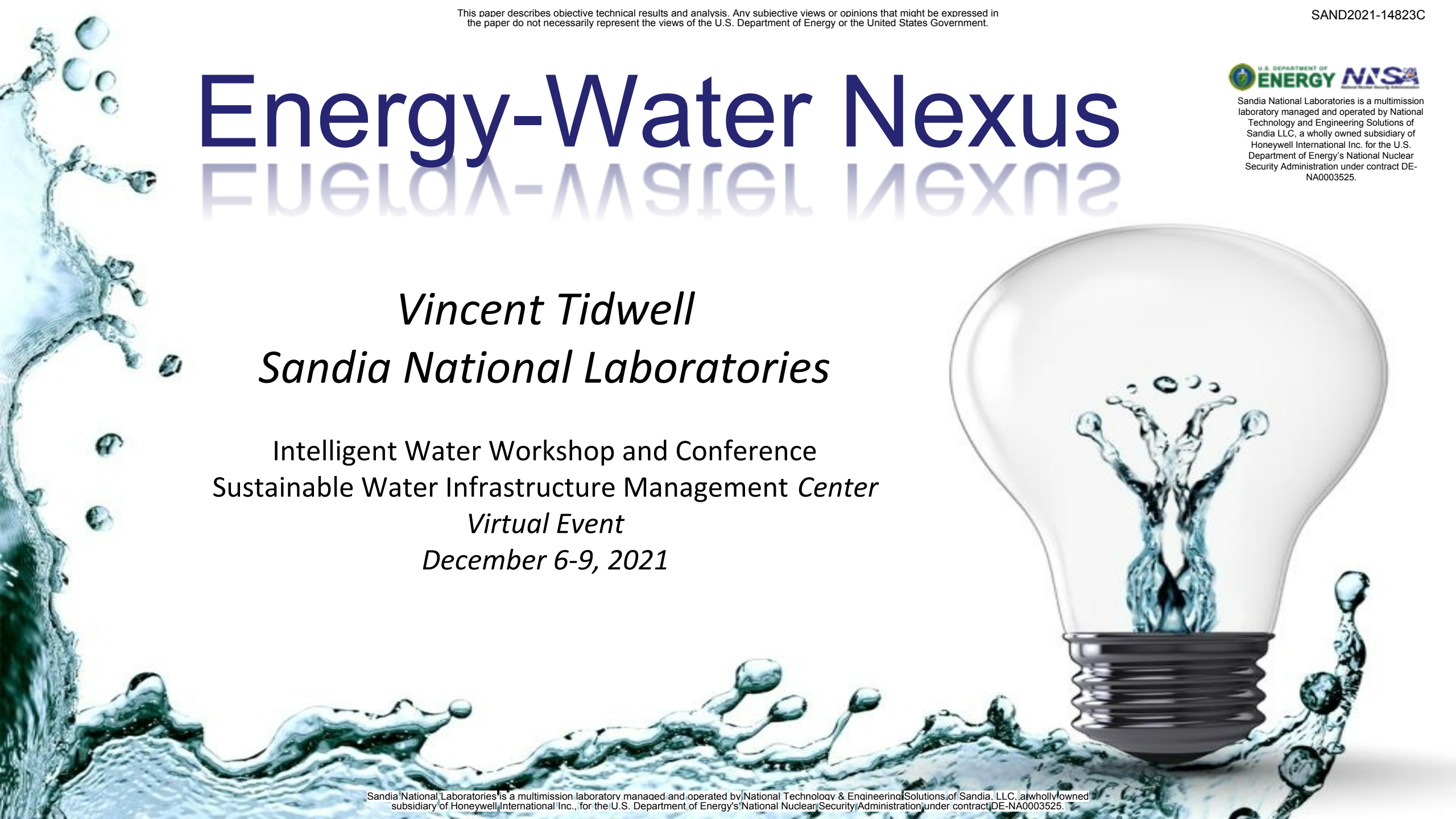
SAND2021-14823C

# Energy-Water Nexus

Sandia National Laboratories is a multimission laboratory managed and operated by National Technology and Engineering Solutions of Sandia LLC, a wholly owned subsidiary of Honeywell International Inc. for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-NA0003525.

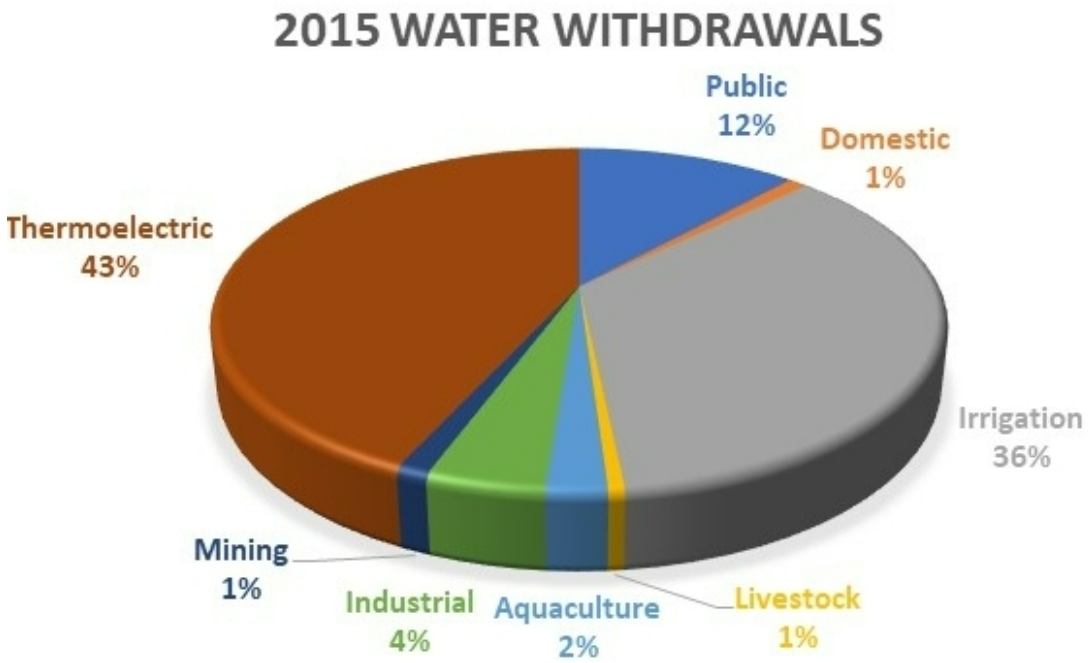
*Vincent Tidwell*
*Sandia National Laboratories*

Intelligent Water Workshop and Conference
Sustainable Water Infrastructure Management *Center*
*Virtual Event*
*December 6-9, 2021*



