Climate Influences on Capacity Expansion Planning

PRESENTED BY

Vincent Tidwell
Sandia National Laboratories

Water and Energy: What Connection Can We Draw?
IAEE Webinar
October 12, 2020

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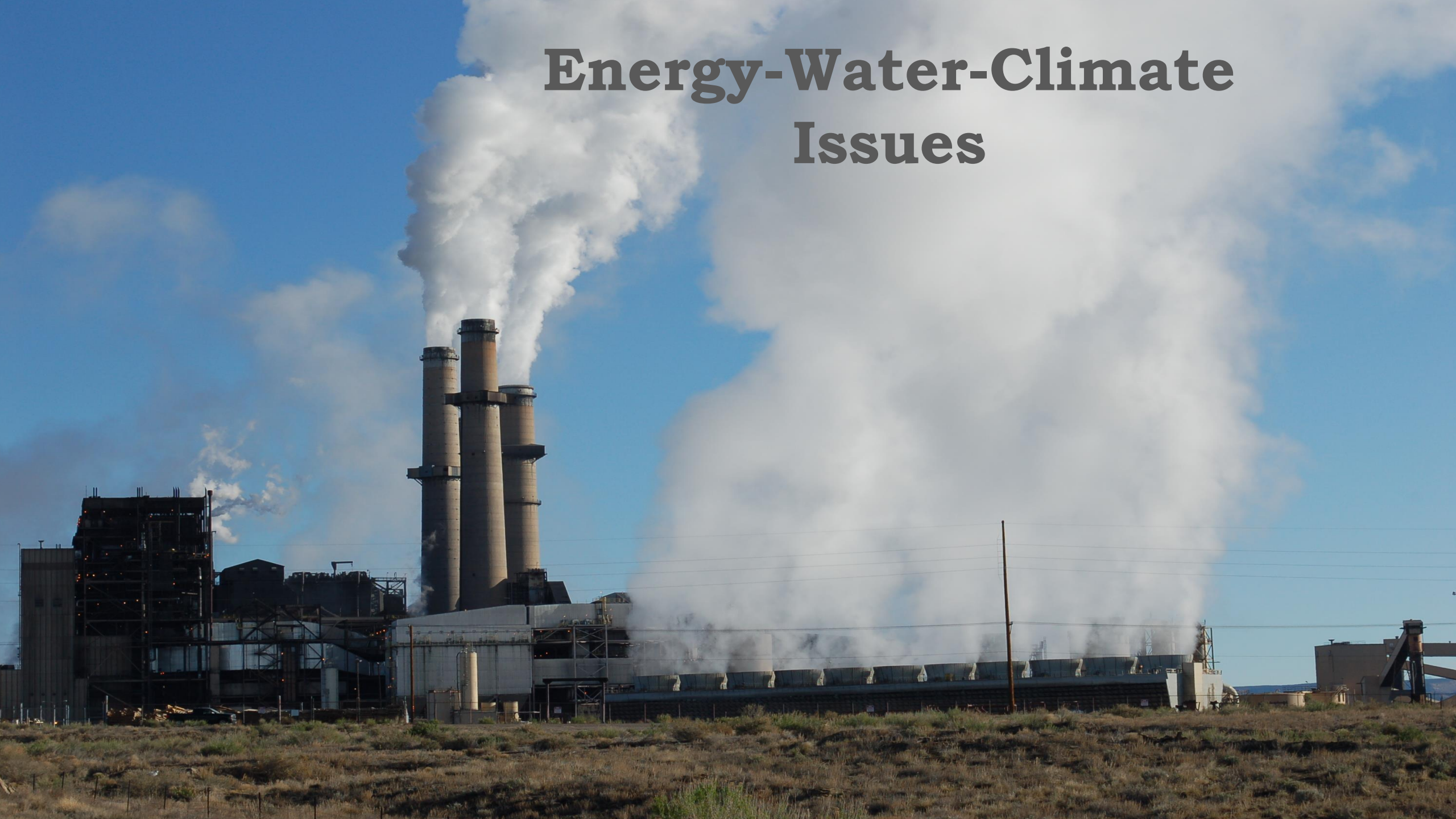
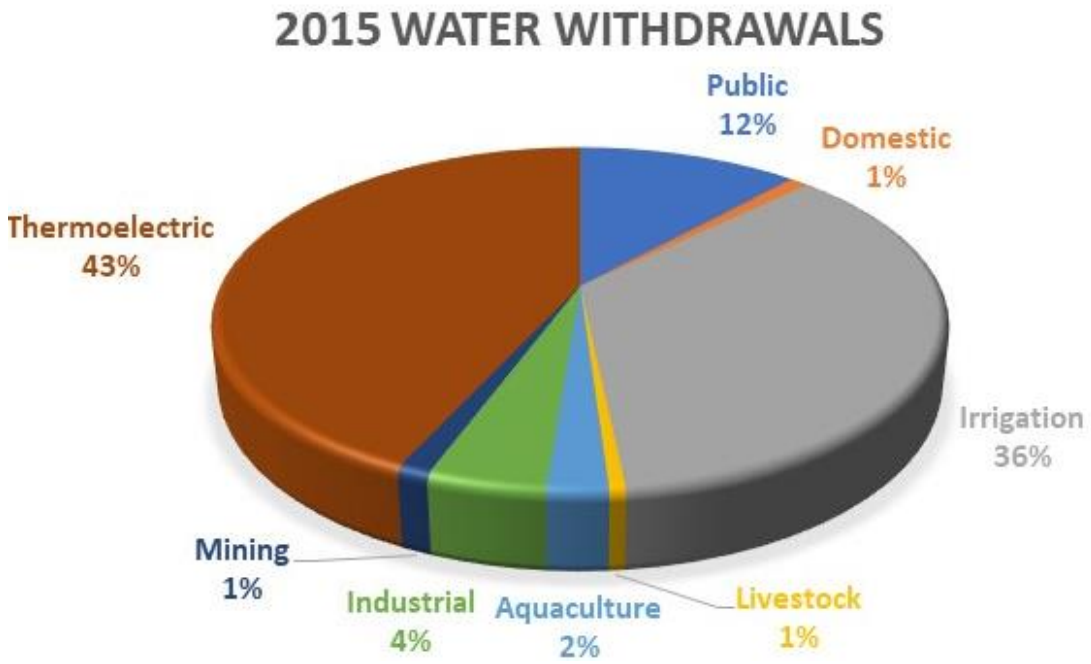
Energy-Water-Climate Issues



Water for Energy

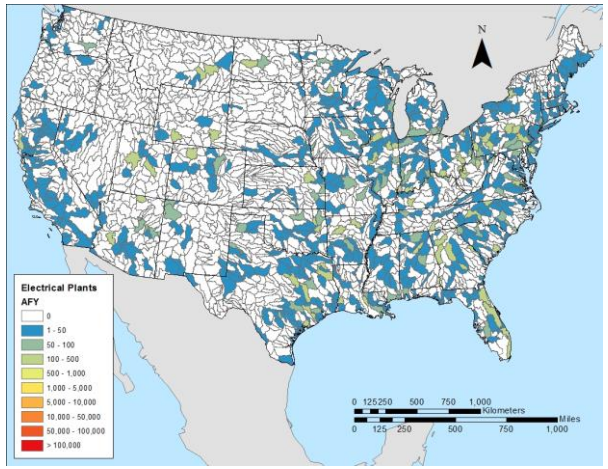


Source: USGS 2018

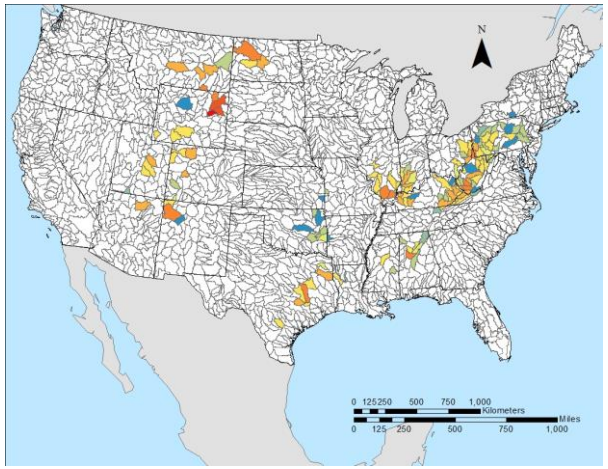
322 BGD Total Withdrawals
~7-8 BGD Total Consumption

