Integrating Energy, Water, Carbon, Climate… and more!

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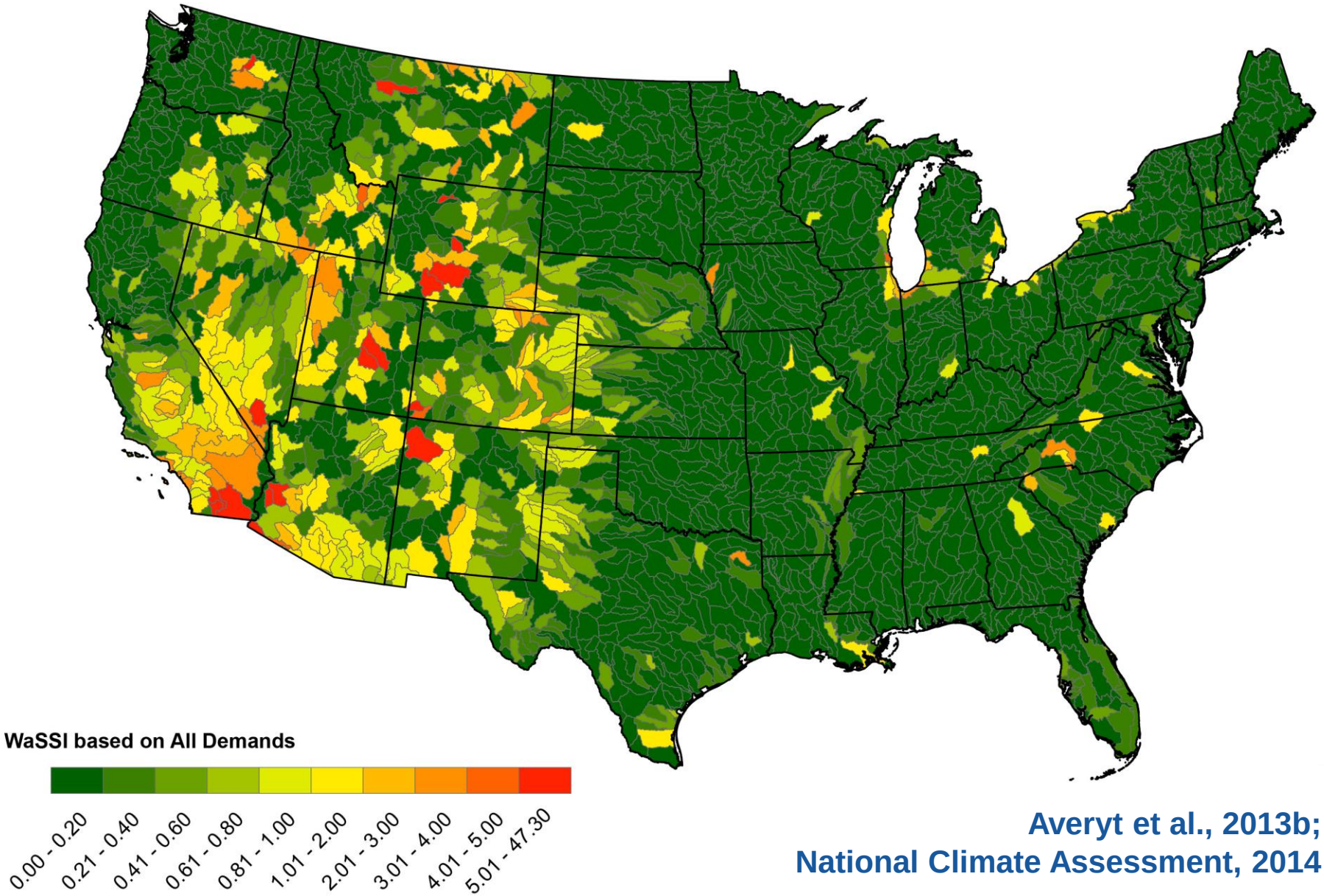
Cooperative Institute for Research
in Environmental Sciences

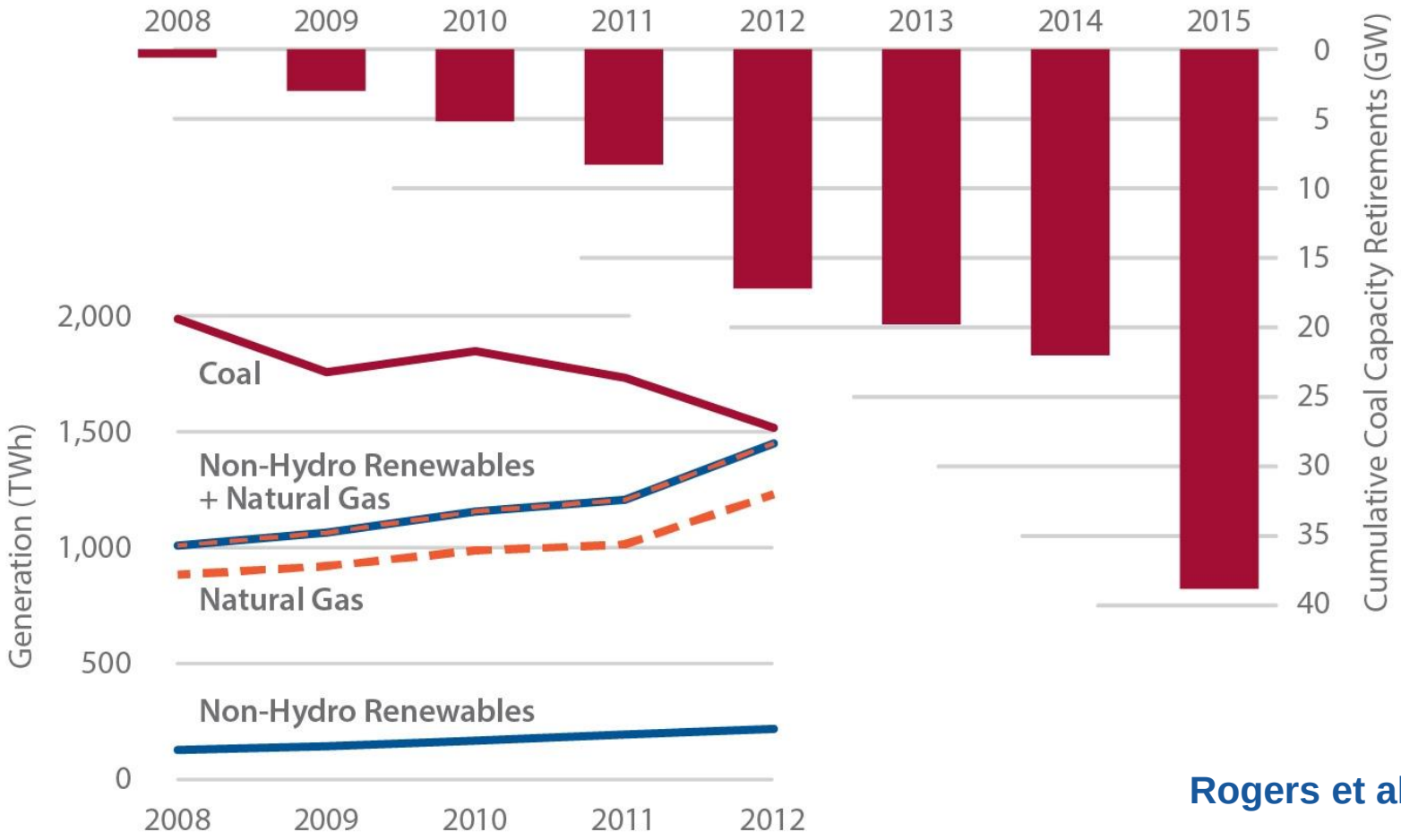
Food-Energy-Water Workshop
Oct. 8, 2015

Surface Water Supply Stress (1999–2007)



Averyt et al., 2013b;
National Climate Assessment, 2014

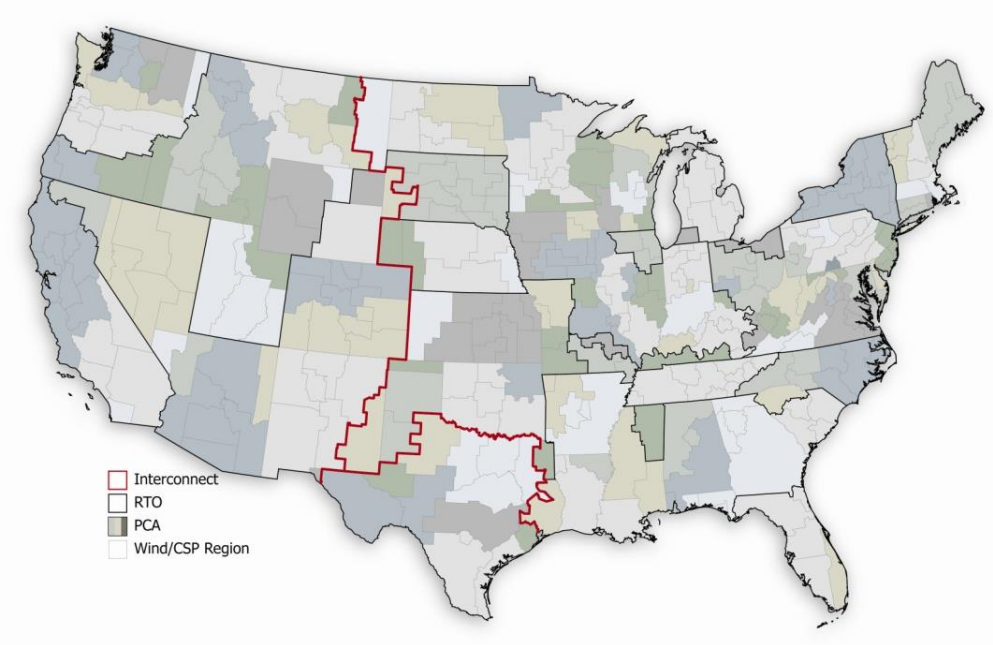
Electricity Sector in Transition



Rogers et al., 2013

What are the implications for water resources of different electricity portfolios out to 2050?