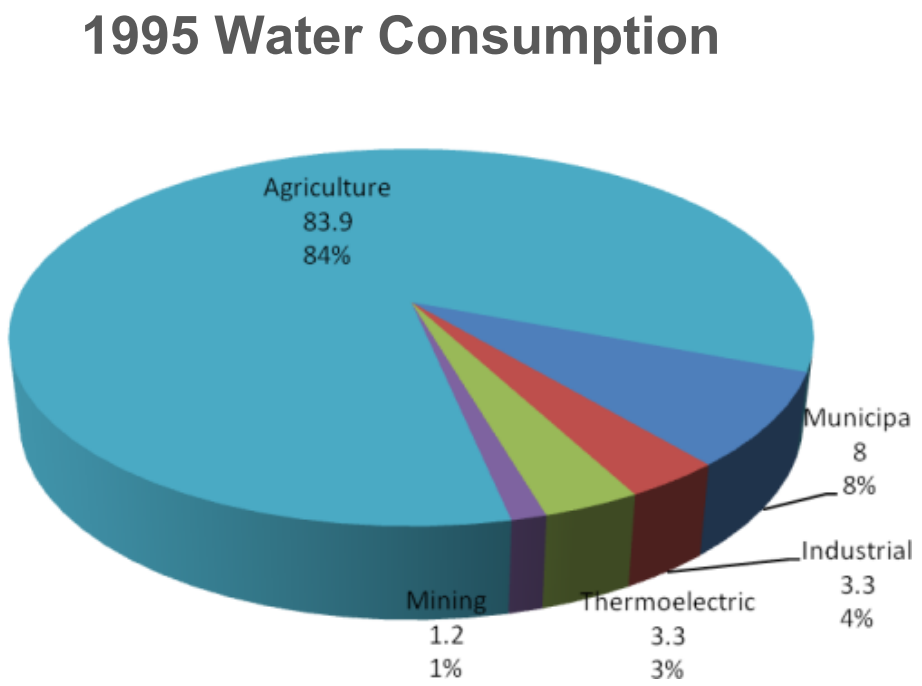
Sandia National Laboratories is a multimission laboratory managed and operated by National Technology & Engineering Solutions of Sandia, LLC, a wholly owned subsidiary of Honeywell International Inc., for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-NA0003525.

# Water Use in the Energy Sector




Source: USGS 2018

322 BGD Total Withdrawals

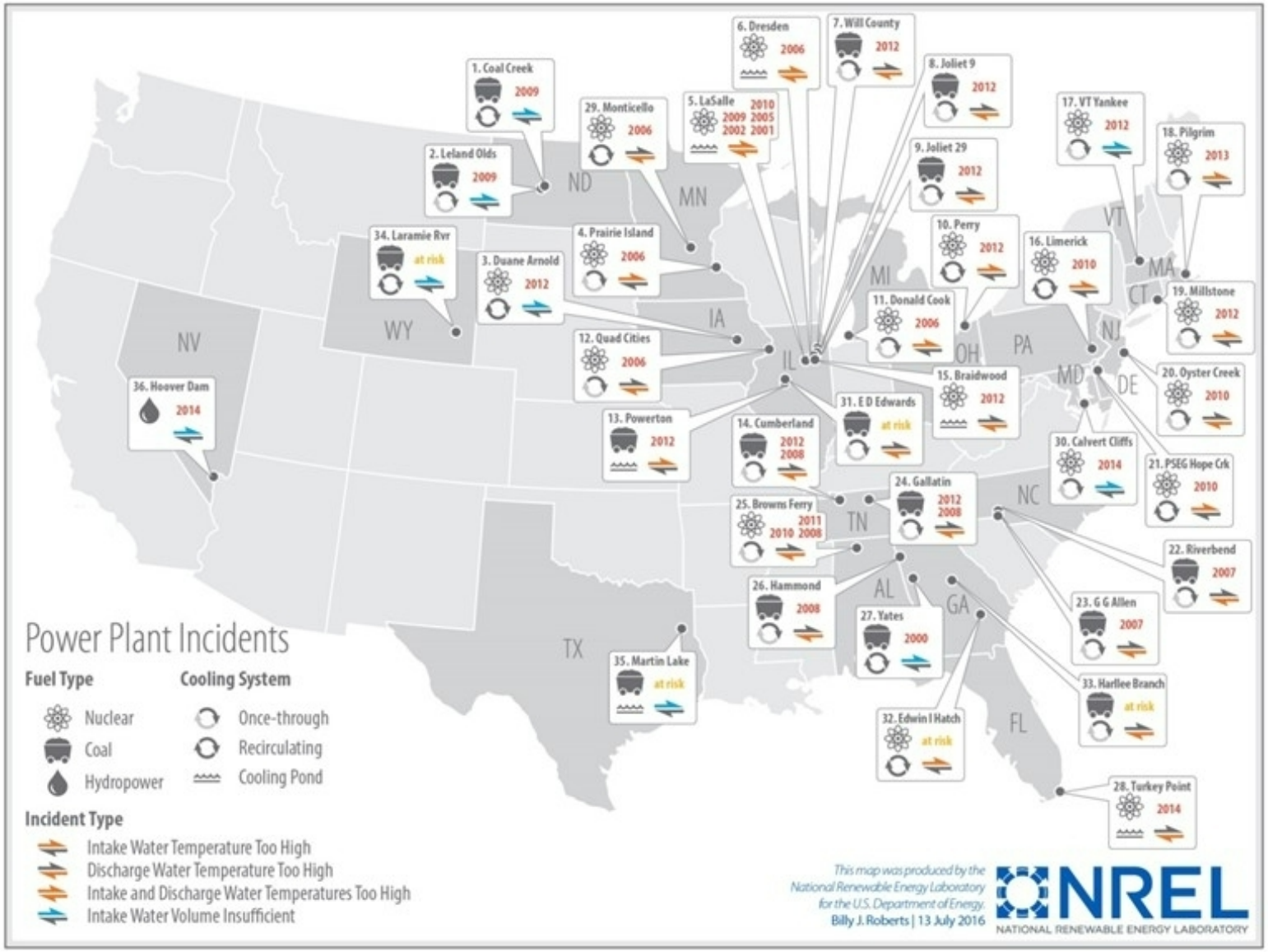



Source: USGS 1998

*4.3 BGD Thermoelectric (USGS 2018)*

*2.6 BGD Mining and Fuel Processing (DOE 2014)*

# Impacts Today




Water Extremes have impacted:

- Power plant operations (shown here),
- Hydropower operations,
- Impacted energy extraction, and
- Damaged production, transmission and processing facilities

# Impacts Today

The Availability, Reliability and Cost of Water is Impacting the Siting of New Power Generation

THE VALLEY Breeze
401.334.9555



Home News Obituaries Opinion Sports Living E-Editions Public

6/20/2019

## State denies permit to Burrillville power plant

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

The decision came after just a few hours of public debate during which members of the state board expressed doubt about the state's need for the 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

CENTER for BIOLOGICAL DIVERSITY *Because life is good.*

For Immediate Release, February 9, 2009

E-mail this page
More press releases

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

**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.

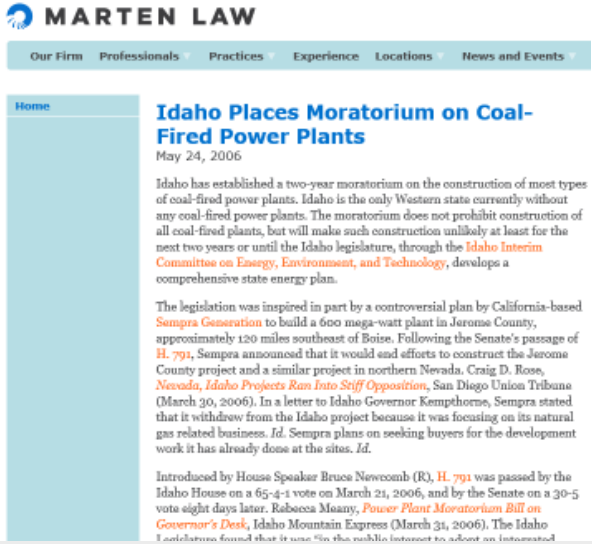
The Center will continue to monitor developments to see that regulatory permitting processes for the Ely Energy Center are halted or withdrawn.