Water Consumption by County

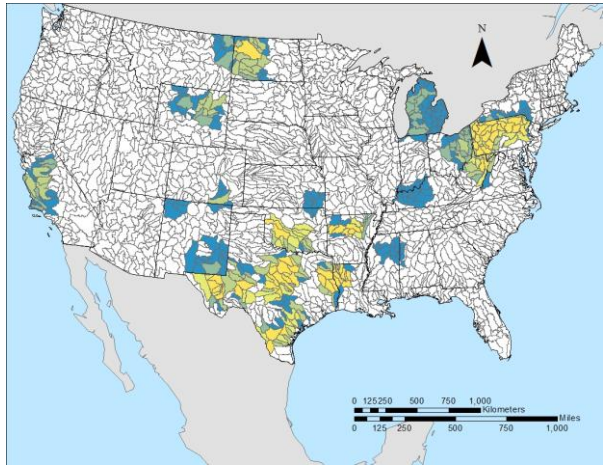
Thermoelectric



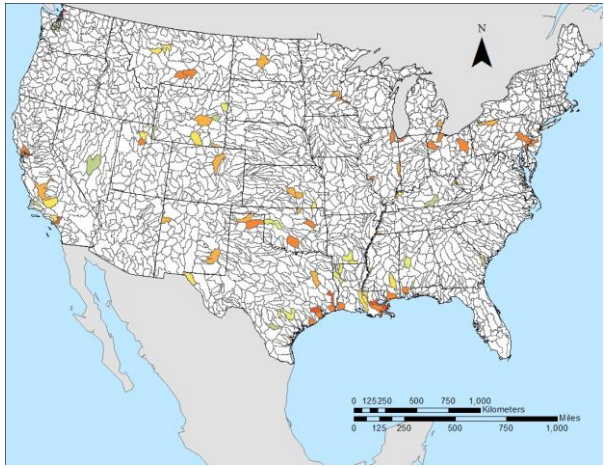
Coal



Unconventional Oil and Gas



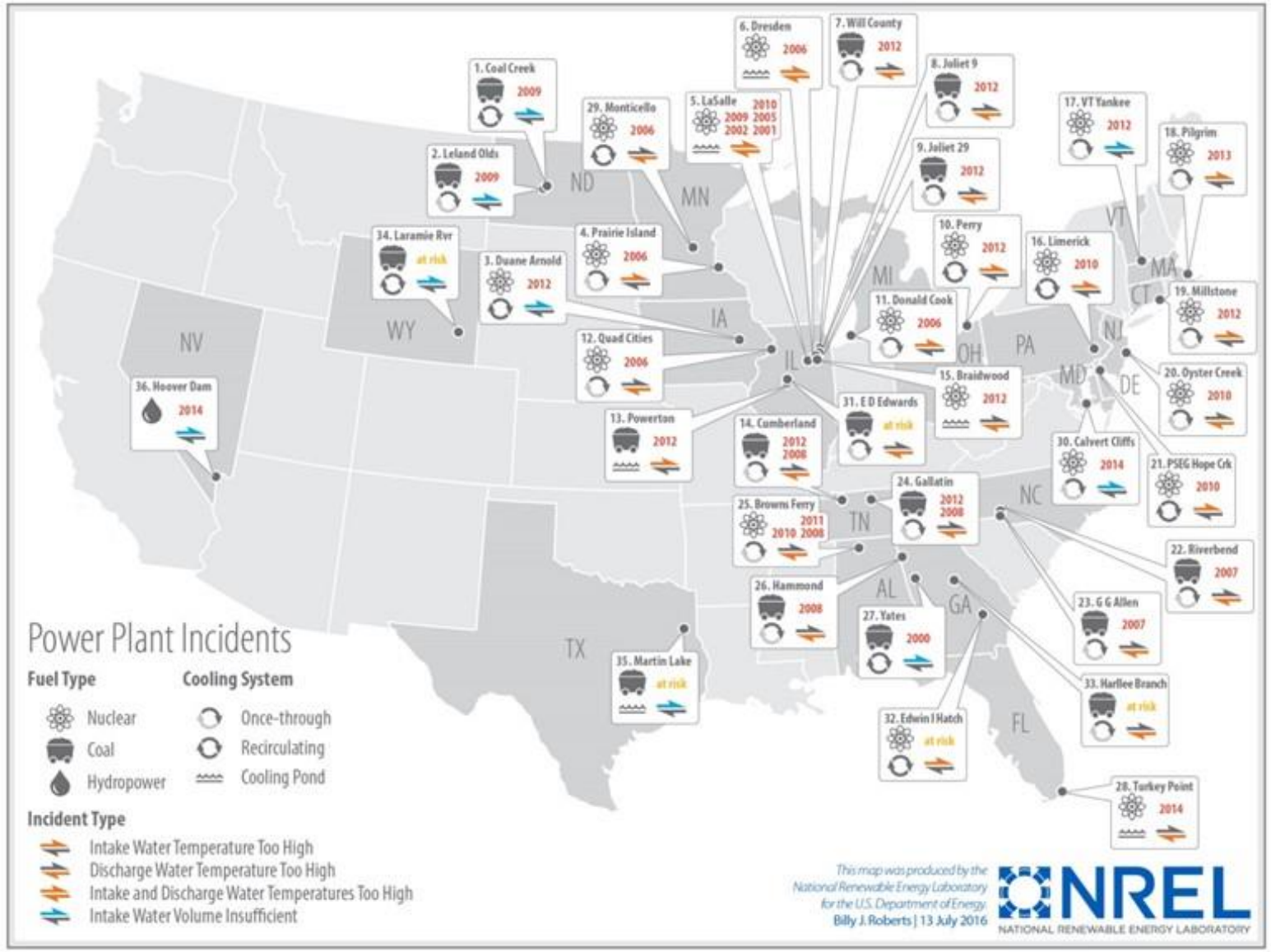
Refineries



Source: Tidwell et al. 2016

Current Impacts

Climate Extremes Impact Power Production



Water Scarcity Impacts Plant Siting

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Idaho Places Moratorium on Coal-Fired Power Plants

May 24, 2006

Idaho has established a two-year moratorium on the construction of most types of coal-fired power plants. Idaho is the only Western state currently without any coal-fired power plants. The moratorium does not prohibit construction of all coal-fired plants, but will make such construction unlikely at least for the next two years or until the Idaho legislature, through the Idaho Interim Committee on Energy, Environment, and Technology, develops a comprehensive state energy plan.

The legislation was inspired in part by a controversial plan by California-based Sempra Generation to build a 600 mega-watt plant in Jerome County, approximately 120 miles southeast of Boise. Following the Senate's passage of H. 791, Sempra announced that it would end efforts to construct the Jerome County project and a similar project in northern Nevada. Craig D. Rose, *Nevada, Idaho Projects Ran Into Stiff Opposition*, San Diego Union Tribune (March 30, 2006). In a letter to Idaho Governor Kempthorne, Sempra stated that it withdrew from the Idaho project because it was focusing on its natural gas related business. *Id.* Sempra plans on seeking buyers for the development work it has already done at the sites. *Id.*

Introduced by House Speaker Bruce Newcomb (R), H. 791 was passed by the Idaho House on a 65-4-1 vote on March 21, 2006, and by the Senate on a 30-5 vote eight days later. Rebecca Meany, *Power Plant Moratorium Bill on Governor's Desk*, Idaho Mountain Express (March 31, 2006). The Idaho Legislature found that it was "in the public interest to adopt an integrated energy plan ... that provides for the states' power generation needs and protects the health and safety of the citizens of Idaho." H. 791. The Legislature also found that "certain coal fired power plants may have a significant negative impact upon the health, safety and welfare of the population, the quality and financial security of existing agricultural business ... and the environmental quality and natural resources of [the] state." *Id.*

H. 791 amends the Idaho Environmental Protection and Health Act, Idaho Code Ann. § 39-101, *et seq.* Under the act, as amended, municipalities, counties, and the Idaho Department of Environmental Quality are prohibited

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State denies permit to Burrillville power plant

BURRILLVILLE – In a gripping decision that followed several debate, the state Energy Facility Siting Board today denied an a Chicago-based Invenergy to build an oil-and-gas-burning powe Wallum Lake Road.

The decision came after just a few hours of public debate durin members of the state board expressed doubt about the state's n energy produced by the plant, a key argument made by representatives of the company.

The decision was a victory for conservationists and local residents, many of

AP NEWS

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Company's bid to use groundwater for nuclear plant denied

November 12, 2019

PHOENIX (AP) — Arizona water regulators have rejected an application by an electr nuclear power plant west of Phoenix because the water is being used by nearby resid

The state Department of Water Resources denied the request from Arizona Public Se Buckeye area and study it as an alternative to expensive reclaimed water because it is Monday.

The permit requires water has no other beneficial use, state department officials said

"The Department finds that this groundwater is currently being used beneficially and deny the application," officials said in the rejection letter.

CENTER for BIOLOGICAL DIVERSITY

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For Immediate Release, February 9, 2006

Contact: Amy Atwood, Center for Biological Diversity, (541) 914-8372

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Statement on NV Energy Inc.'s Abandonment of Plans to Construct Coal-Fired Power Plant in Eastern Nevada

LAS VEGAS, Nev. — The Center for Biological Diversity is celebrating NV Energy Inc.'s announcement today that it will abandon original plans to construct the Ely Energy Center, a coal-fired power plant in eastern Nevada. Citing growing environmental and economic concerns, the company stated that the project has been postponed until greenhouse gas capture and storage capture technology becomes commercially viable, which is "not likely before the end of the next decade."

"Today's announcement reflects the fact that power companies are starting to recognize coal's bleak future," said Amy Atwood, public lands energy director at the Center for Biological Diversity. "The Obama administration should take swift action to halt regulatory approvals for other coal-fired power plants that are still proposed for the region. Not another acre of public lands should be destroyed for coal combustion in an age of global warming."