ReEDS (Regional Energy Deployment) Model



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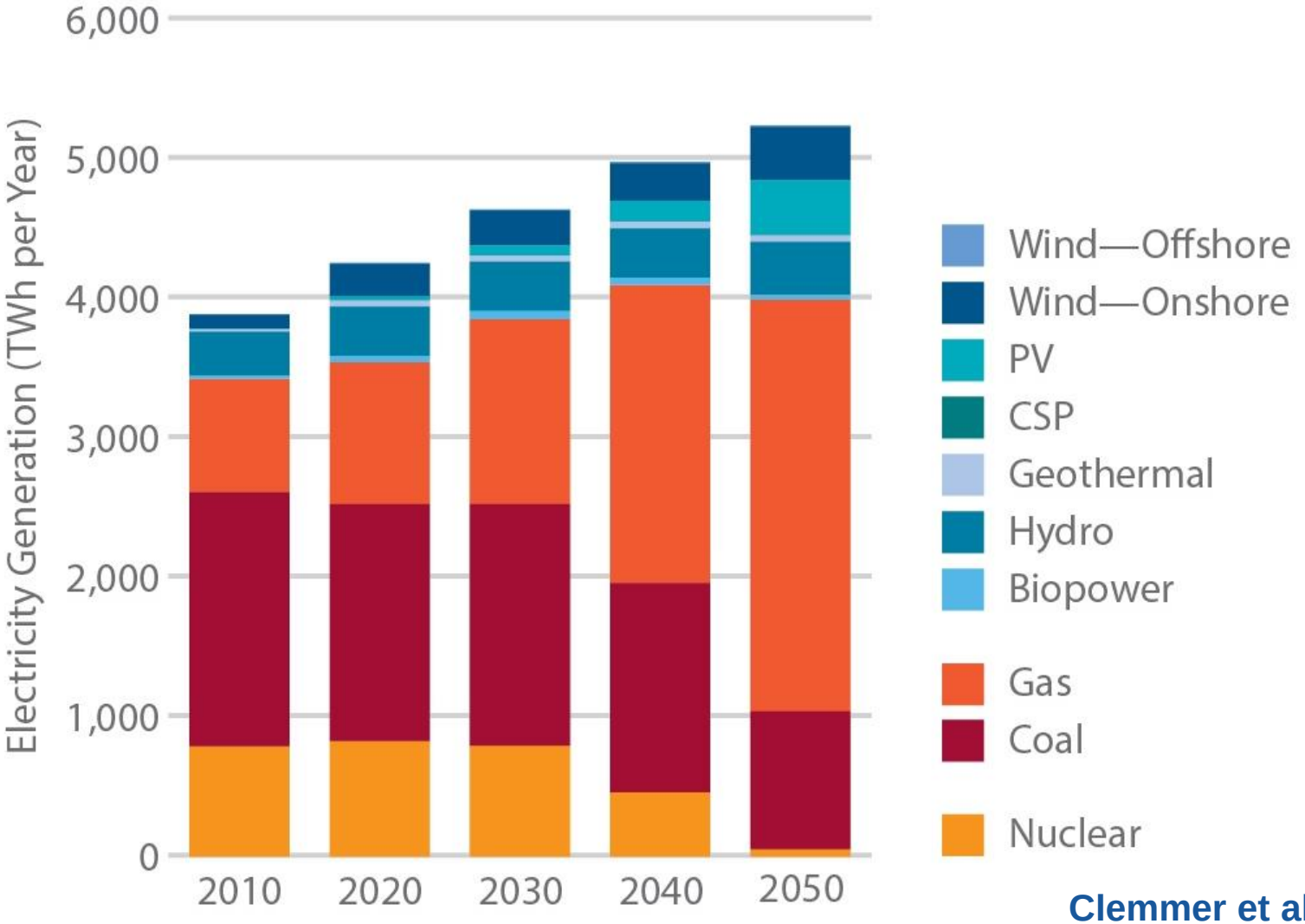
See also: Short, W.; Sullivan, P.; Mai, T.; Mowers, M.; Uriarte, C.; Blair, N.; Heimiller, D.; Martinez, A. (2011). Regional Energy Deployment System (ReEDS).NREL Report No. TP-6A20-46534.

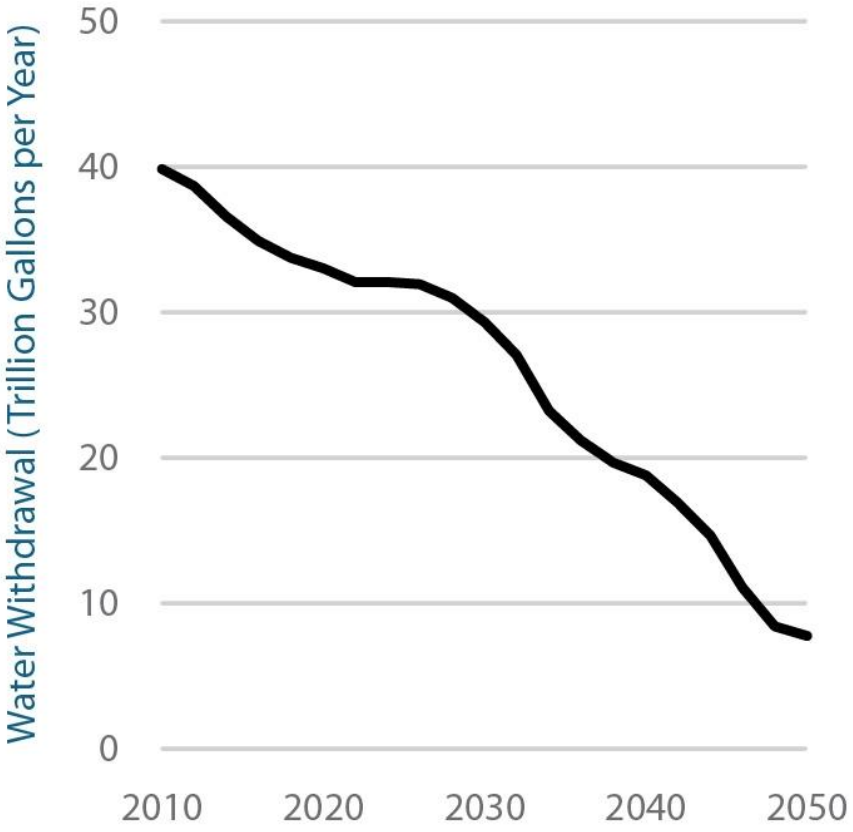
Business as Usual: Electricity Portfolio