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

Go back



MARTEN LAW

Our Firm Professionals Practices Experience Locations News and Events

Home

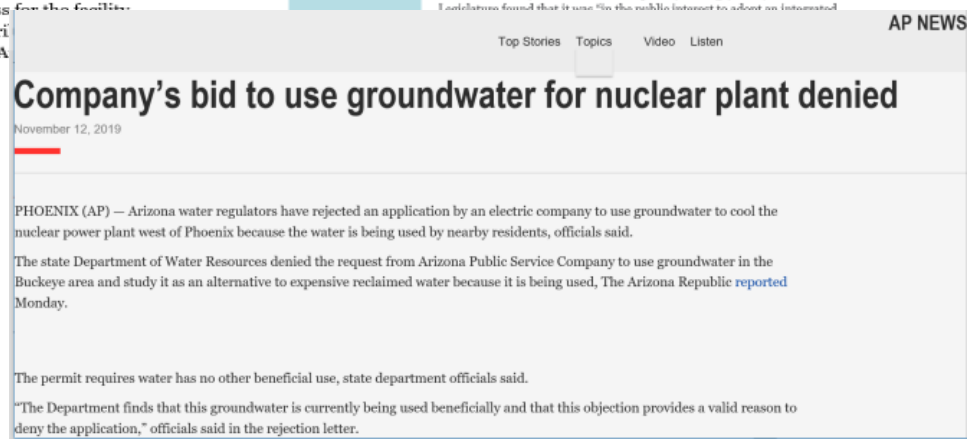
## Idaho Places Moratorium on Coal-Fired Power Plants

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



AP NEWS

Top Stories Topics Video Listen

## Company's bid to use groundwater for nuclear plant denied

November 12, 2019

PHOENIX (AP) — Arizona water regulators have rejected an application by an electric company to use groundwater to cool the nuclear power plant west of Phoenix because the water is being used by nearby residents, officials said.

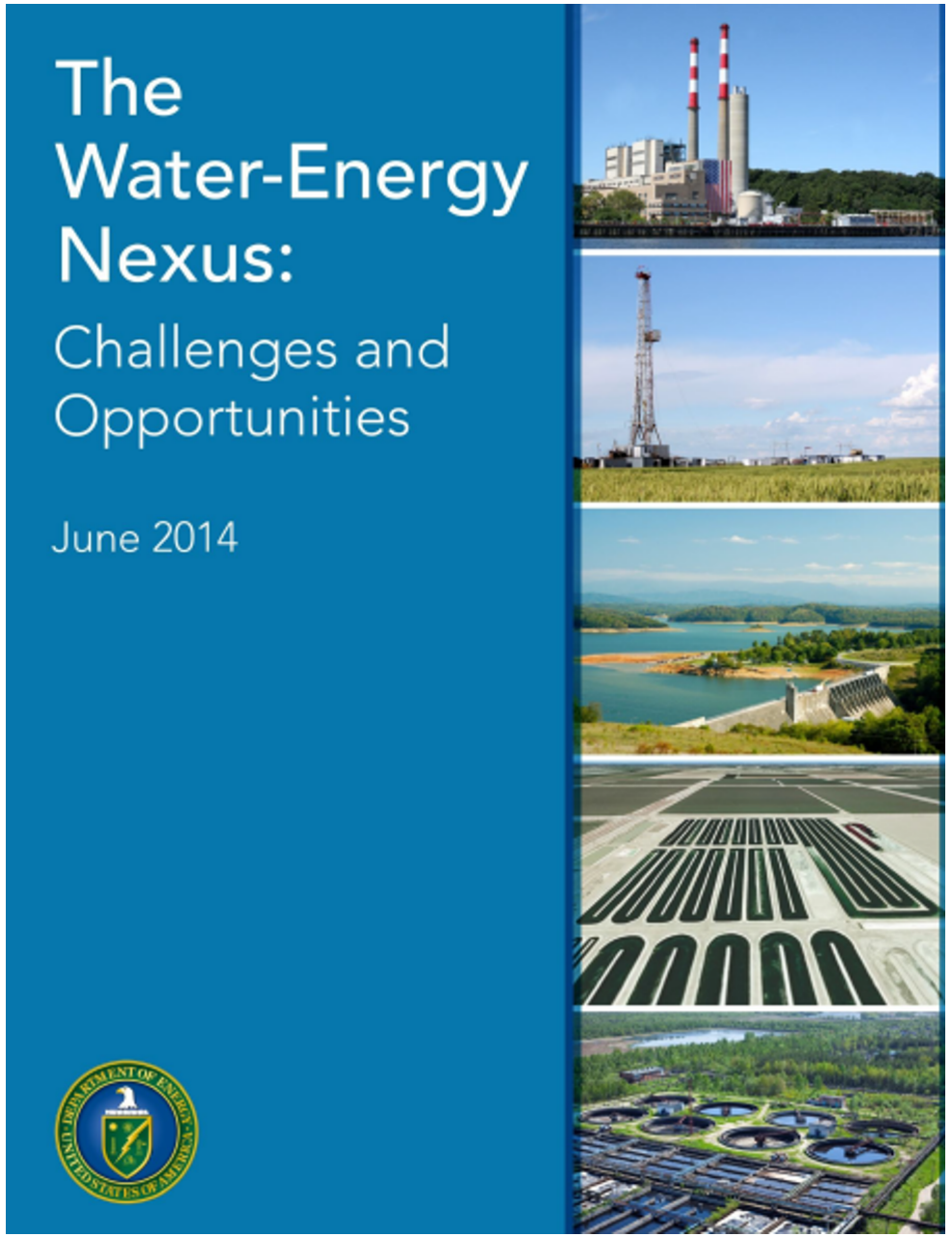
The state Department of Water Resources denied the request from Arizona Public Service Company to use groundwater in the Buckeye area and study it as an alternative to expensive reclaimed water because it is being used, The Arizona Republic reported Monday.

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 that this objection provides a valid reason to deny the application," officials said in the rejection letter.