Ely Energy Center, which would have been located about 20 miles north of Ely in White Pine County, Nevada, would have consisted of two coal-fired 750-megawatt (MW) ultra-supercritical steam turbine units, two 500-MW integrated gasification combined cycle units, and associated facilities. The Center would have had a 2,500-MW generating capacity and an estimated lifespan of 50 years.

Ely Energy Center would consume approximately 8,000 acre-feet of water per year during the first phase alone, compromising the viability of local threatened and endangered species while contributing an estimated 10.6 million tons of CO_2 to the atmosphere every year. Additional greenhouse gas emissions would have resulted from the mining and transportation of coal between eastern Nevada and the Powder River Basin in Wyoming.

The Center will continue to monitor developments to see that regulatory permitting processes for the Ely Energy Center are halted or withdrawn.

The Center for Biological Diversity is dedicated to ensuring that atmospheric CO_2 pollutant levels are reduced to below 350 ppm, which leading climate scientists warn is necessary to prevent devastating climate change. Further development of greenhouse gas-intensive energy sources, including oil shale, tar sands, and coal-fired power plants, is fundamentally incompatible with achieving this goal. If greenhouse gas emissions are not immediately reduced, the current atmospheric CO_2 level of 385 ppm will rise to approximately 500 ppm by mid-century, triggering mass wildlife extinctions, catastrophic global weather and ecosystem changes, and tragic human suffering.

Arizona • California • Colorado • Florida • N. Carolina • New York • Oregon • Virginia • Washington, D.C. • La Paz, Mexico

BiologicalDiversity.org

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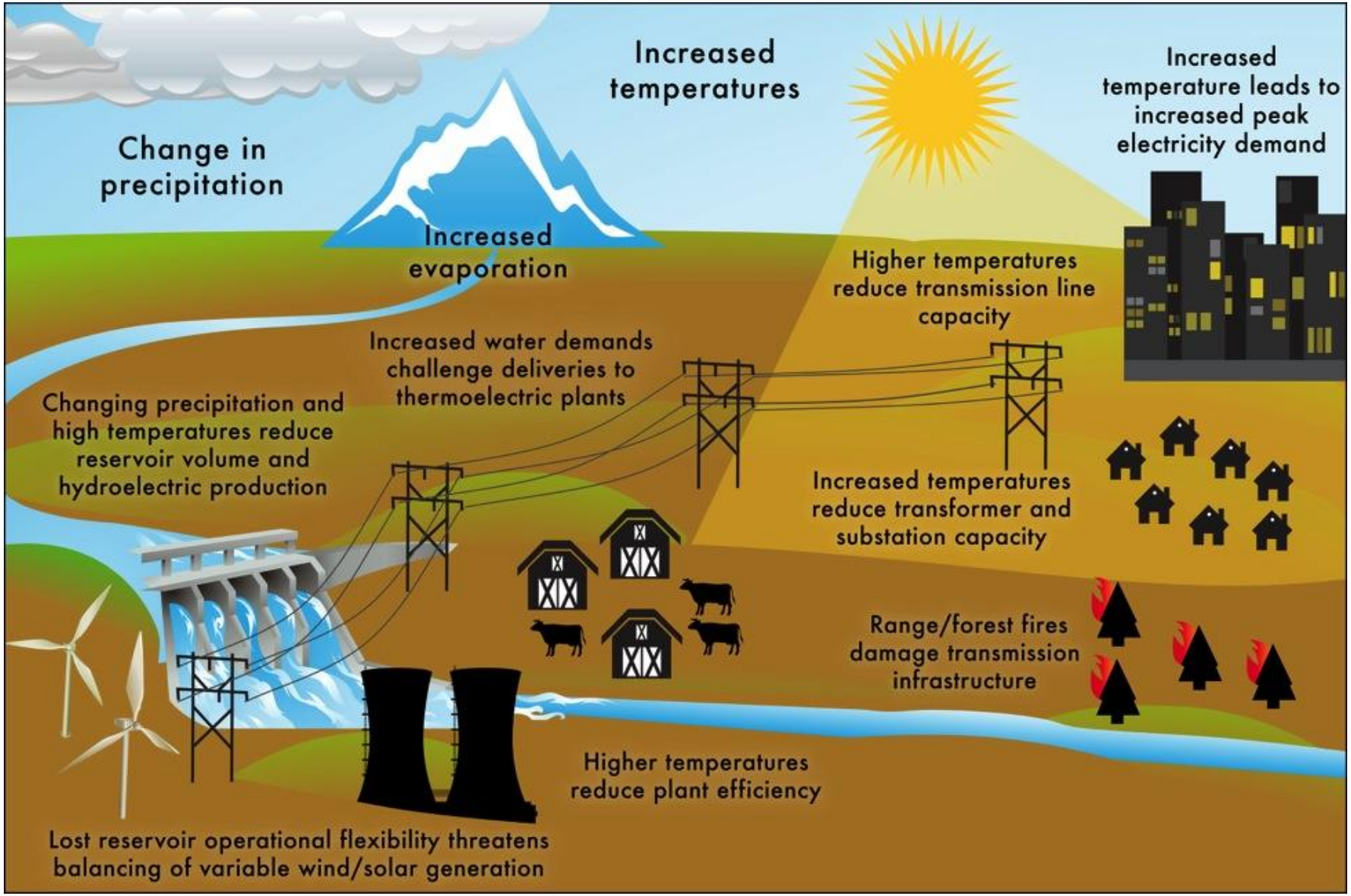
Cascading Impacts on Electric Power



Reduced Water Use

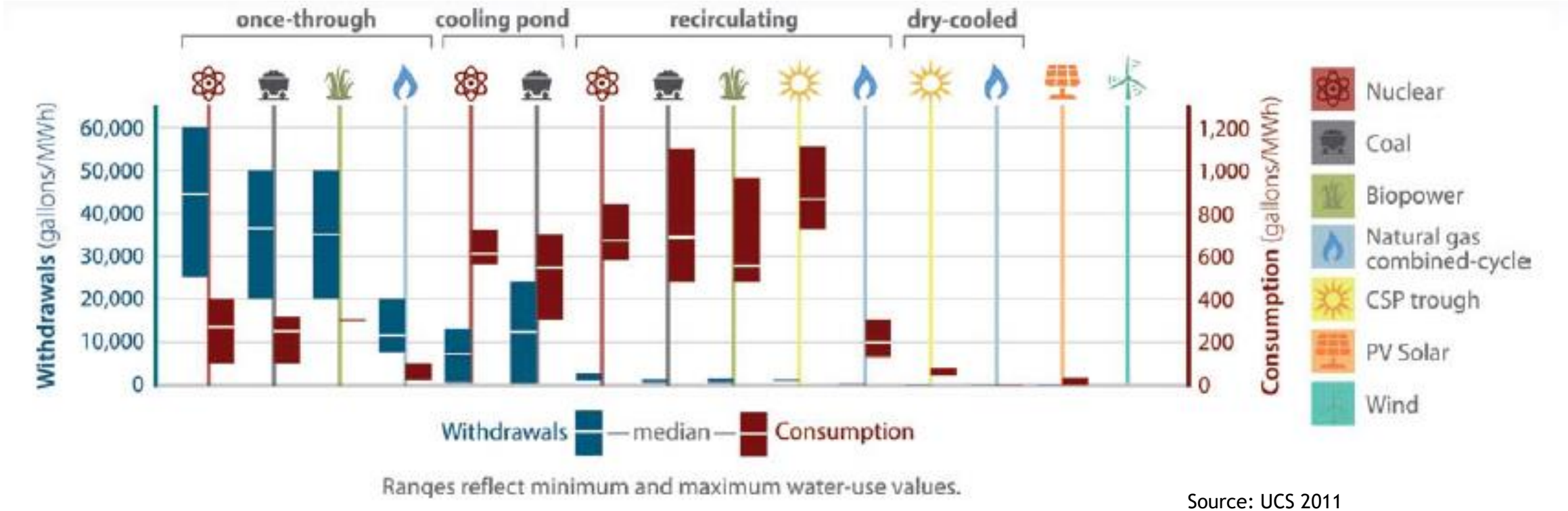
Systems are Moving to Less Water Intensive Forms of Generation

Current generation relies on high-water use technology:

- Coal
- Gas-Steam
- Nuclear

New capacity favors low-water use technology:

