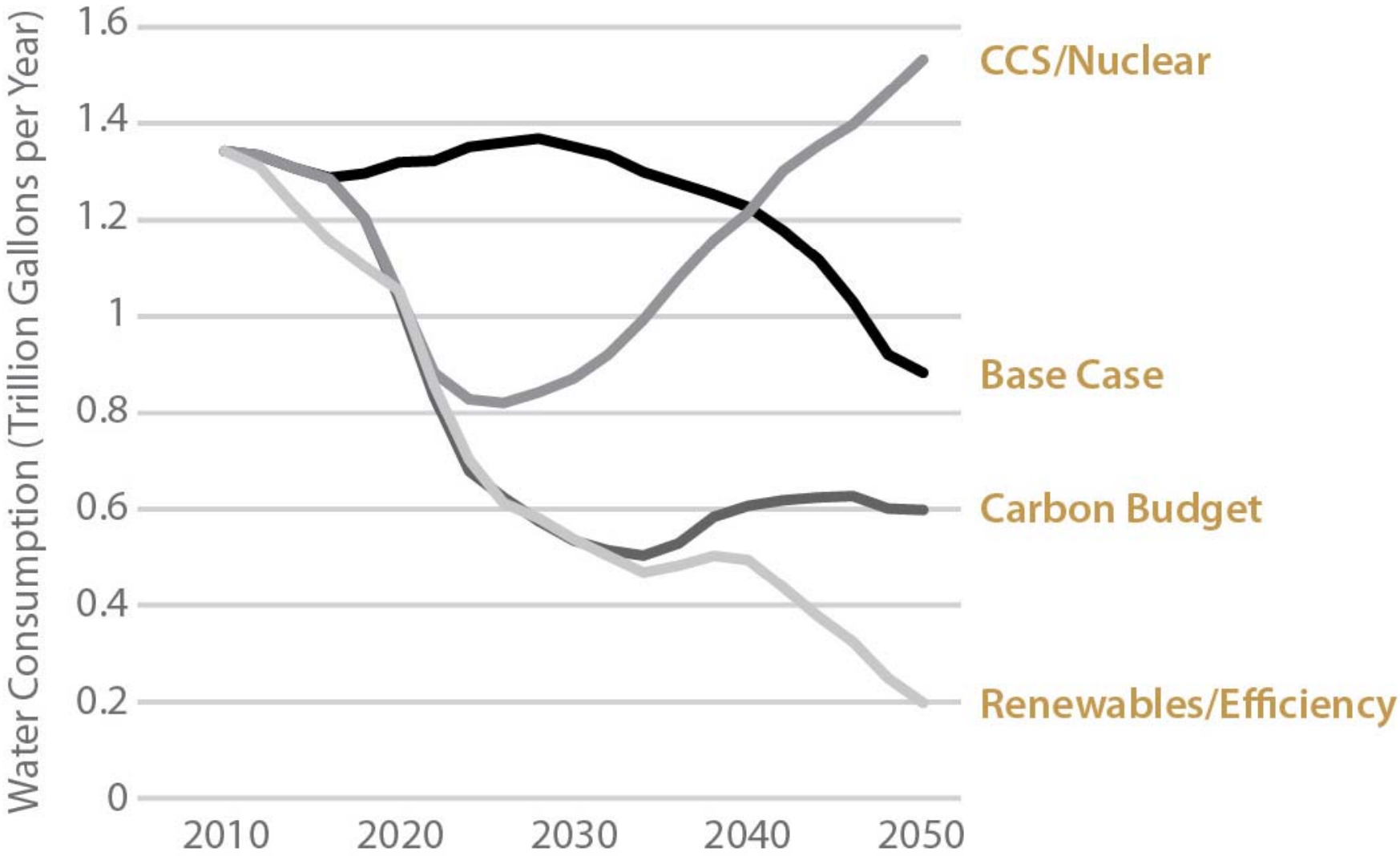
Possible Action	Impact on Carbon Emissions	Impact on Water Dependence	
		Withdrawal	Consumption
Switch a Coal Plant from Once-Through to Recirculating Cooling	↑	↓	↑
Switch to Natural Gas	↓ *	↓ *	↓ *
Adopt Carbon Capture and Storage	↓	↑	↑
↓ Energy Demand/ ↑ Energy Efficiency	↓	↓	↓
Switch to Wind/ Solar PV	↓	↓	↓