# Water-Energy Nexus

- 2014 report kicked-off coordinated effort to address the Water-Energy Nexus
- Nature of program has evolved over the past three administrations
- Identified need for advanced technology, data, modeling and analysis to address the impacts of changing climate, population, policies and technologies on the Nexus



# Integrated Multi-Sector, Multi-Scale Modeling

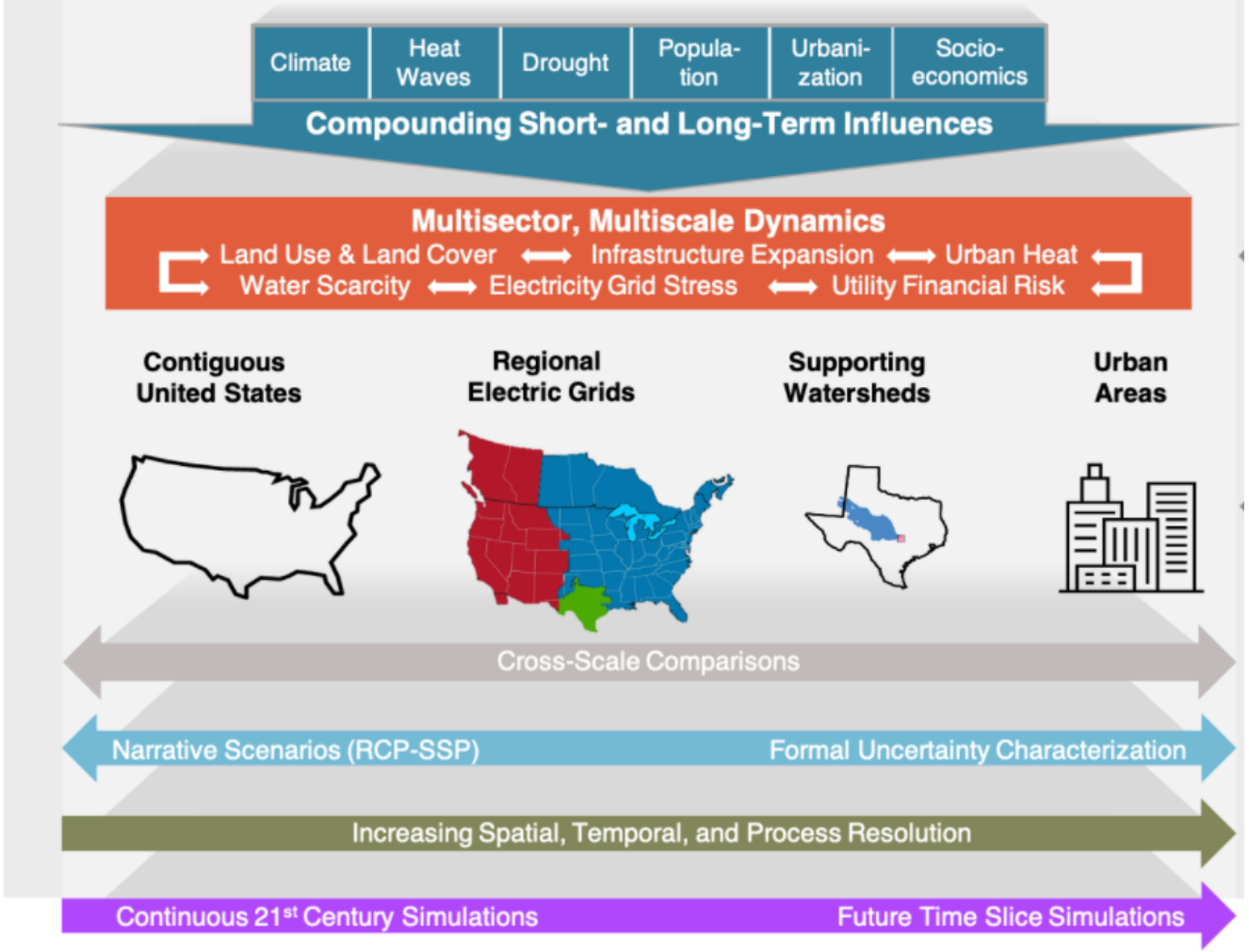
U.S. DEPARTMENT OF ENERGY

Office of Science

Pacific Northwest NATIONAL LABORATORY · BERKELEY LAB · Sandia National Laboratories · NC STATE UNIVERSITY · BOSTON UNIVERSITY · OAK RIDGE National Laboratory · BAYLOR · Cornell University

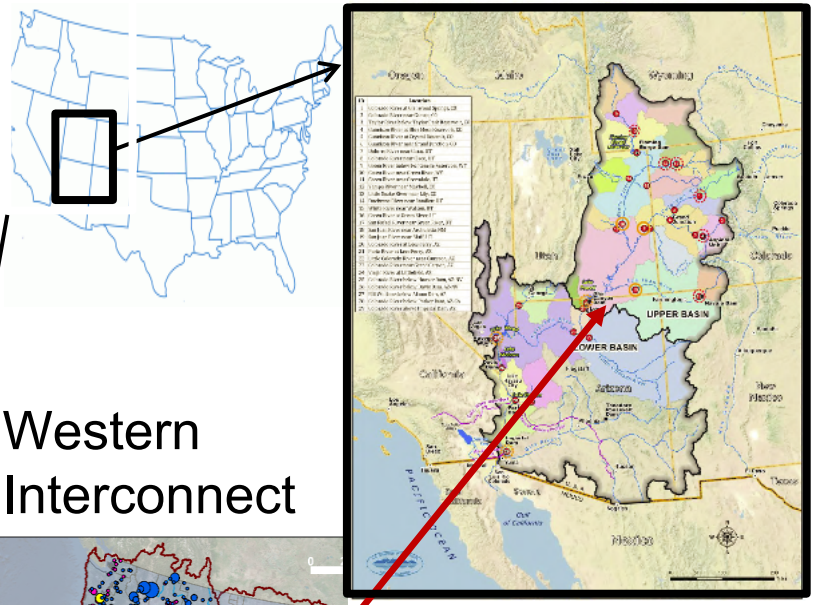
## Technical Challenge

- How will changes in extreme weather, economic development and other related stresses affect the performance and reliability of coupled energy-water systems? How best do we adapt to these changes?
- How do different model configurations, levels of complexity, multi-model coupling strategies, and spatiotemporal resolutions influence simulation fidelity and the propagation of uncertainties?