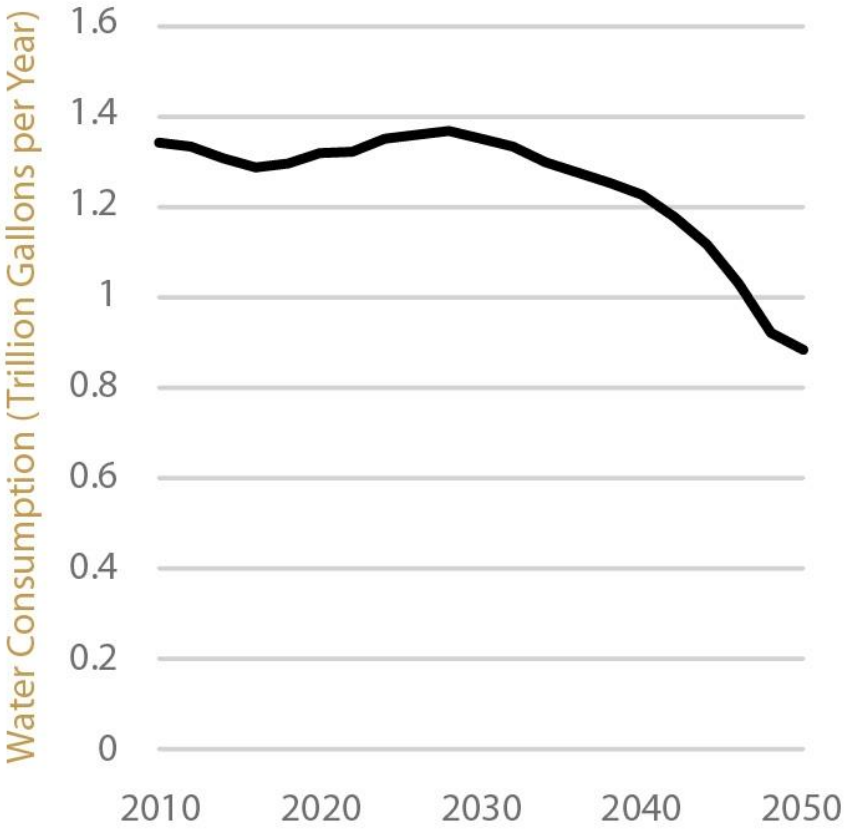
Clemmer et al., 2013

Business as Usual: Water

Withdrawal

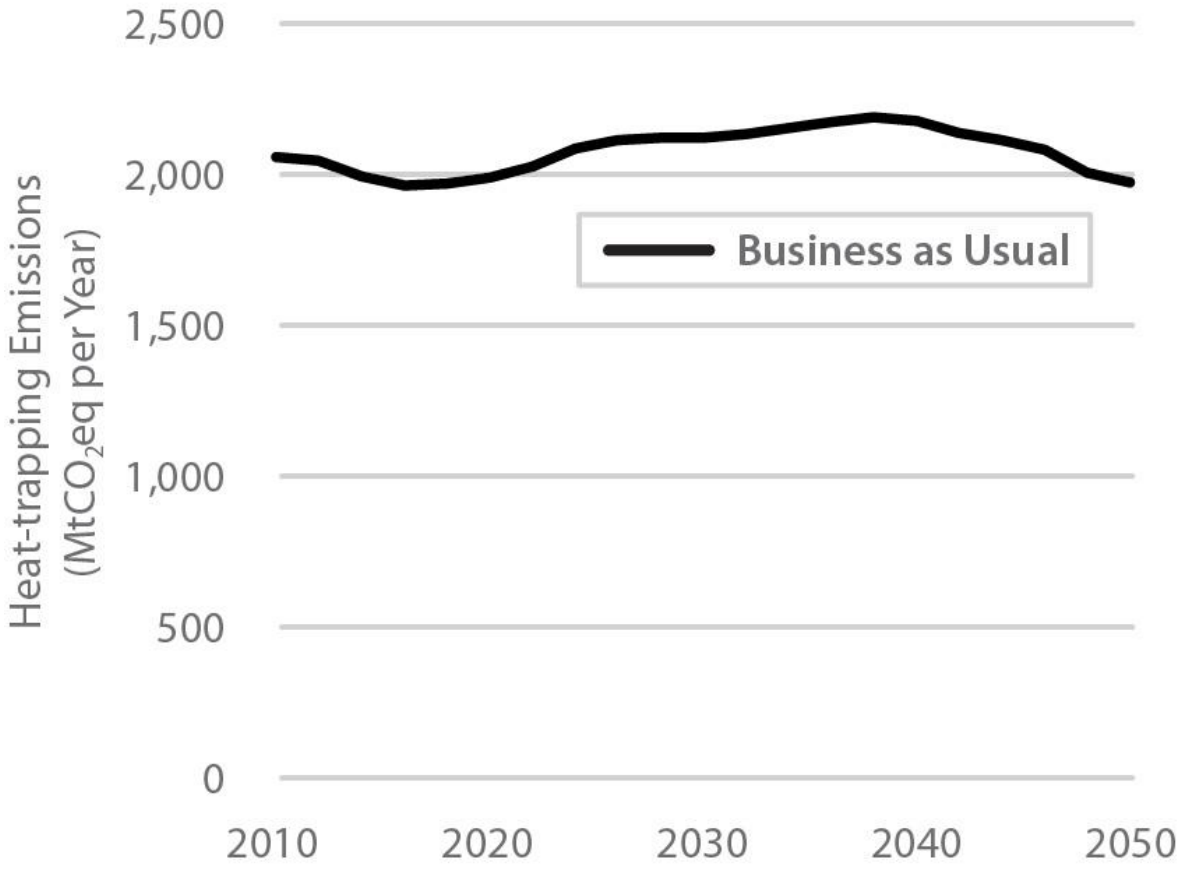


Consumptive Use



Macknick et al., 2012

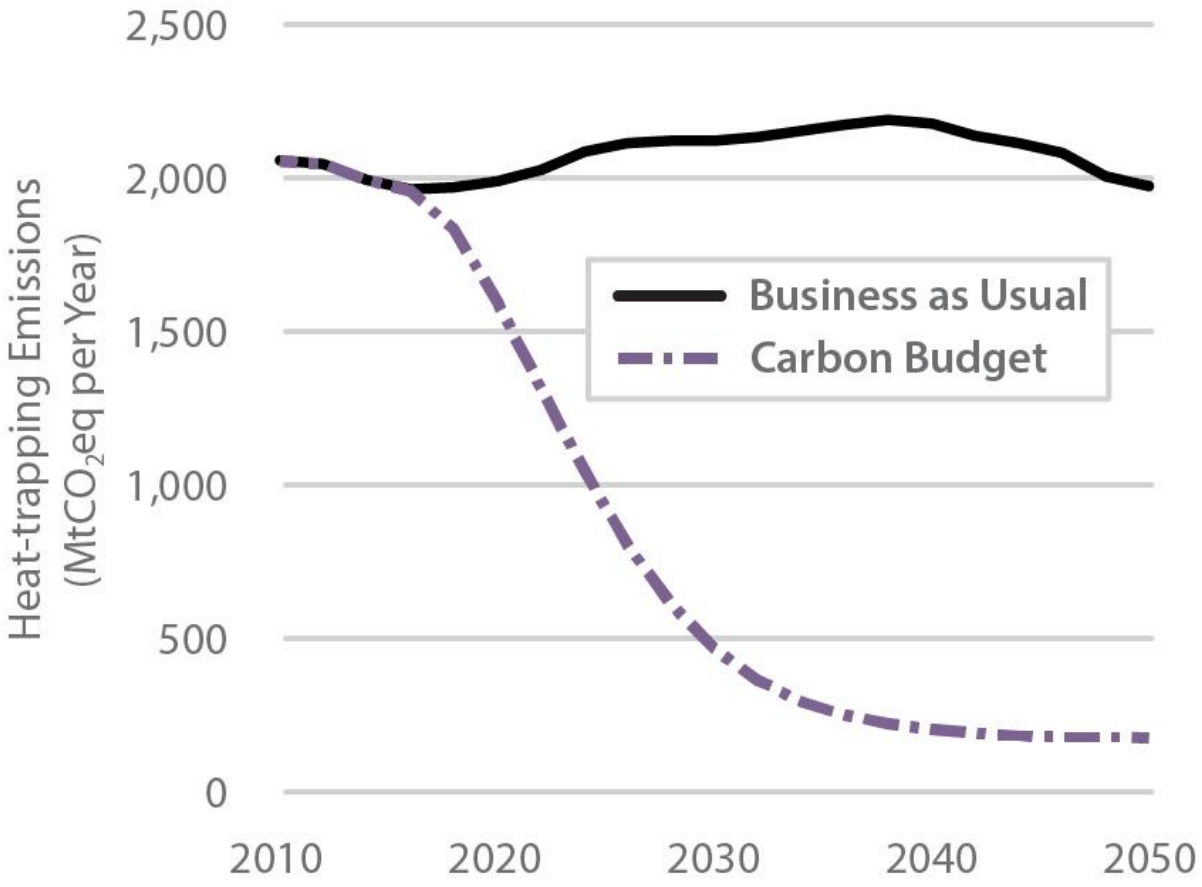
Business as Usual: Carbon Emissions



Clemmer et al., 2013

Business as usual: emissions stable, concentrations increase

Business as Usual vs. Carbon Budget



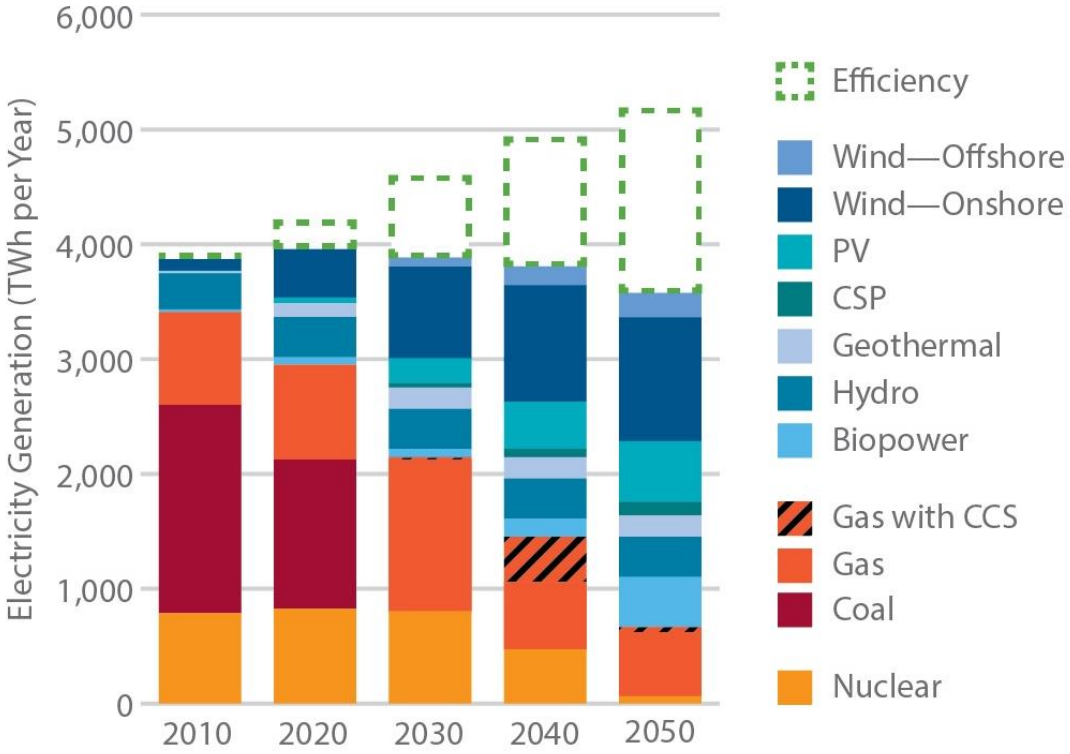