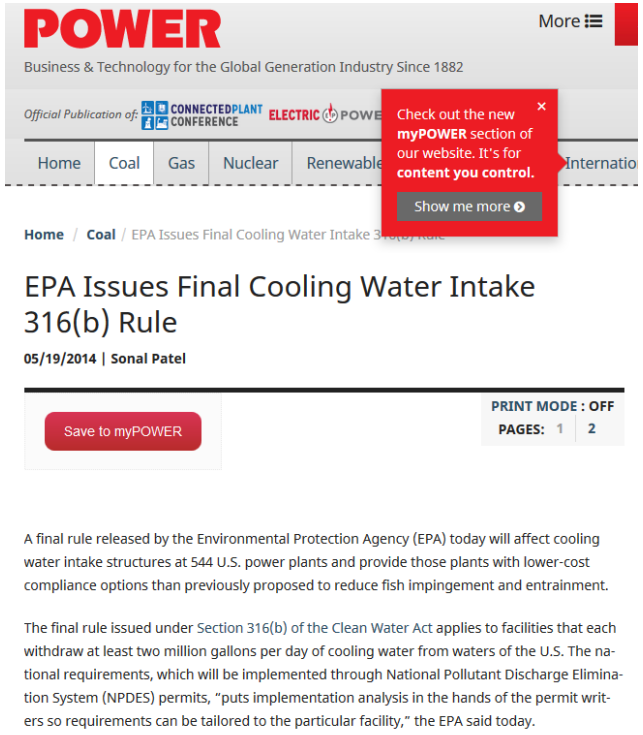
- Natural gas combined cycle
- Wind
- Solar PV



Source: UCS 2011

Reduced Withdrawals

Systems are Moving to Less Water Intensive Forms of Cooling



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EPA Issues Final Cooling Water Intake 316(b) Rule

05/19/2014 | Sonal Patel

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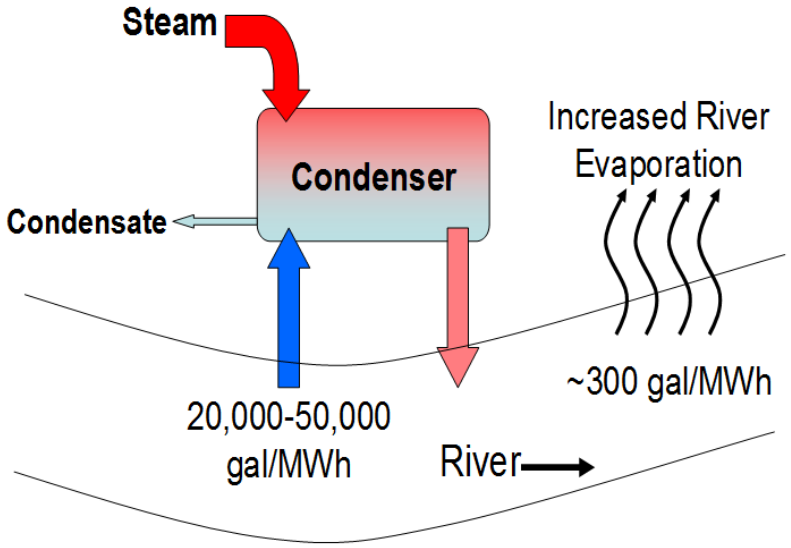
A final rule released by the Environmental Protection Agency (EPA) today will affect cooling water intake structures at 544 U.S. power plants and provide those plants with lower-cost compliance options than previously proposed to reduce fish impingement and entrainment.

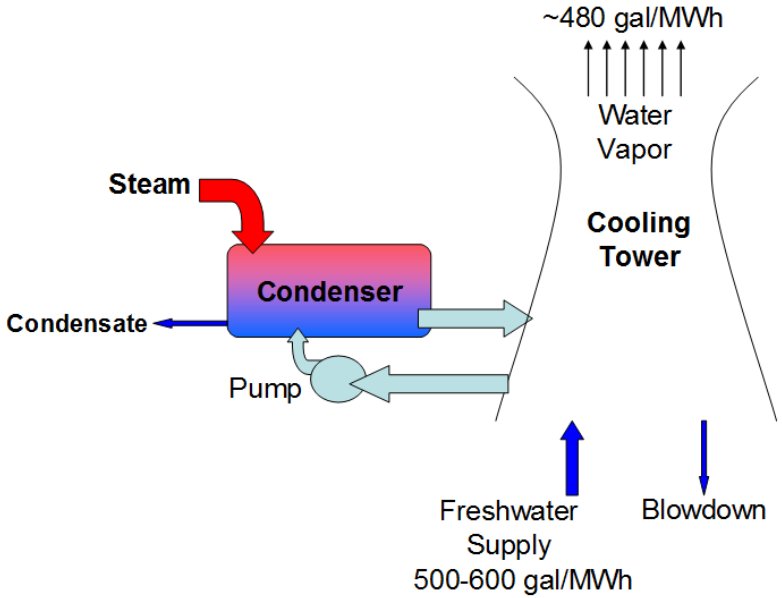
The final rule issued under Section 316(b) of the Clean Water Act applies to facilities that each withdraw at least two million gallons per day of cooling water from waters of the U.S. The national requirements, which will be implemented through National Pollutant Discharge Elimination System (NPDES) permits, "puts implementation analysis in the hands of the permit writers so requirements can be tailored to the particular facility," the EPA said today.

High Water Withdrawal Low Water Consumption



Open-loop "once-through" cooling cycle

Low Water Withdrawal High Water Consumption



Closed-loop cooling cycle

Source: EPRI 2002

Climate Adaptation Opportunities

Alternative Water Source

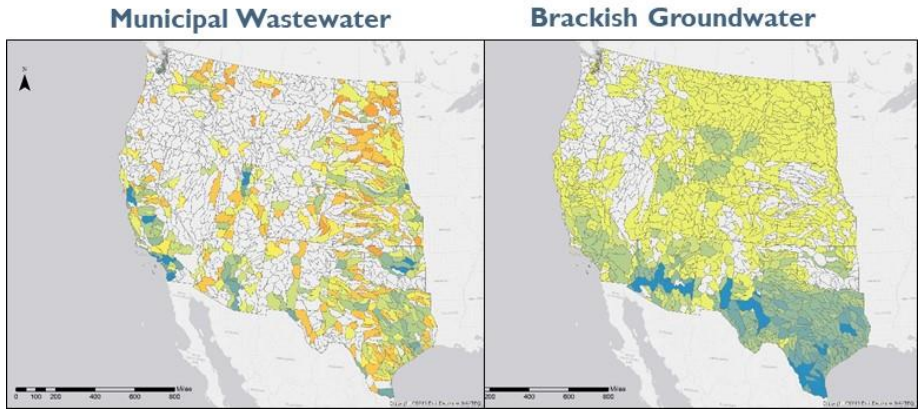
Retrofit existing plants to eliminate freshwater use

- Retrofit options:
  - Dry cooling
  - Municipal waste water
  - Brackish groundwater

1,178 Freshwater Using Thermoelectric Power Plants

- Costs:
  - Capital
  - Operating and Maintenance
  - Capture
  - Treatment
  - Parasitic energy losses

Water Availability

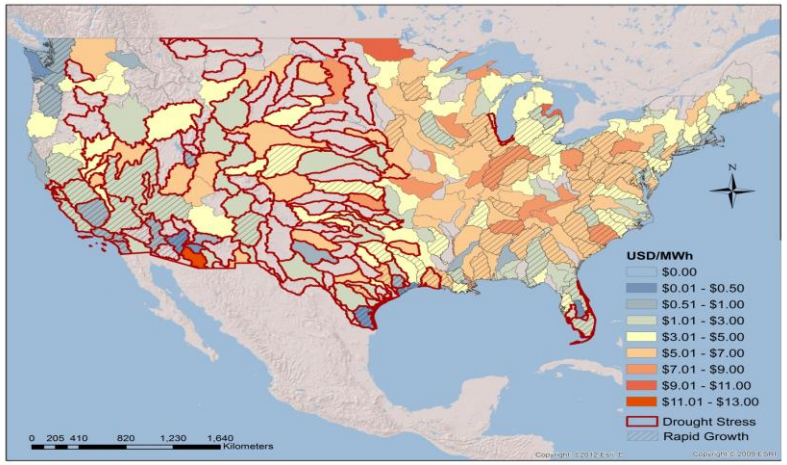


Alternative Water Source

Technology	Number of plants
Waste water	823
Brackish water	109
Dry cooling	246

1,178 Freshwater Using Thermoelectric Power Plants

Note: ΔLCOEs tend to be lower in the West, Texas Gulf Coast and south Florida, which are areas prone to drought stress



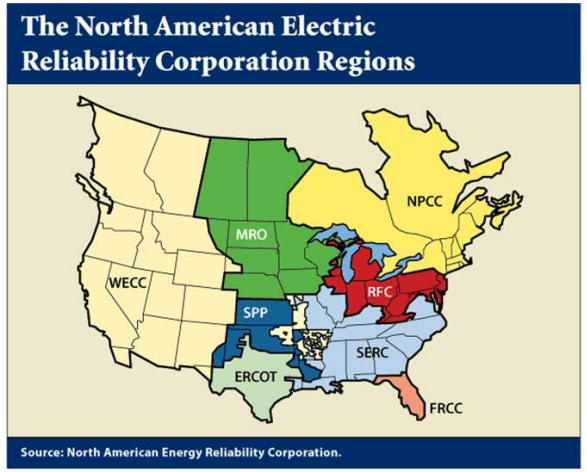
Least cost alternative values mapped on watersheds vulnerable to drought (outlined in red)

With wholesale cost of electricity about $40/MWh, many retrofits could be accomplished at levels that would add less than 10% to current power plant generation expenses.*