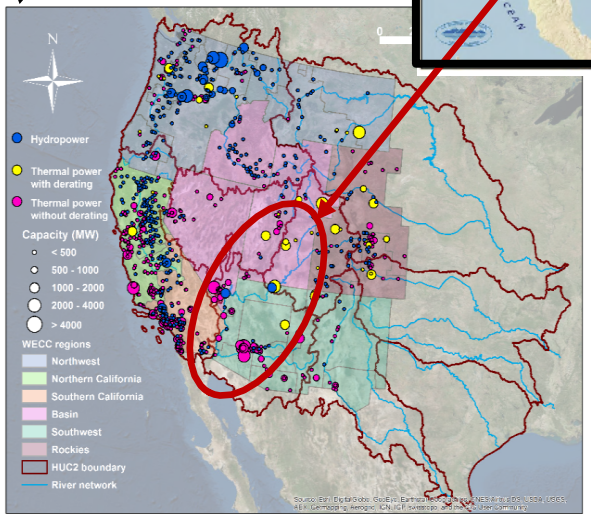


# Water Shortage and Scale

Colorado River Basin



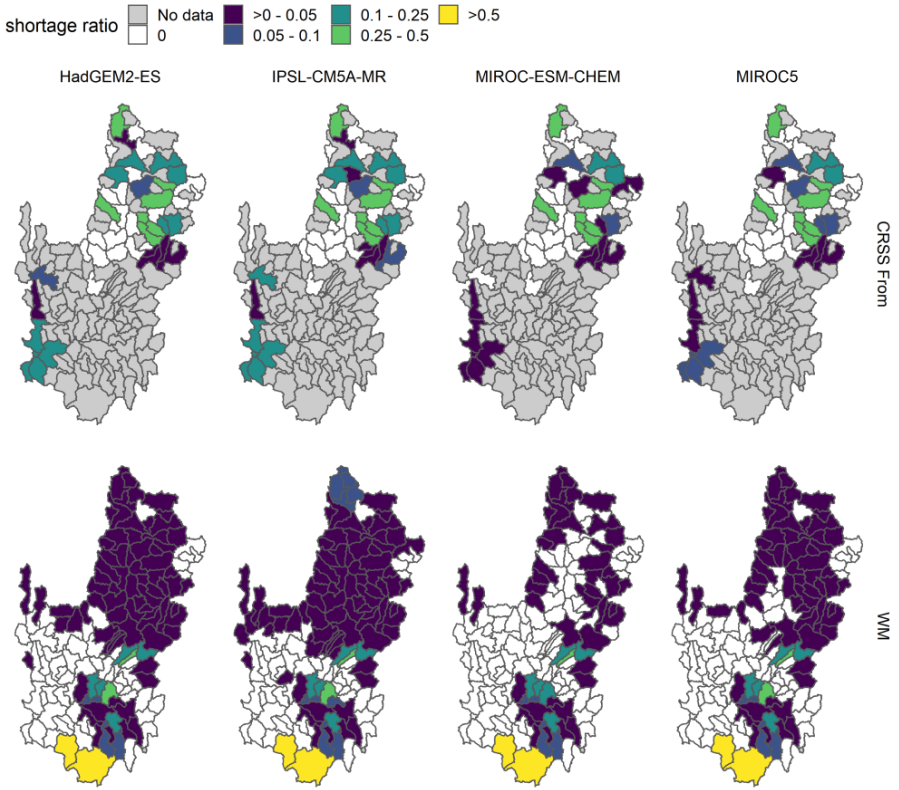

Western Interconnect




*RiverWare*

*MOSART-WM*

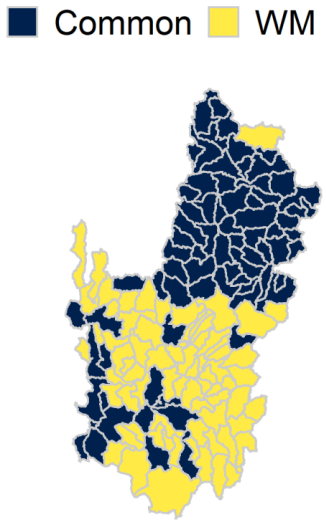
- How is water shortage impacted by changing climate conditions?
- How sensitive are estimates of water shortage to the scale and purpose of model?



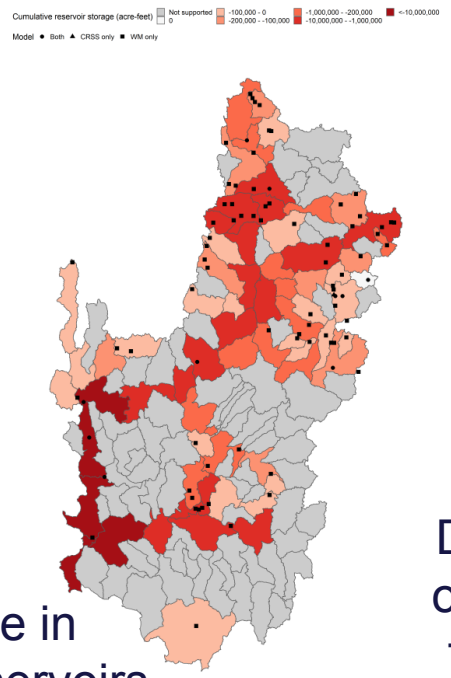

*Comparison of average water shortage CRSS (top) WM (below) for four future climate scenarios (2060)*

# Water Shortage and Scale

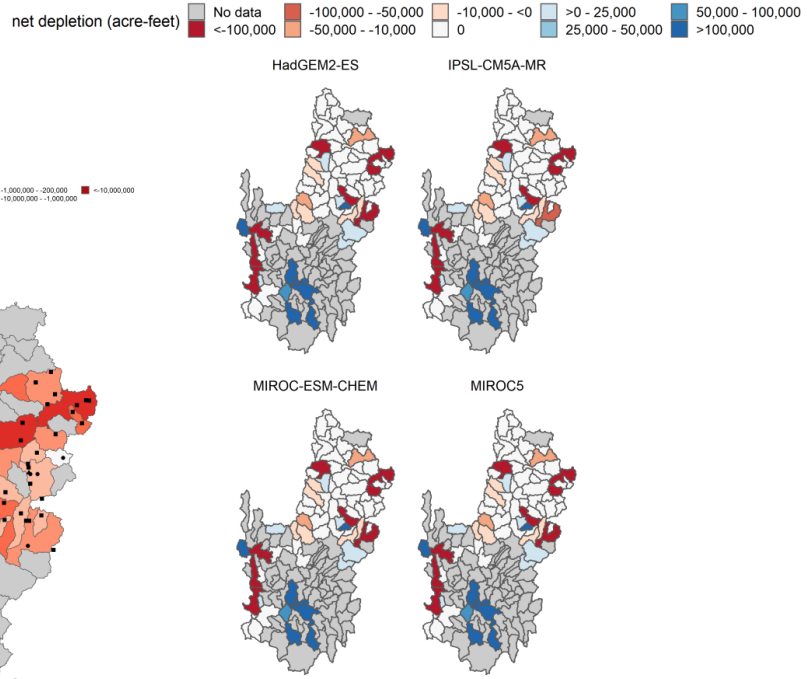
## Models are fundamentally different—and thus yield different results




Difference in basin representation

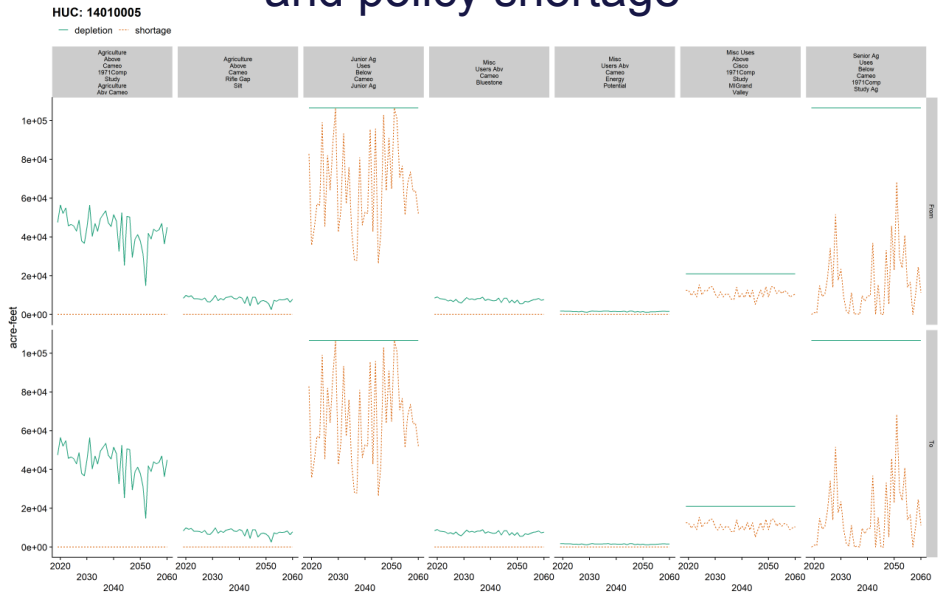



Difference in operated reservoirs




Difference in treatment of inter- and intra-basin transfers that account for roughly 30% of demand

Difference in evaluation of water scarcity in terms of physical shortage and policy shortage