A US Electricity Sector Carbon Budget for a 450 Co2eq (~2° C) World



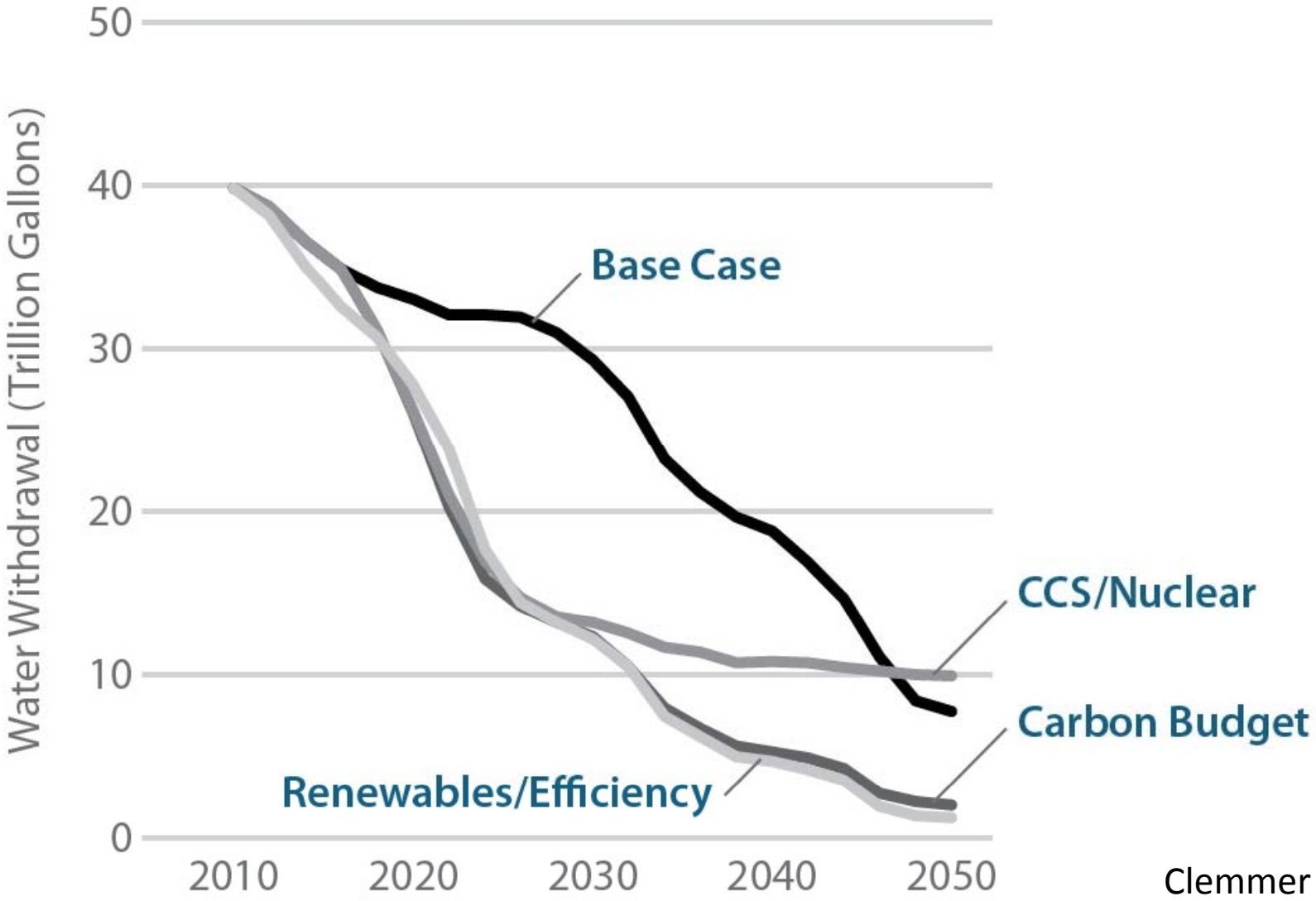
Fawcett et al 2009; NRC 2010; Clemmer et al ERL 2012