Clemmer et al., 2013

carbon budget: 170 GT $CO_{2\ (eq)}$ by 2050

Carbon Budget: Electricity Profiles

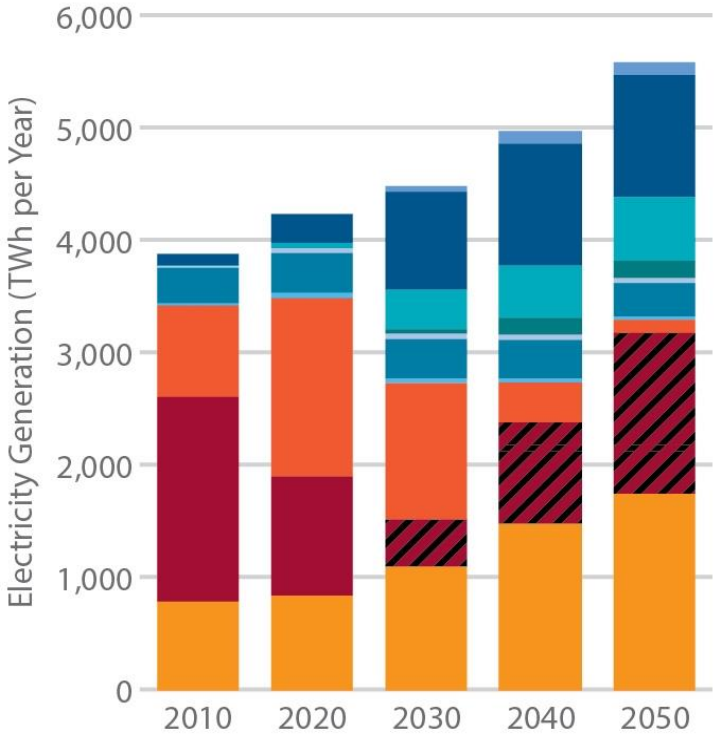
Low Water

Renewables & Efficiency



High Water

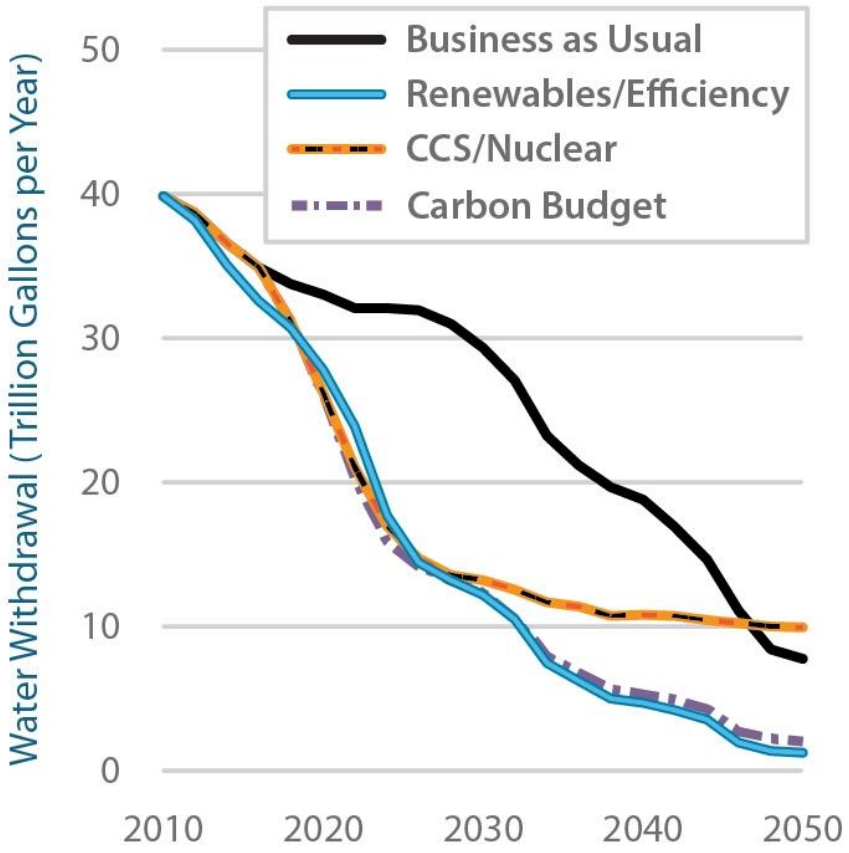
Nuclear & CCS



Clemmer et al., 2013

Water for Energy: US Projections

Withdrawal



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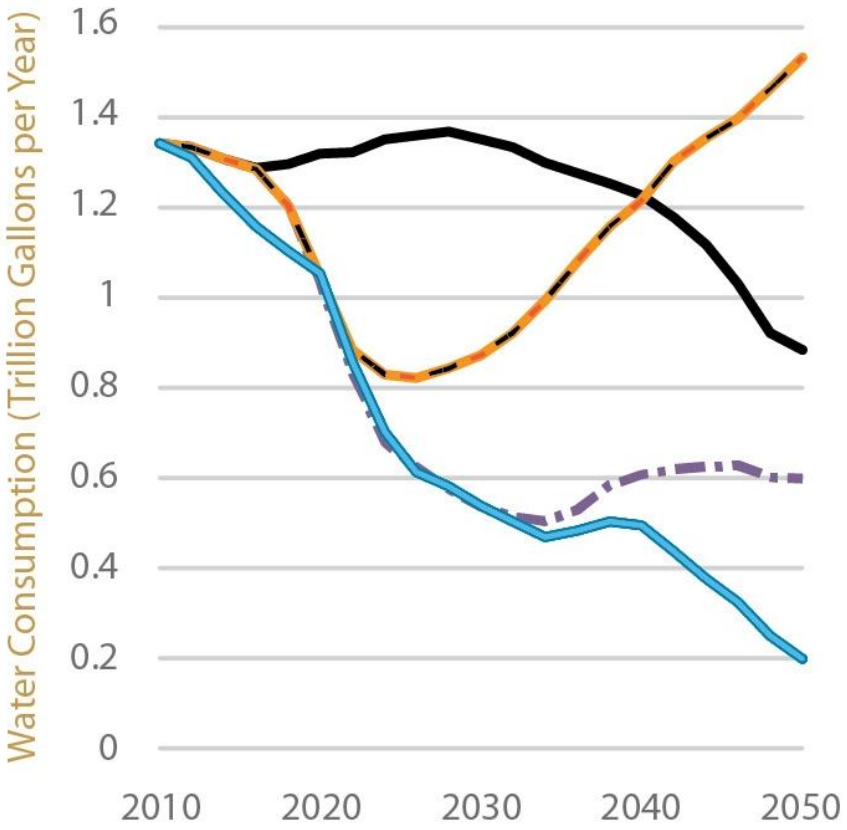