## Both models subject to critical limitations—understanding limitations required to interpret results

# Water and Electric Sector Planning

U.S. DEPARTMENT OF ENERGY | OFFICE OF ELECTRICITY

HydroWIRES
U.S. DEPARTMENT OF ENERGY

Sandia National Laboratories

Pacific Northwest NATIONAL LABORATORY

WECC

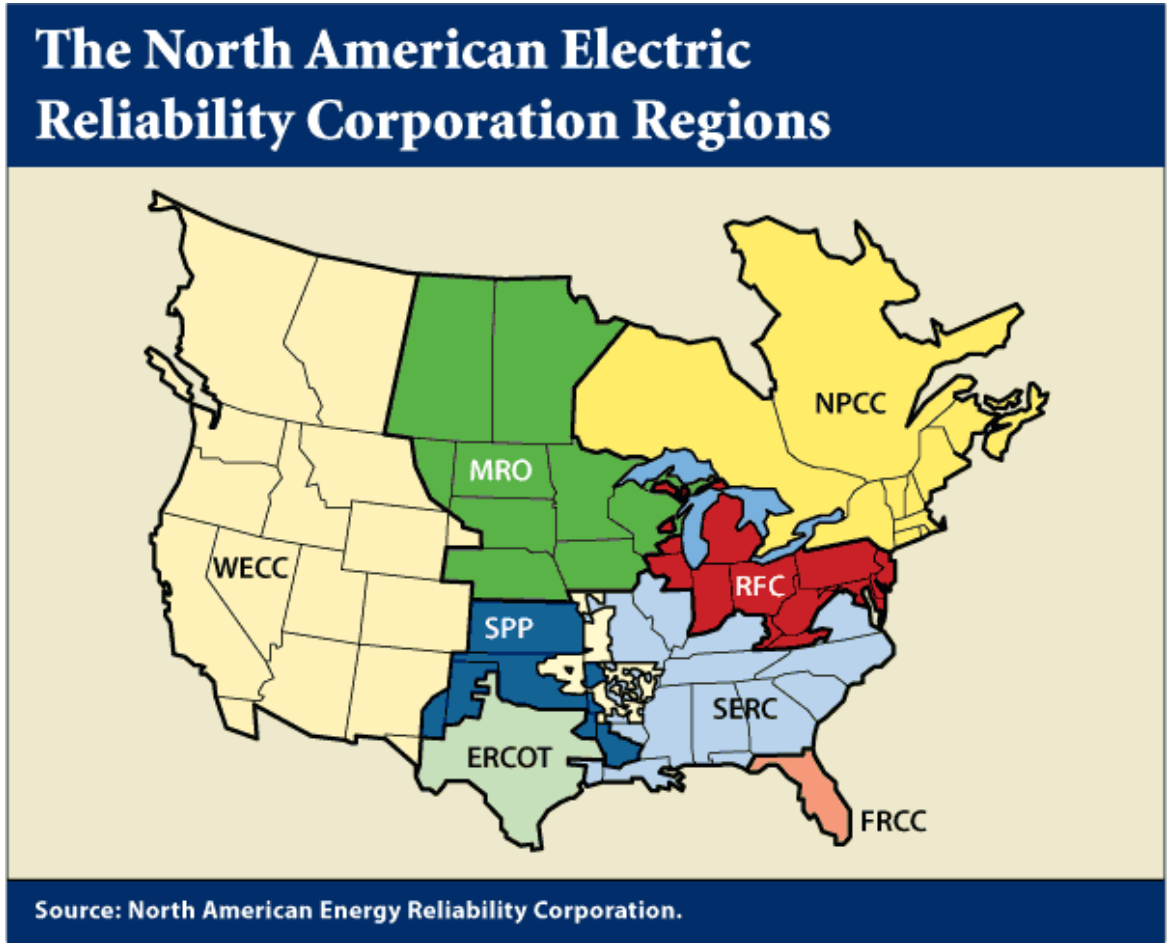
NREL
NATIONAL RENEWABLE ENERGY LABORATORY

ADVANCED SCIENCE RESEARCH CENTER
THE GRADUATE CENTER
CITY UNIVERSITY OF NEW YORK

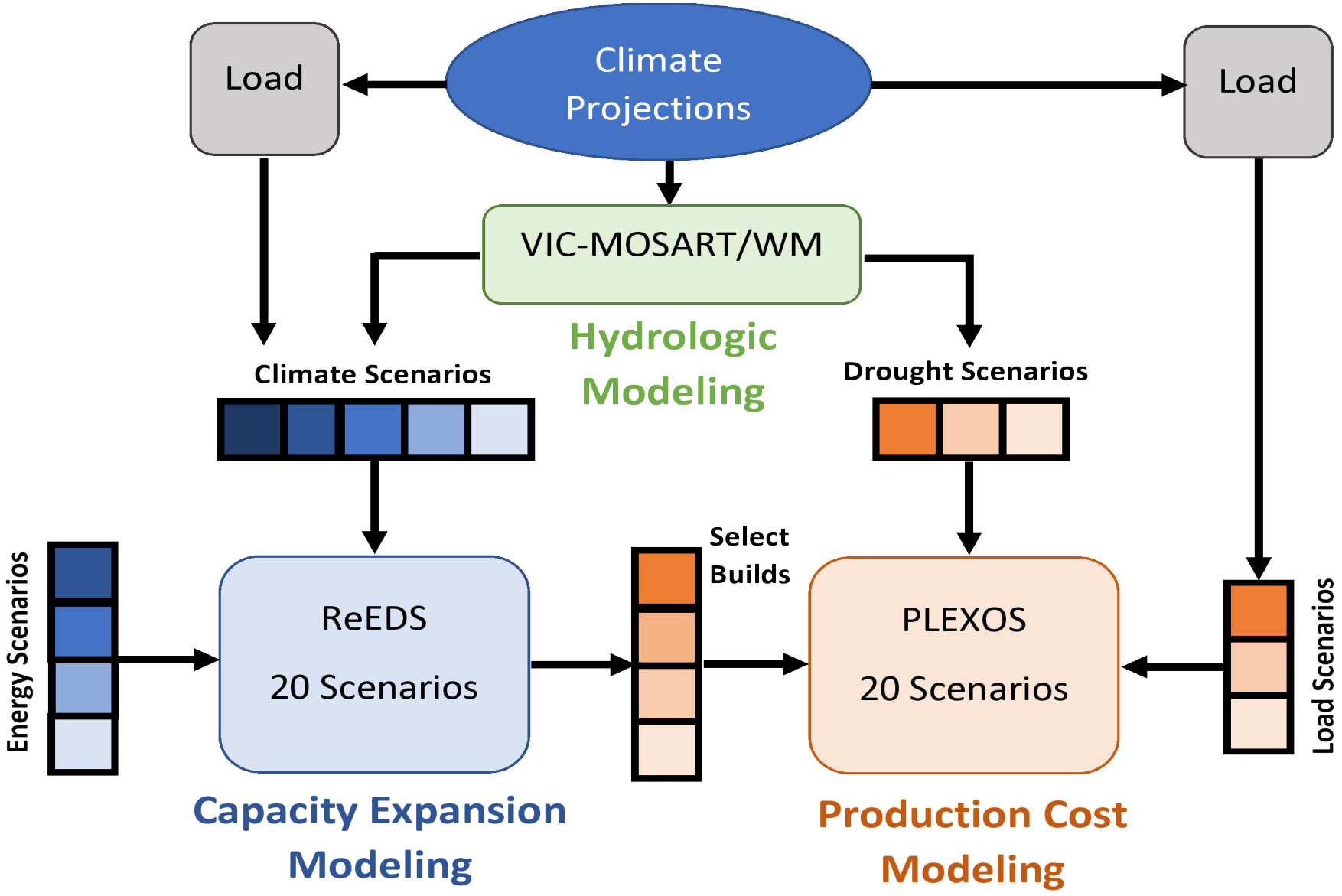
OAK RIDGE National Laboratory

## Technical Challenge

- What potential risks to the reliability of the Bulk Electric System in the Western Interconnection would result through changes to the climate, and how would those changes impact the electrical reliability of the Western Interconnection?