Source: Tidwell et al. 2014

*average 2012 wholesale cost over 3 US trading hub regions

Integrated Planning



- Integrated climate into WECC's capacity expansion planning exercise
- Explored how water extremes influence planning decisions

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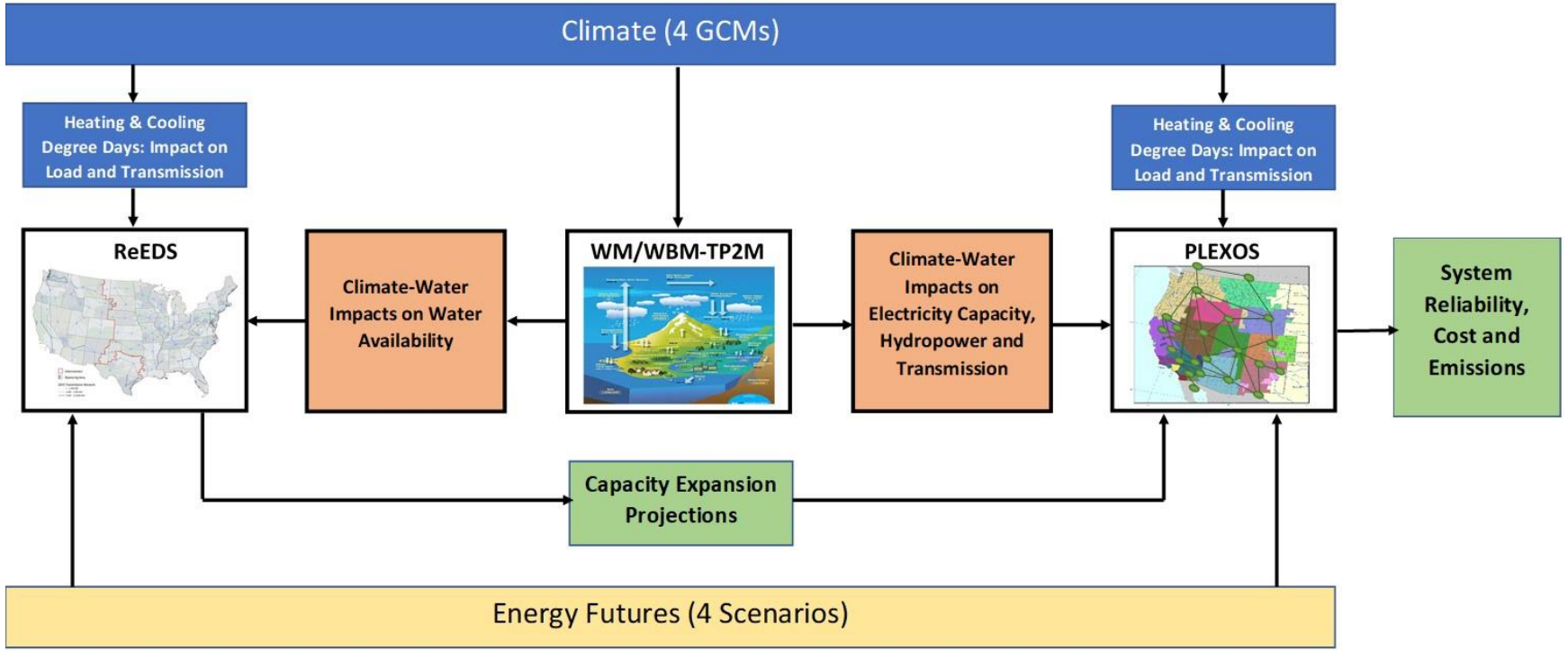
WECC

WSWC Western States Water Council

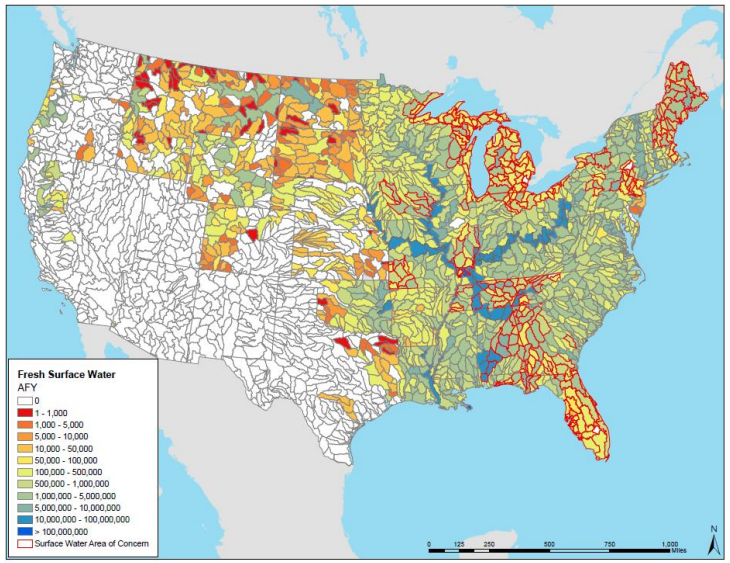
Analysis platform included:

- Hydrologic modeling,
- Capacity expansion modeling, and
- Production Cost Modeling