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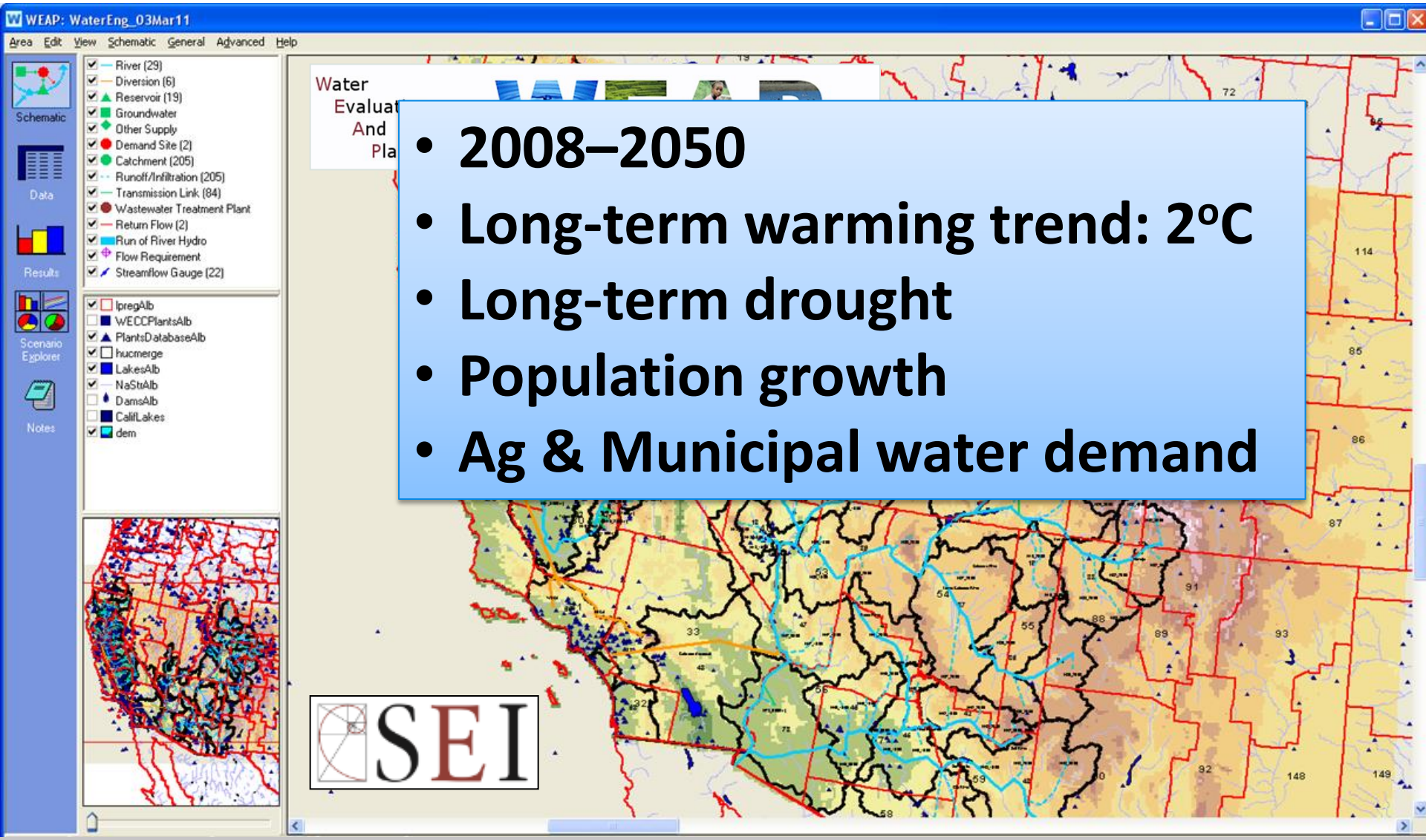
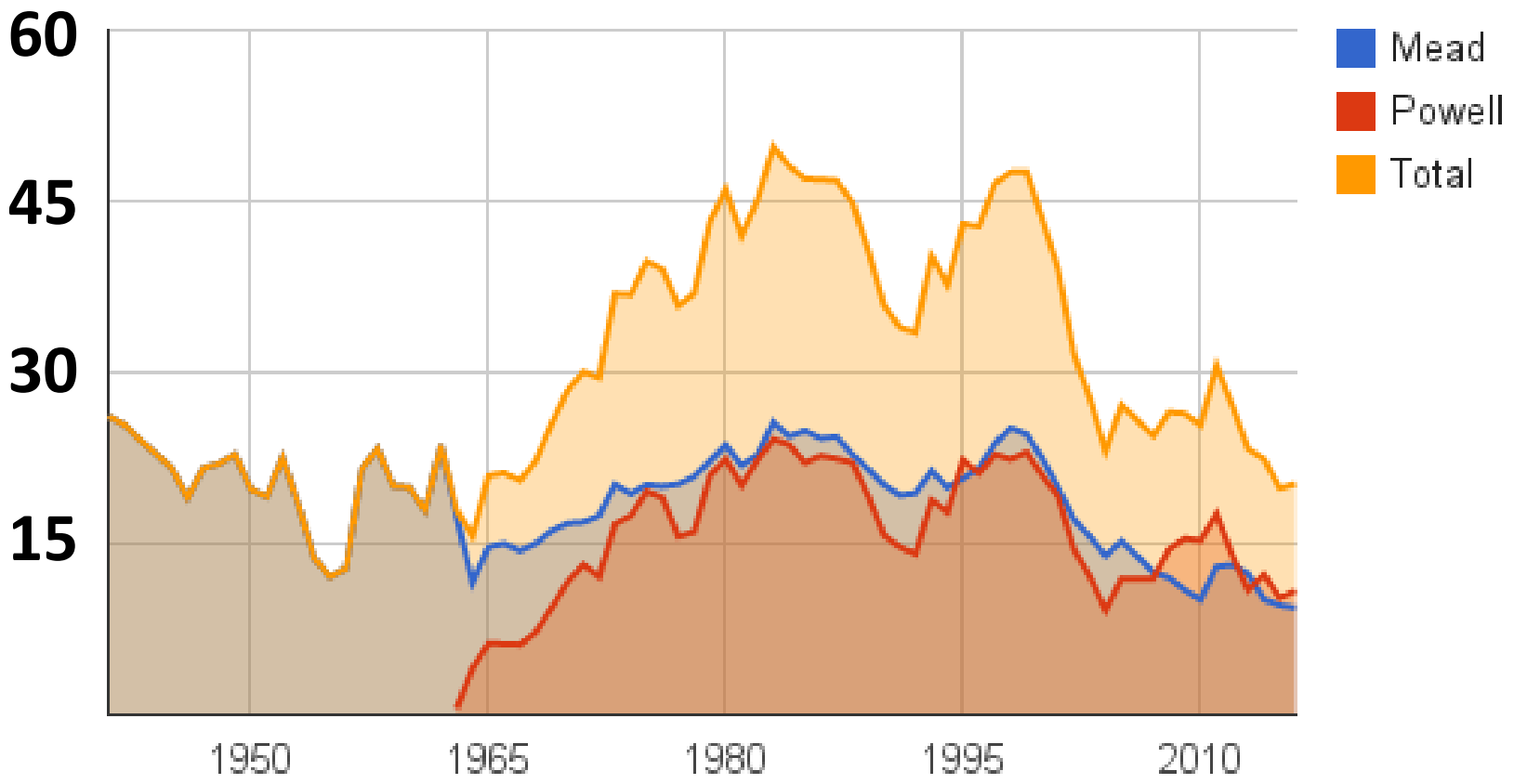
Case Studies: Water & Climate

Water Evaluation and Planning (WEAP) Model

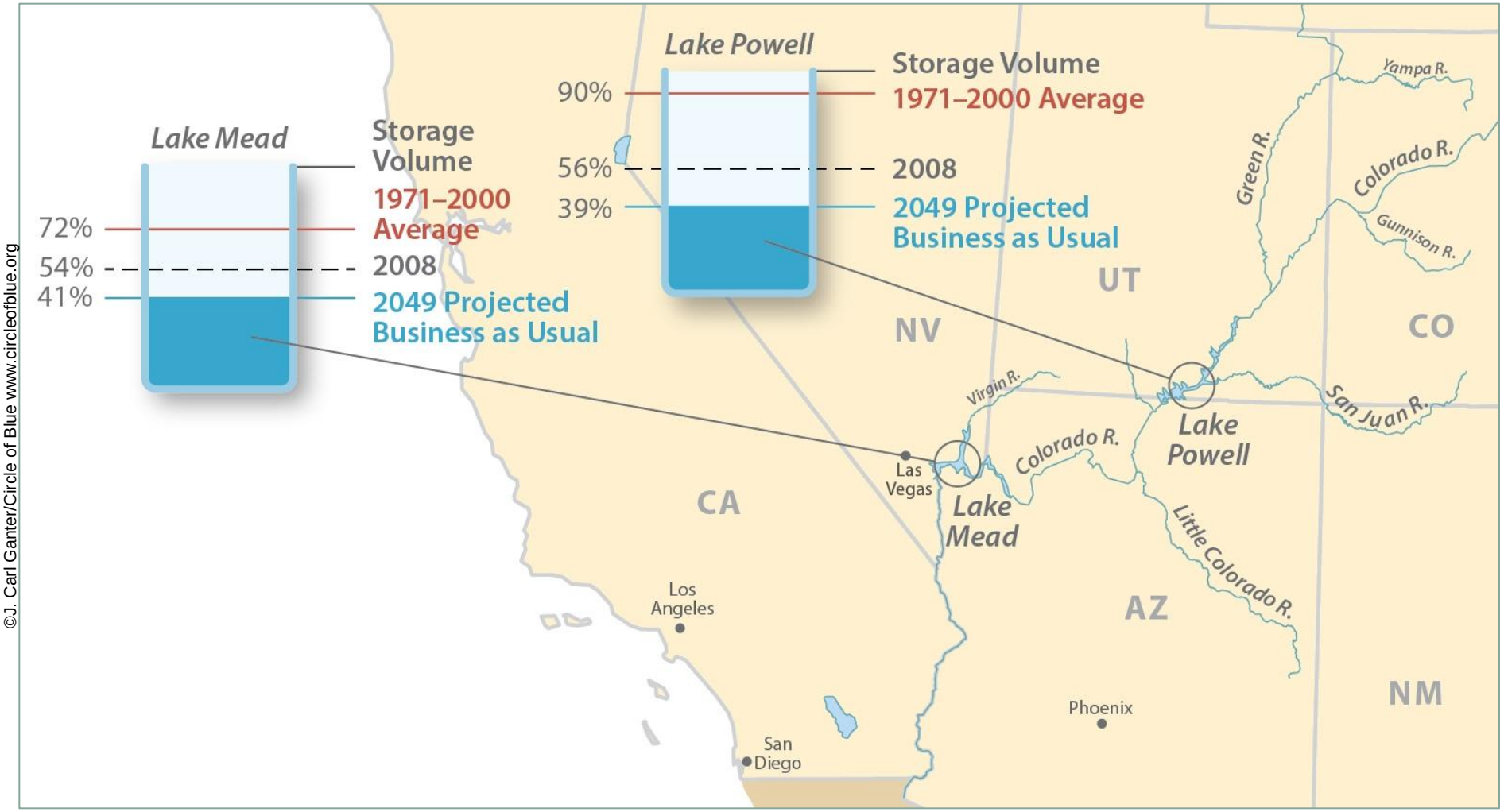


- 2008–2050
- Long-term warming trend: 2°C
- Long-term drought
- Population growth
- Ag & Municipal water demand