# Multi-Model Energy-Water Modeling Platform



# Infrastructure and Climate Scenarios

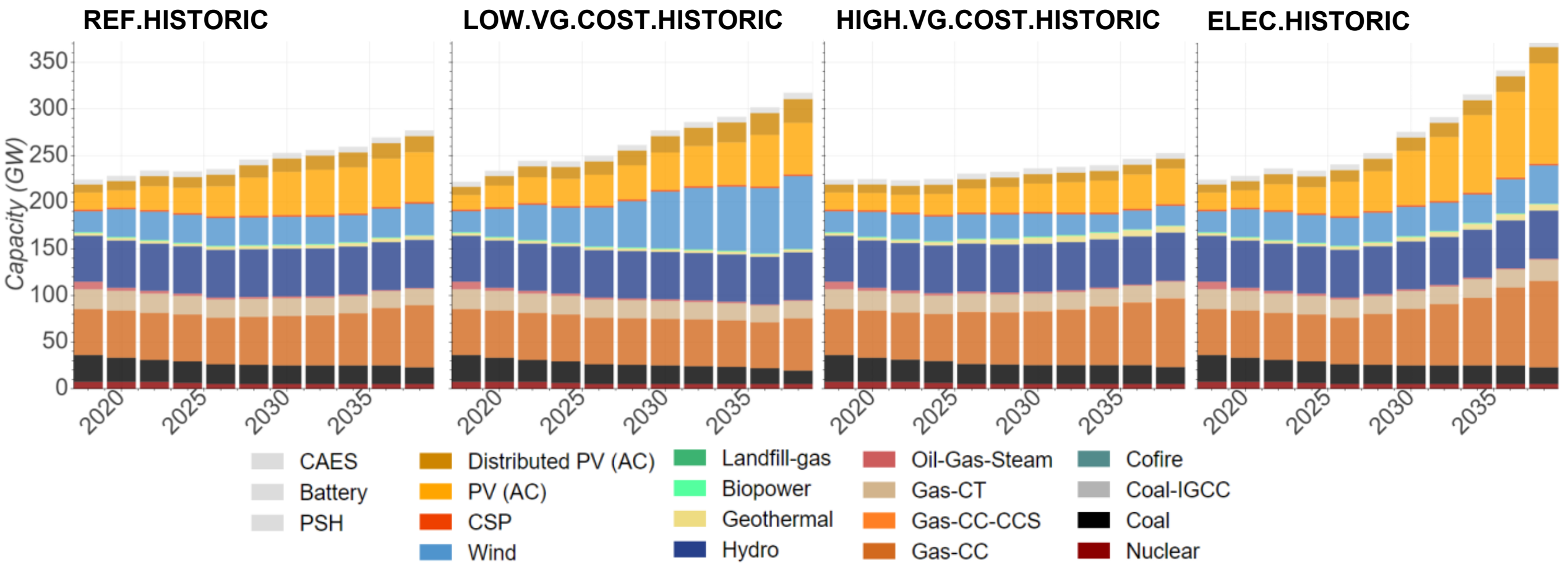
Infrastructure expansion scenarios vary the possible future generation mix

1. REF: default ReEDS v2018 assumptions
2. LOW.VG.COST: NREL ATB 2018 Low Cost case for wind and solar
3. HIGH.VG.COST: NREL ATB 2018 High Cost case for wind and solar
4. ELEC: NREL Electrification Futures High Technology Adoption, Moderate Technology Advancement case with moderate demand flexibility (in review)

Climate scenarios bound future temperature and precipitation

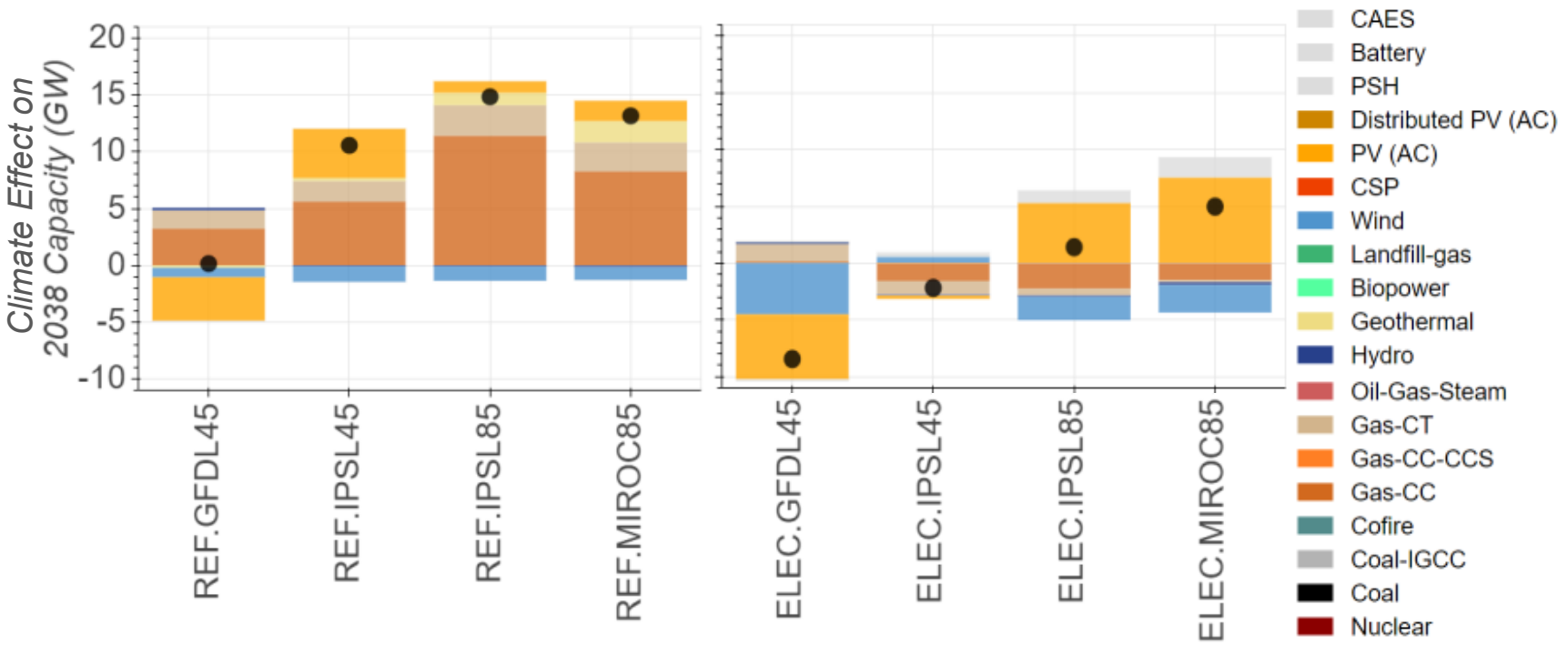
1. HISTORIC: Static historical climate conditions
2. IPSL85: Uses data from the IPSL climate model under RCP8.5 conditions
3. MIROC85: Uses data from the Miroc climate model under RCP8.5 conditions
4. IPSL45: Uses data from the IPSL climate model under RCP4.5 conditions
5. GFDL45: Uses data from the GFDL climate model under RCP4.5 conditions