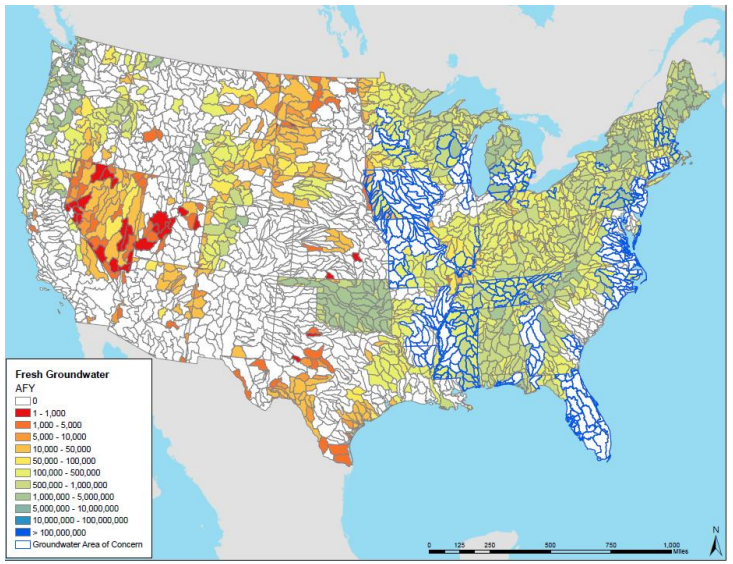


Limited Supply for Development

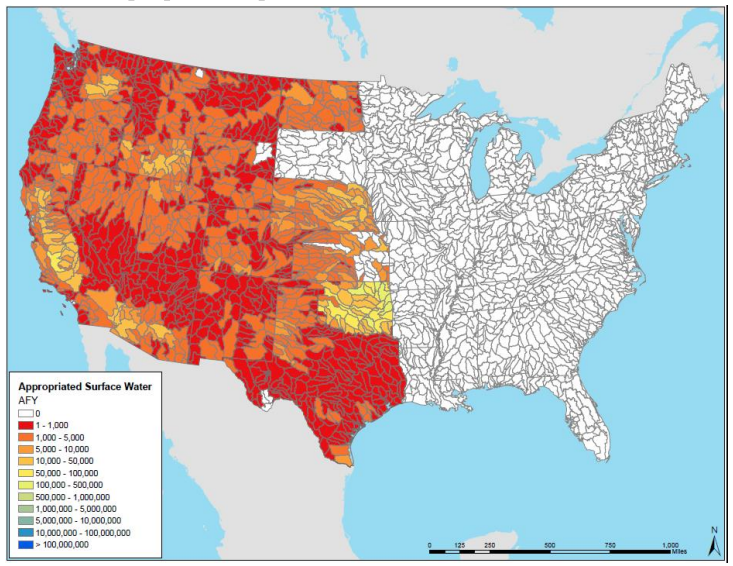
Fresh Surface Water



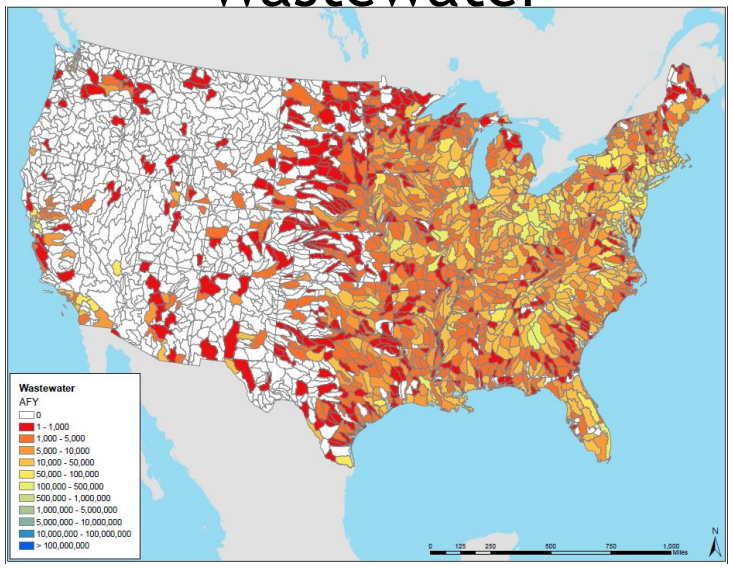
Fresh Groundwater



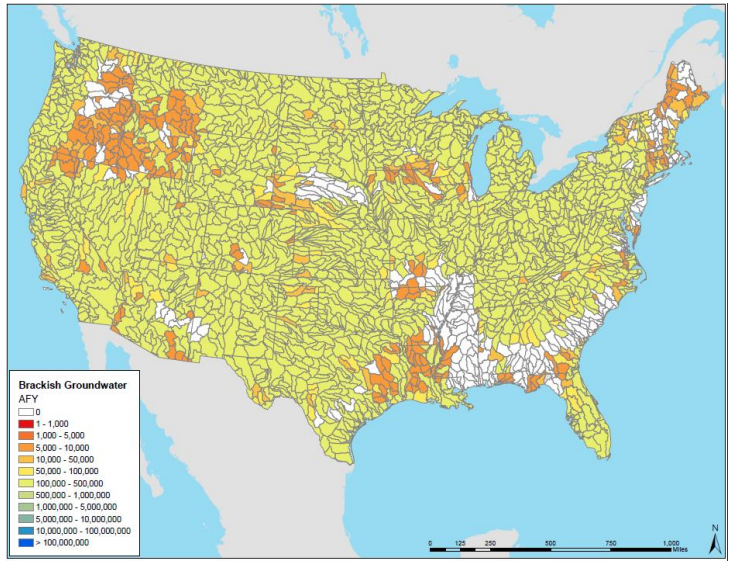
Appropriated Water



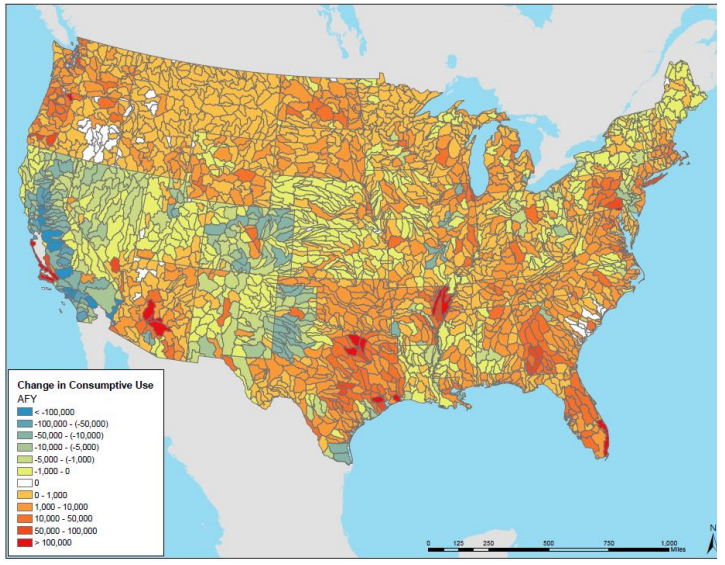
Wastewater



Brackish Water



Growth in Demand 2015-2035



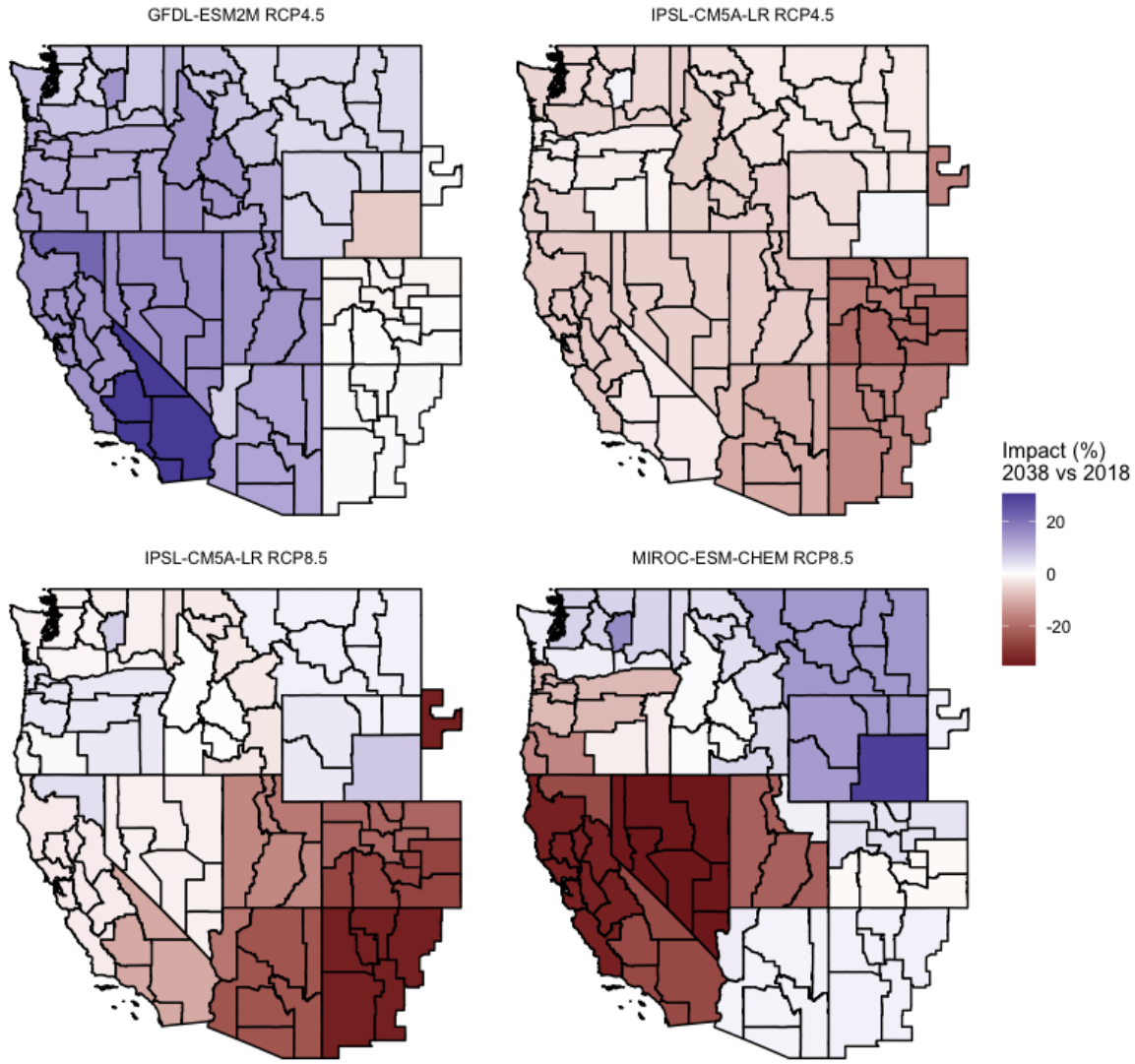
Source: Tidwell et al. 2018

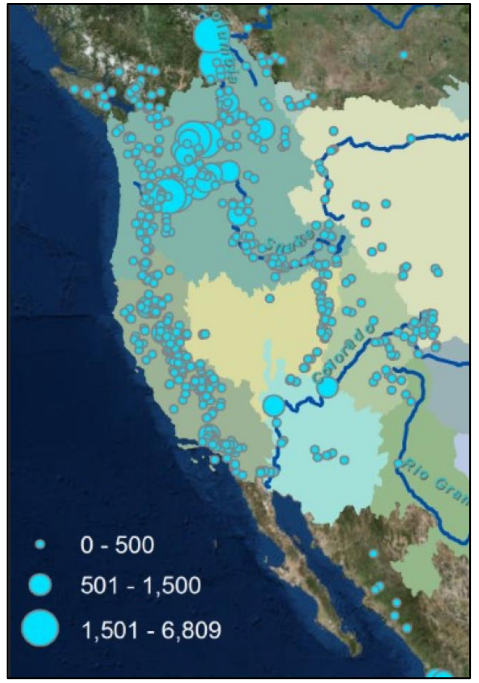
Limited Water for Hydropower