Colorado River Basin: Total Storage (million acre-ft)



Colorado River Basin: Results



Yates et al., 2013

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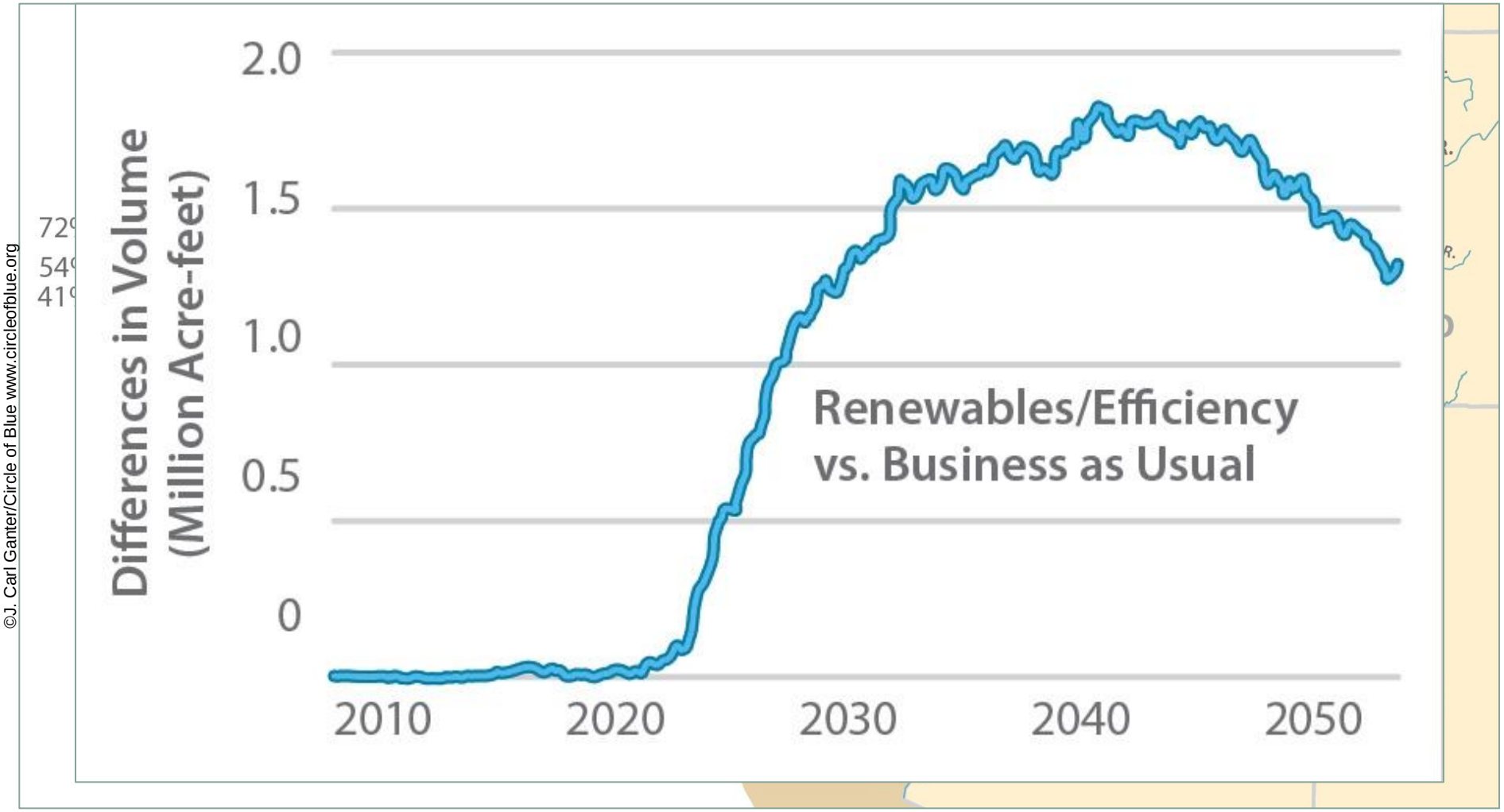

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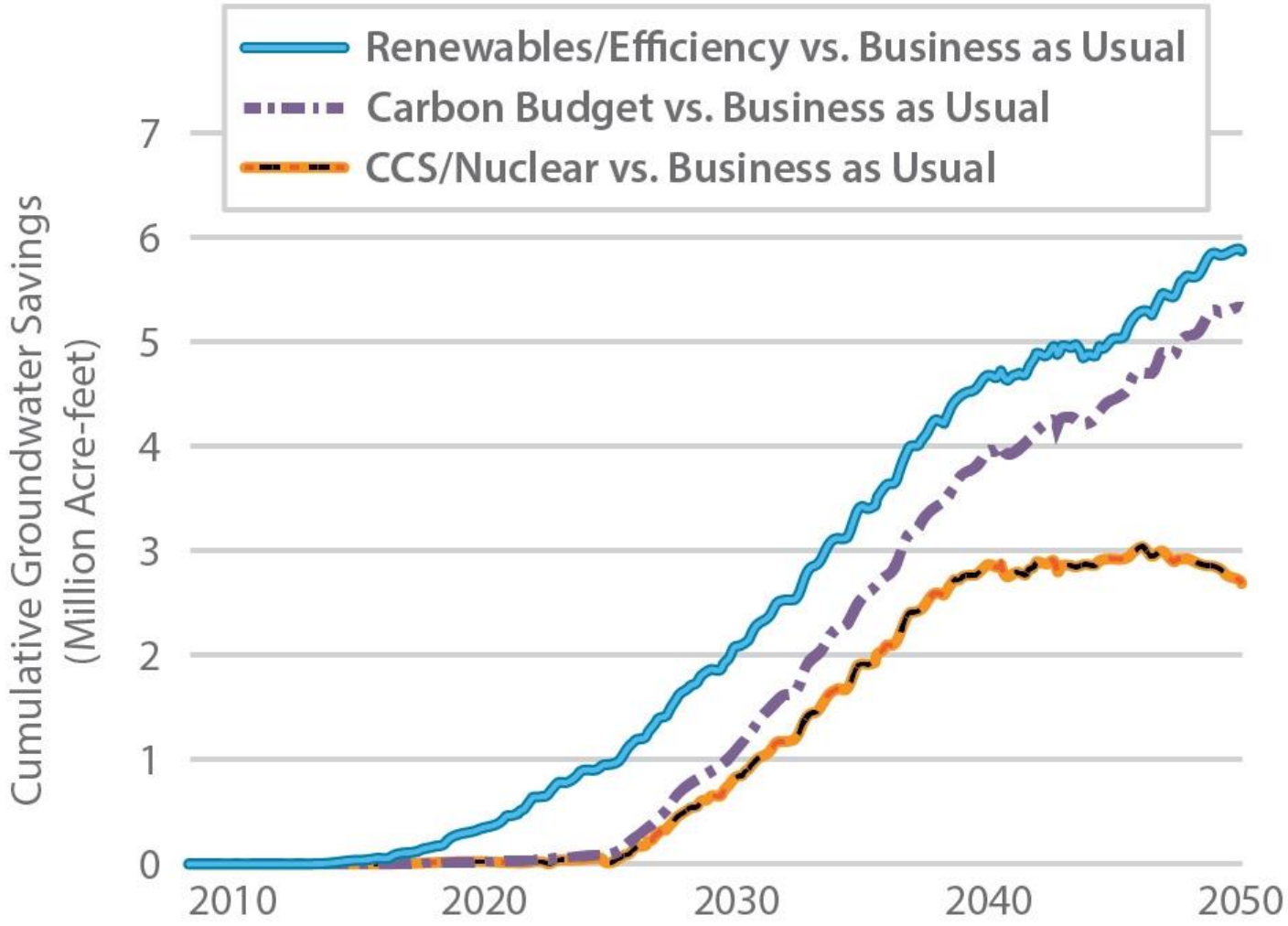
Groundwater



Yates et al., 2013

Yates, Meldrum, and Averyt 2013

Southeastern US: Temperature Results

Coosa River above Lake Weiss:

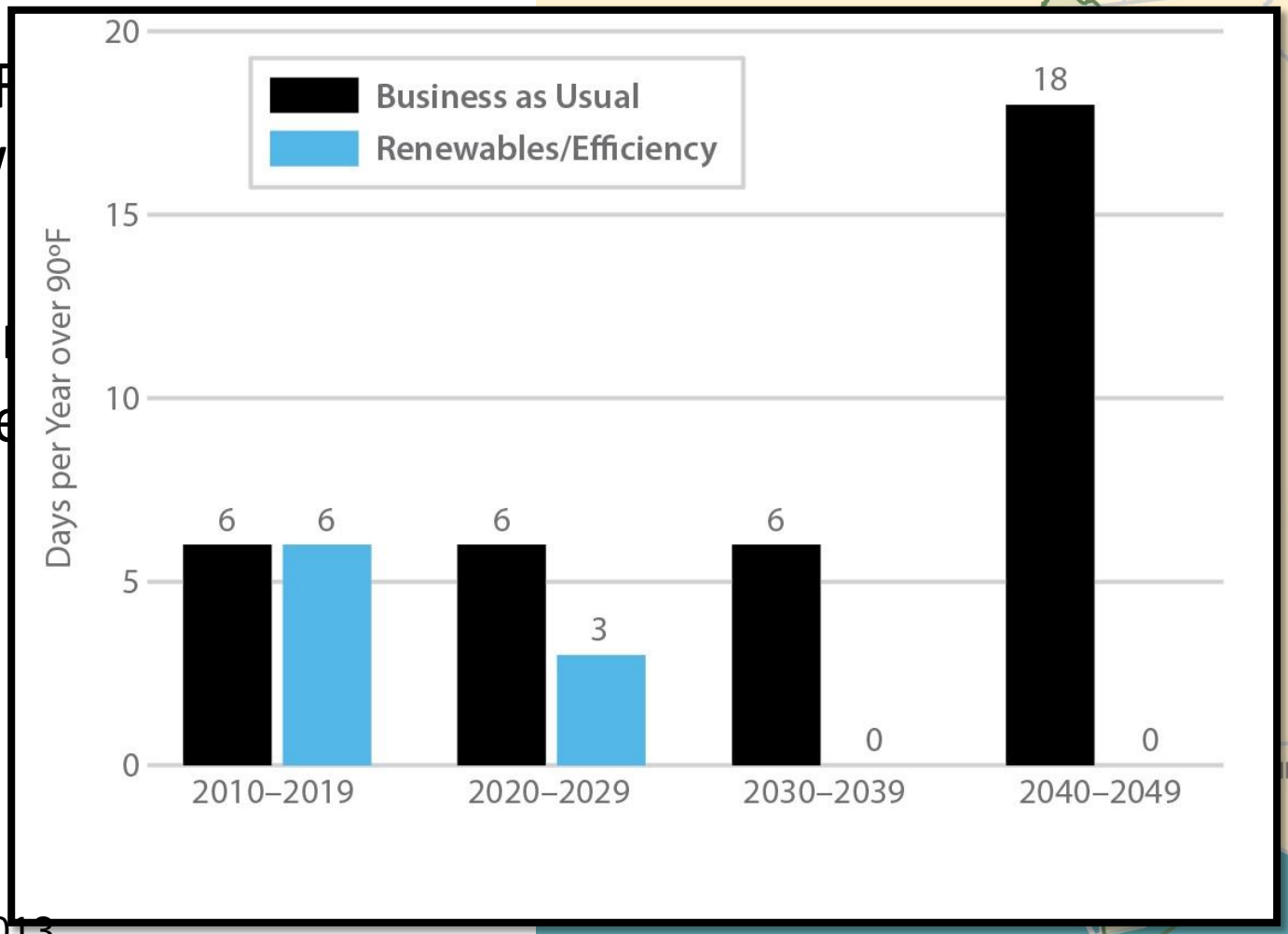
- Land locked river system
- Striped bass

Yates et al., 2013

Southeastern US: Temperature Results

Coosa R
Lake W

- Land
  syste
- Stripe



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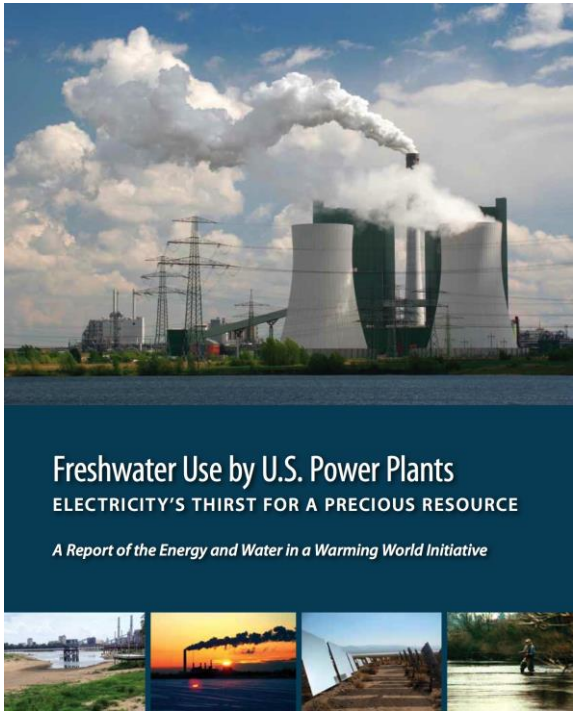
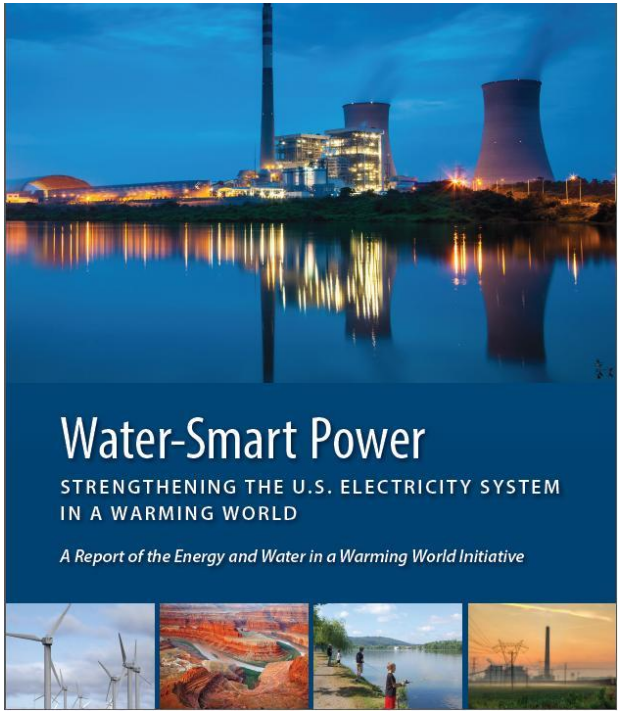


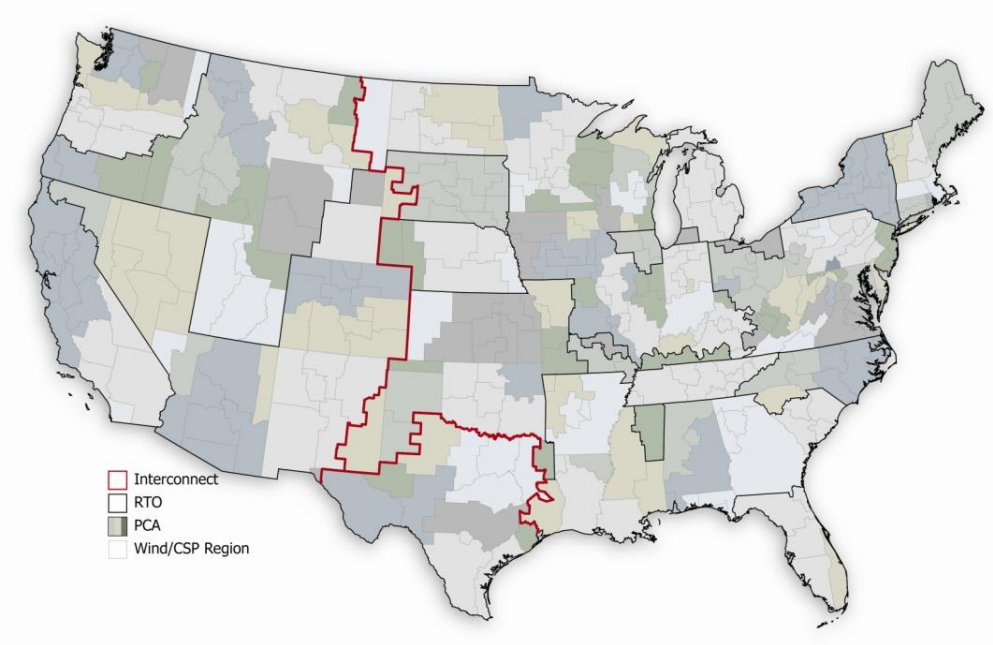


J. Meldrum (CU Boulder),
D. Yates (NCAR),
J. Macknick (NREL),
R. Newmark (NREL),
J. Rogers (UCS),
S. Clemmer (UCS),
S. Sattler (UCS),
F. Flores (SEI),
N. Madden (UCS),
M. Webber (UT Austin),
A. Huber-Lee (Tufts)

Current Analysis: Climate Change

What would the electricity portfolio have to look like in order to accommodate these changing supplies and demands?