Impacts of Electricity Technology Pathways on Cooling Water Consumption



Clemmer et al ERL 2012

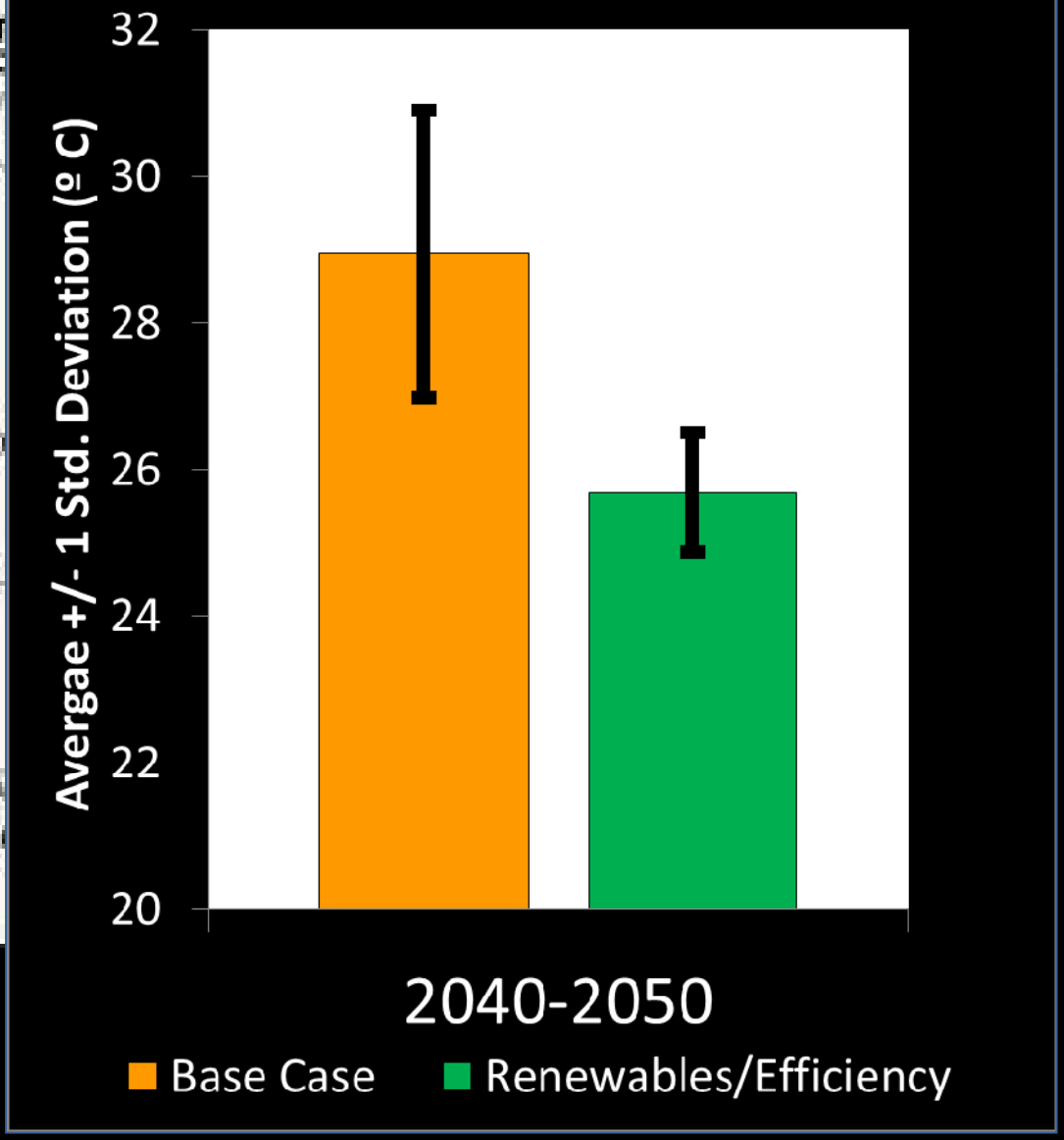
Impacts of Electricity Technology Pathways on Cooling Water Withdrawals



Clemmer et al ERL 2012

The ACT and A
River Basin

Average July Water Temperatures



EW3 2013 in prep

Electricity-Water-Climate Nexus
Science, Research and Innovation Needs

- *Spurring accelerated adoption of low water/low carbon electricity: efficiency, wind, solar pv.*
- *Reducing water use of electricity – cooling, extraction (fracking), CCS + switching to waste-water sources*
- *Improving modeling of electricity and water futures: esp. extremes (climate + energy demand) at geographically and temporally relevant scales.*
- *Expand modeler-stakeholder engagement in building + using water-energy (+land use) scenarios for planning and policy.*

For more information:

www.ucsusa.org/ew3