Relative trends in available hydropower

Moderate emissions pathway

Extreme emissions pathway





Climate Impacts on Capacity Expansion

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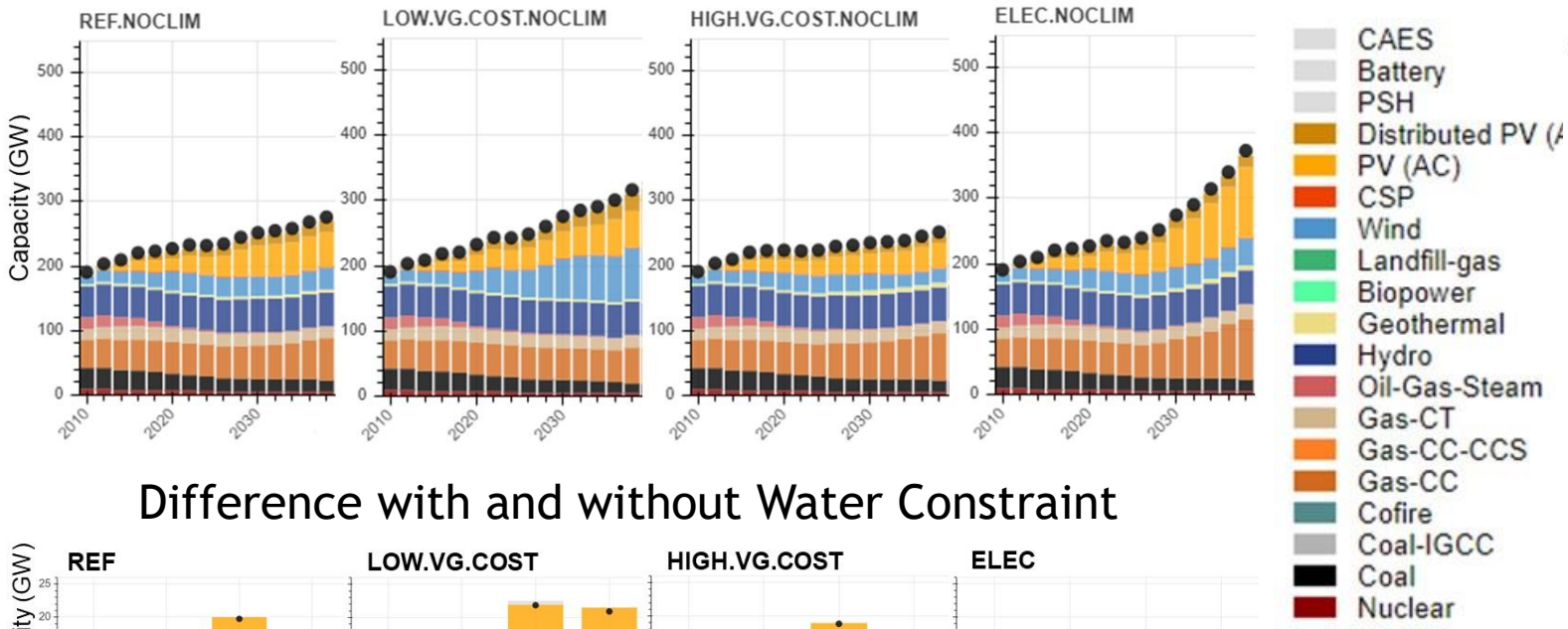
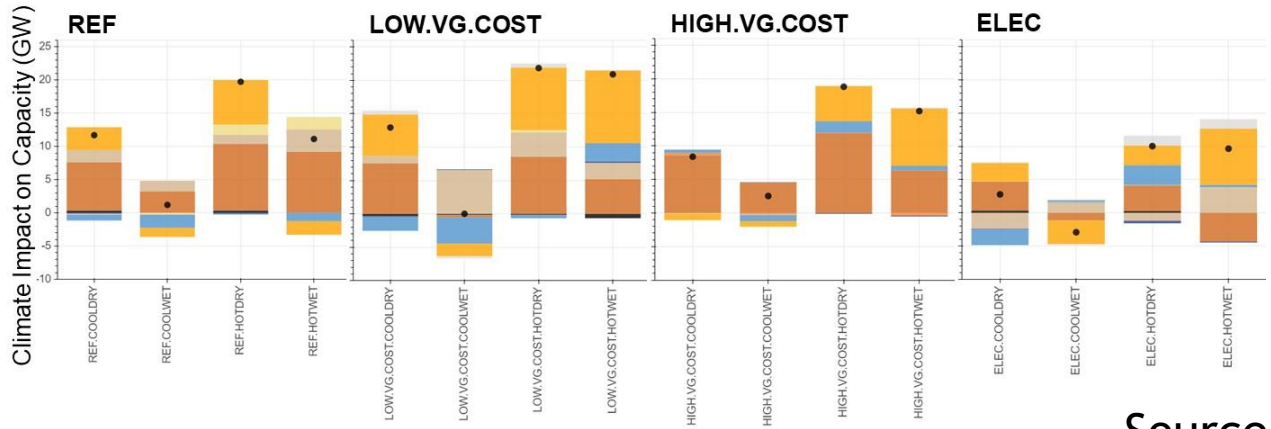
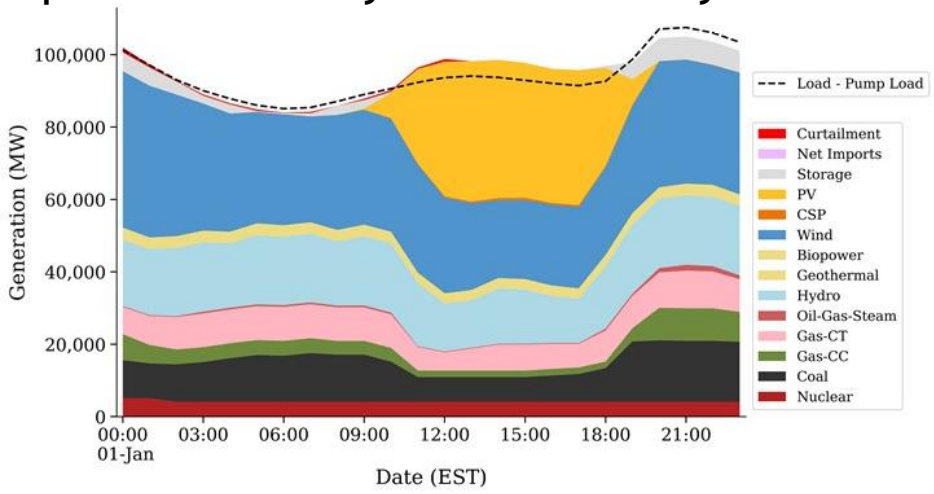
Generation Expansion Profiles



Difference with and without Water Constraint



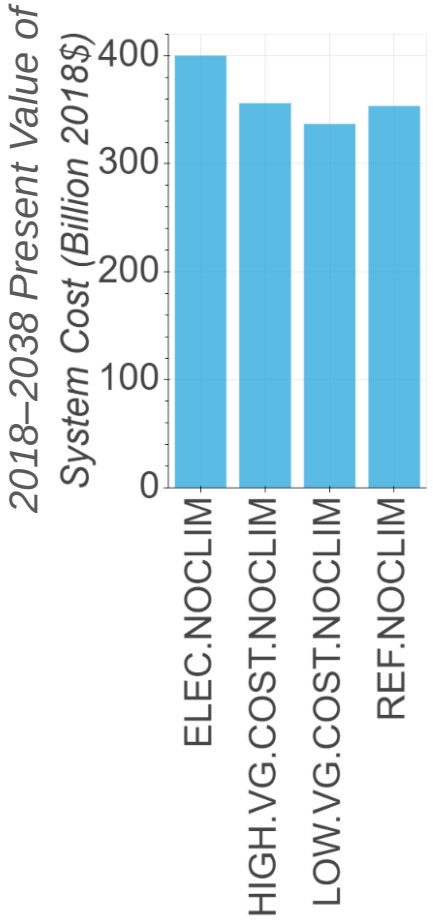
Implications for System Reliability and Cost