ReEDS (Regional Energy Deployment) Model



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Climate Scenario Selection

Scenario Selection: CMIP5

- Downscaled Temperatures (Reclamation, 2013)
- Hydrology (Wood & Mizukami, 2014)
- Colorado River Basin
- Summer/Fall Months (June–September)

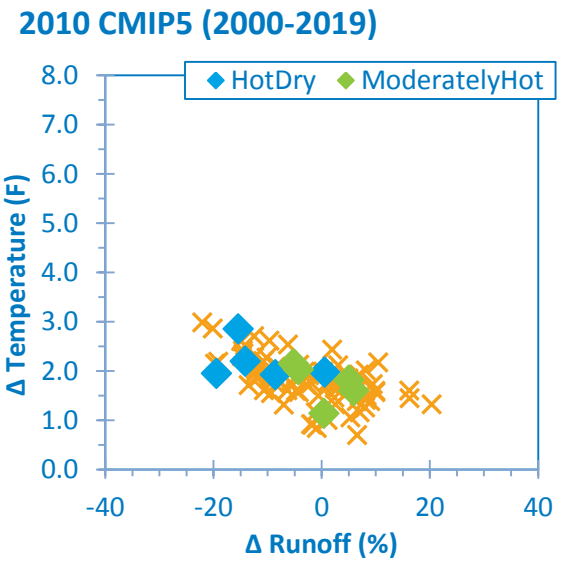
Scenarios

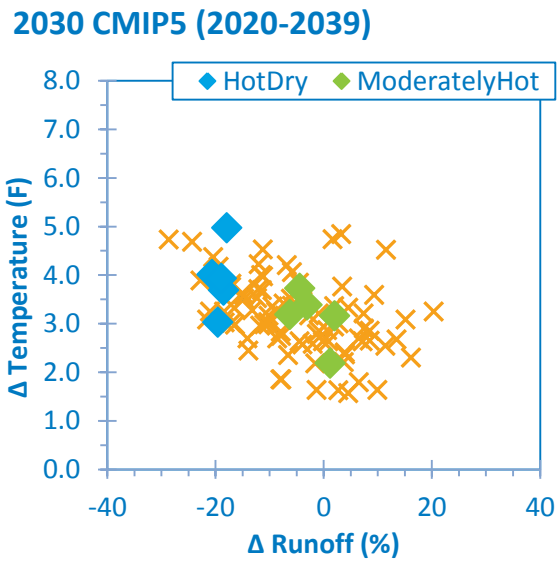
- Hot-Dry, Hot-Wet, Mod Hot

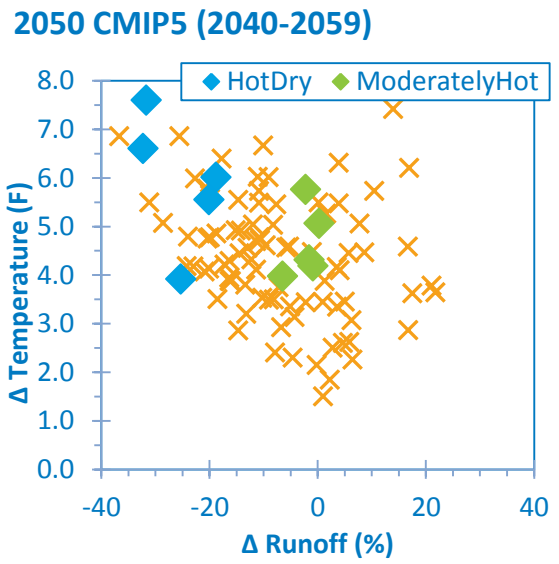
Data Input

- Humidity, CDD, HDD, Water Availability
- Population: Ag, Municipal Water

Model Name	CMIP5 Scenario*
Hot/Dry Scenario	
ACCESS1.0	RCP 8.5
CCSM4	RCP 6.0
HadGEM2-AO	RCP 8.5
HadGEM2-ES	RCP 8.5
MIROC-ESM-CHEM	RCP 4.5
Moderately Hot Scenario	
BCC_CSM1.1	RCP 8.5
CESM1(CAM5)	RCP 8.5
FGOALS-G2	RCP 4.5
INM-CM4	RCP 8.5
MPI-ESM-LR	RCP 4.5
*All use r1i1p1 experiment	







Thank you!

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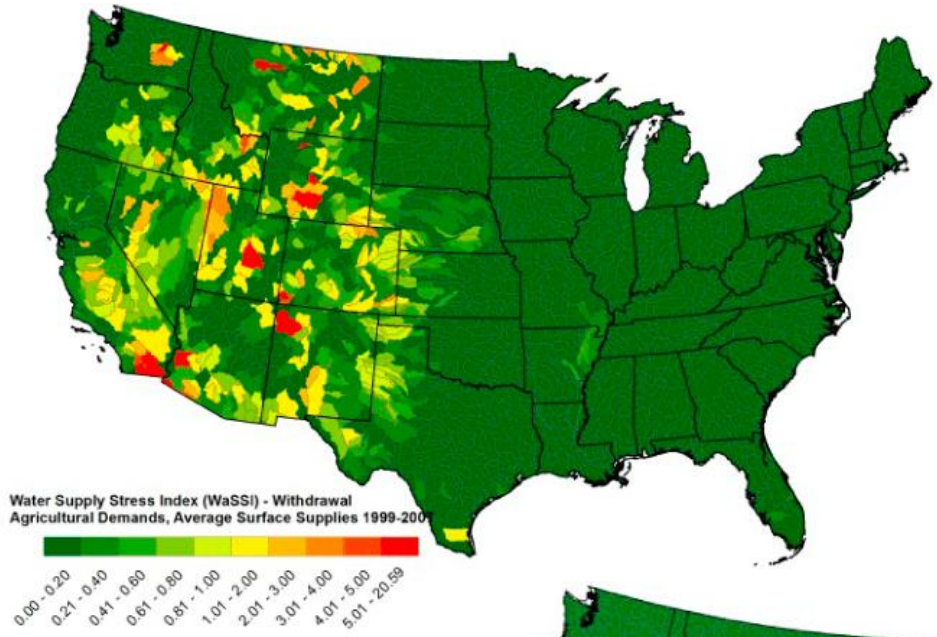
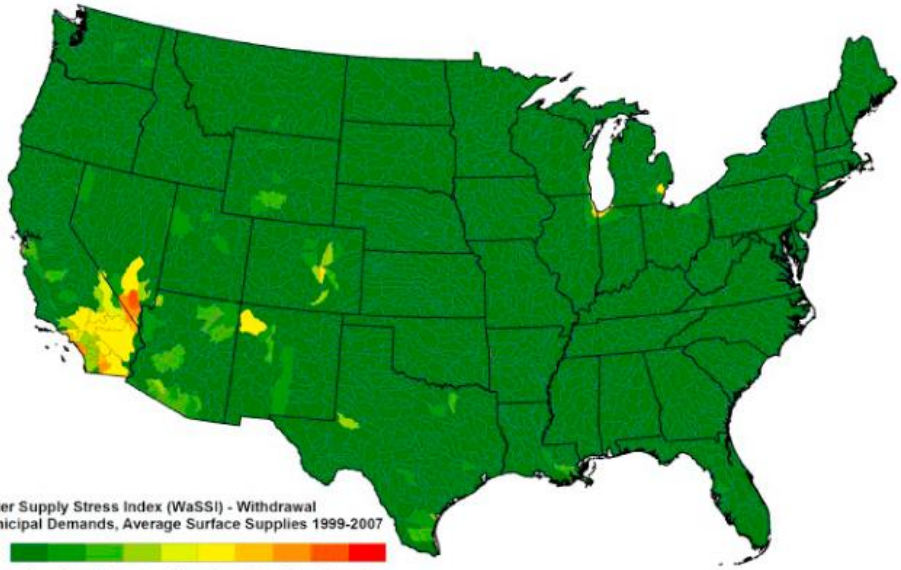
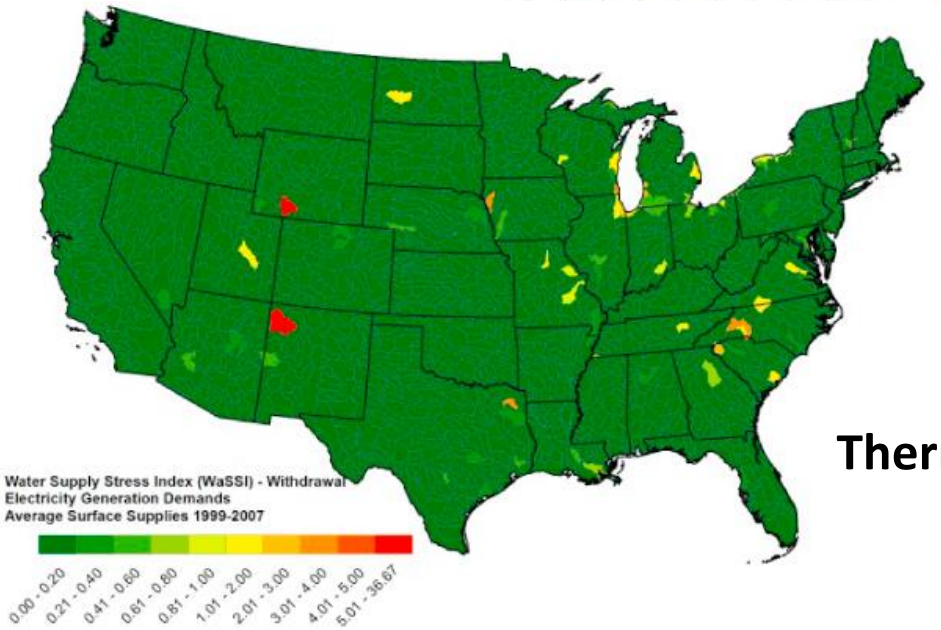
Surface Water Supply Stress (1999–2007)



Agriculture



Municipal



Thermoelectric

Averyt et al., 2013b