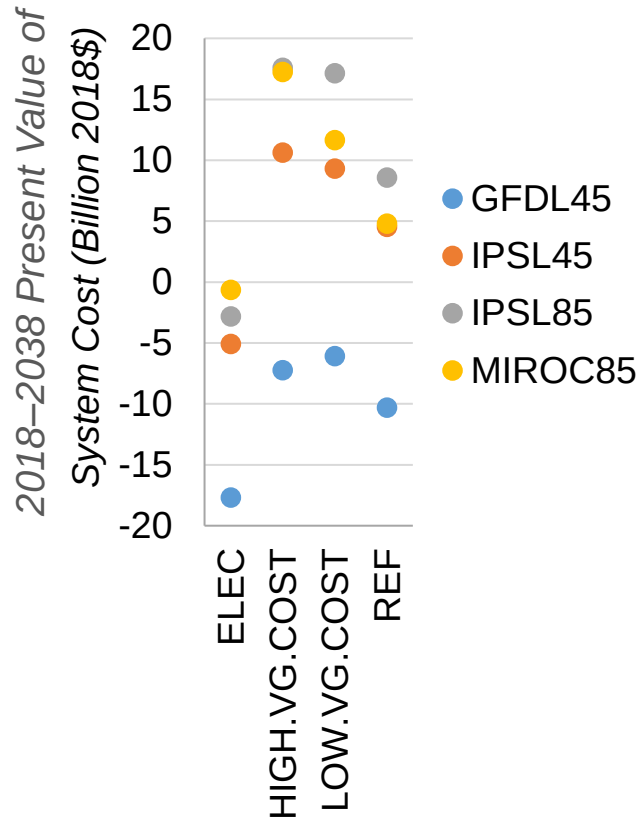


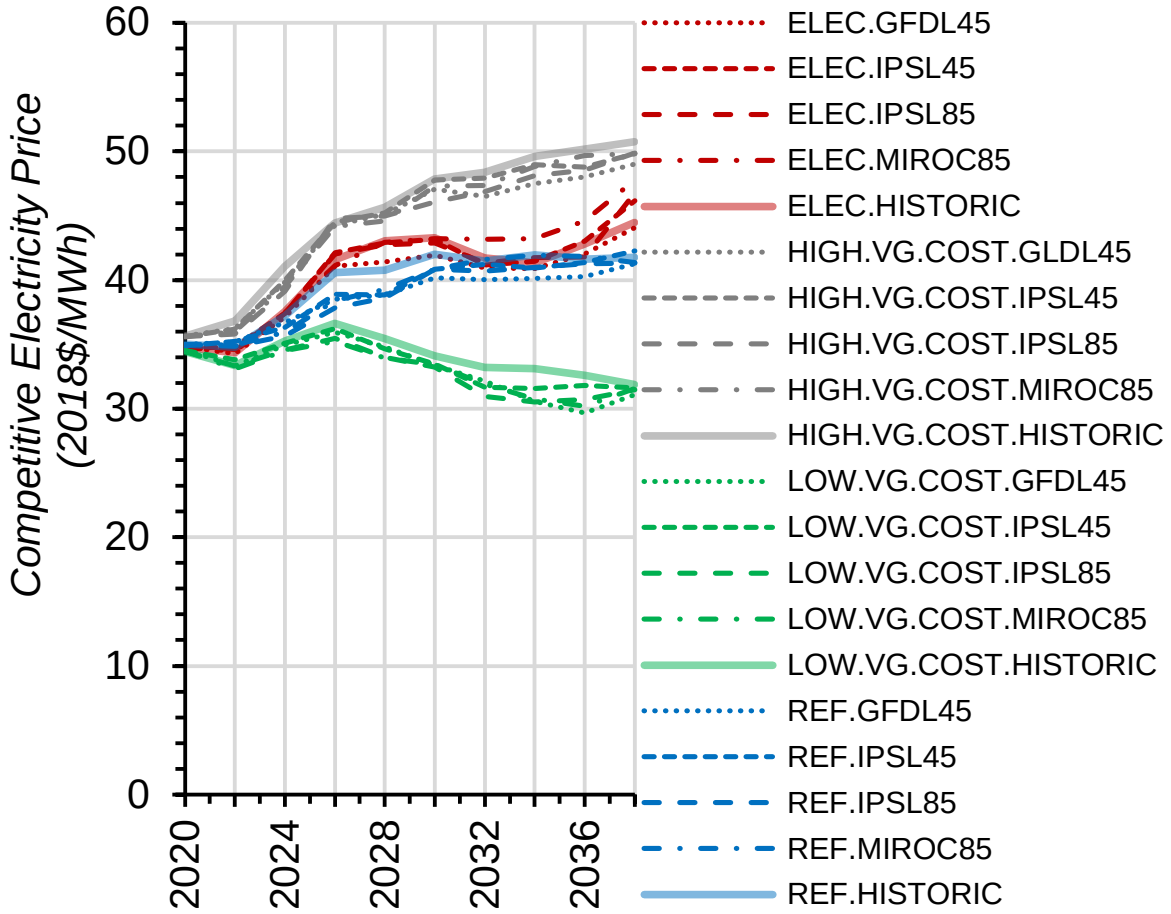
- Additional capacity needed to meet peak load.
- Hydropower production is key uncertainty.
- Considerable adaptive capacity available in the grid.

Source: Tidwell et al 2020

Climate Impacts on Economics







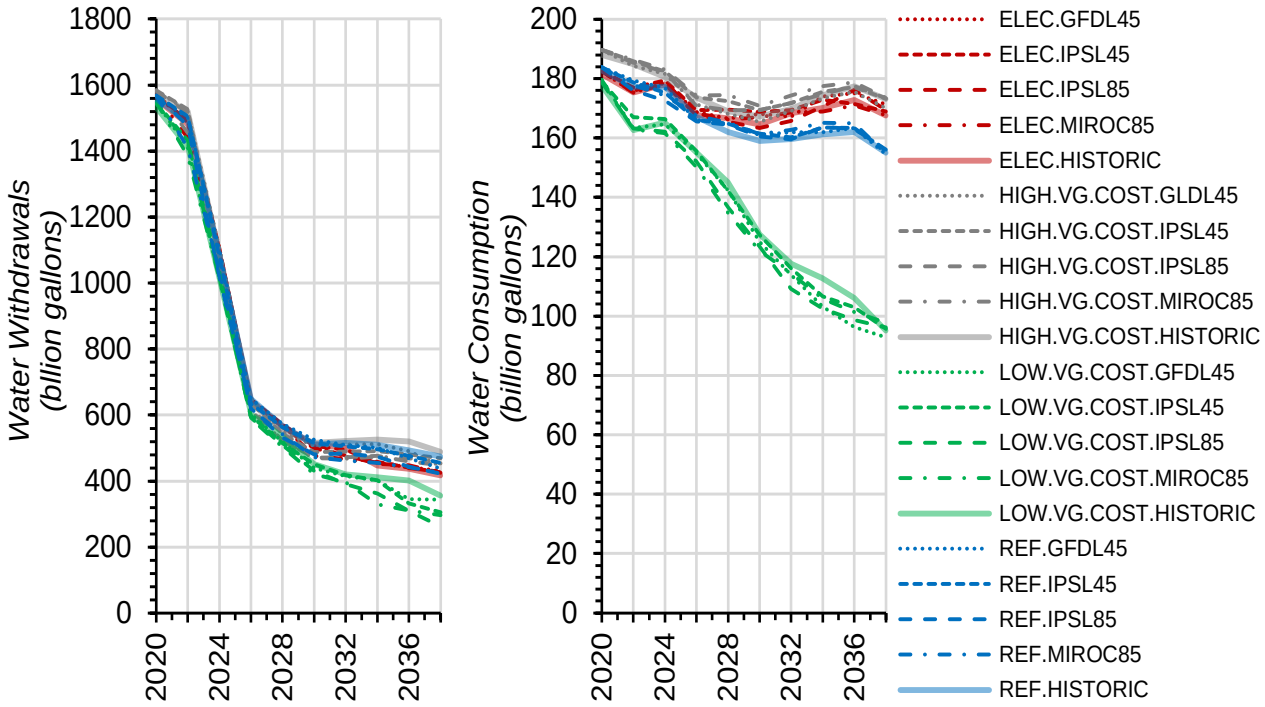
Heat-driven demand can increase costs, but increased hydropower can reduce costs

Cumulative climate impacts on cost range from -17.7–17.6 billion $

Climate impacts on electricity prices are small compared to technology and electrification

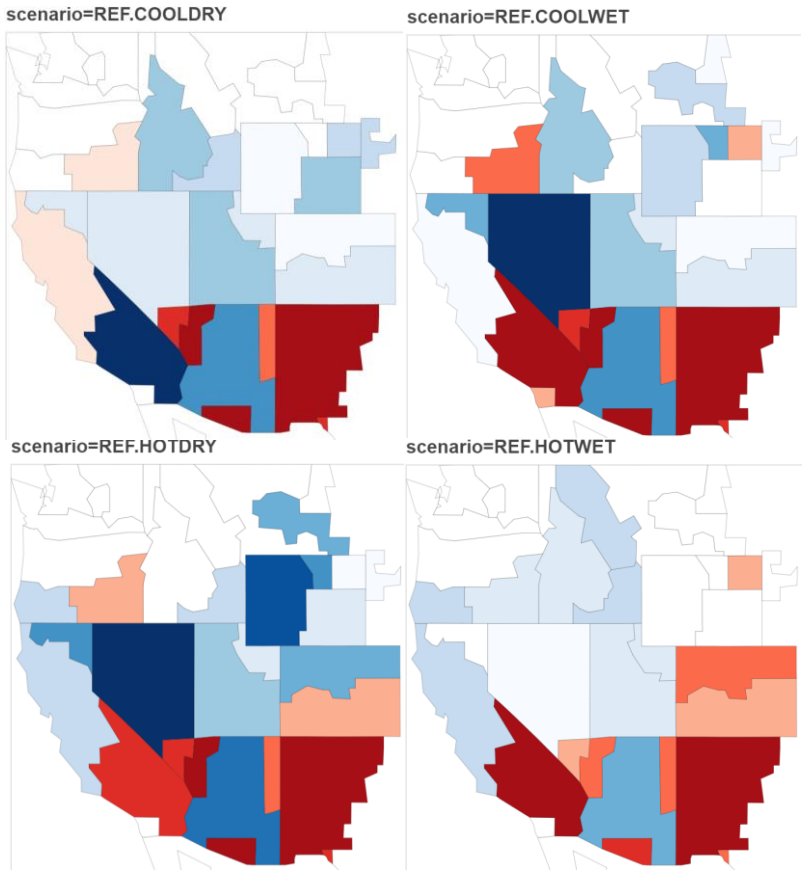
Climate Impacts on Environment

Implications for Future Water Use



Source: Tidwell et al 2020

Combined influence of climate and water availability influence siting decisions



Key Points

1. Energy-Water-Climate issues are affecting energy production today.

2. Without attention these issues will intensify.

3. Changes in the energy and water sectors are mitigating some climate vulnerabilities.

4. Options are available to adapt to a changing and uncertain future.

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