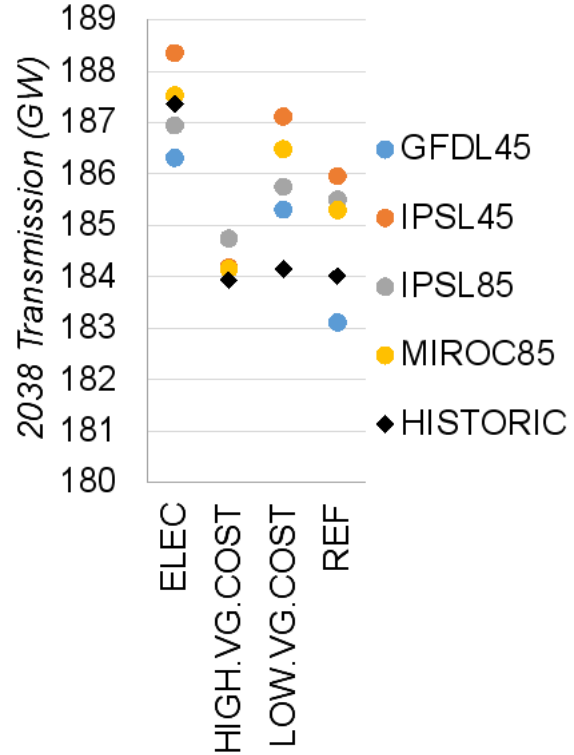
# Future Expansion Trends




- New deployment in these scenarios is primarily a combination of PV, wind, and natural gas
- The relative competitiveness of technologies depends on assumed technology costs and demand

# Changes in Climate Impact Generation and Transmission Investment Decisions

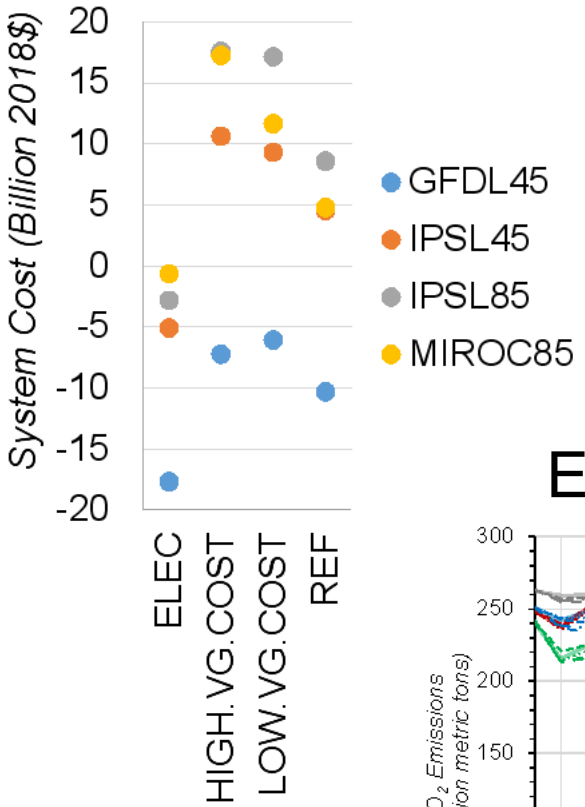


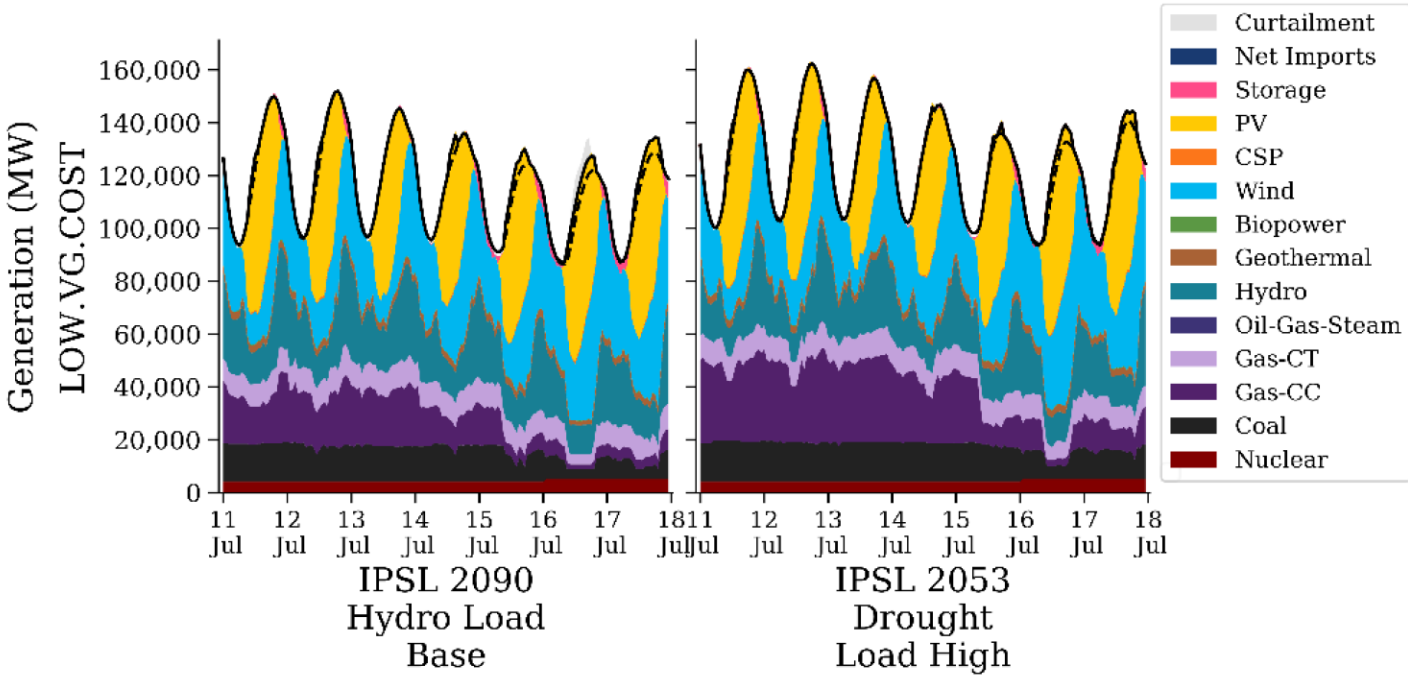

- Climate change primarily affects PV and gas capacity, with up to a 7% increase in total 2038 capacity
- Hotter climate requires more total capacity
- Wetter climate can reduce capacity needs with additional hydropower generation
- Electrification can reduce capacity needs through flexible demand
- Higher generation capacity typically leads to more transmission capacity

# Climate Impacts System Performance

## System Costs



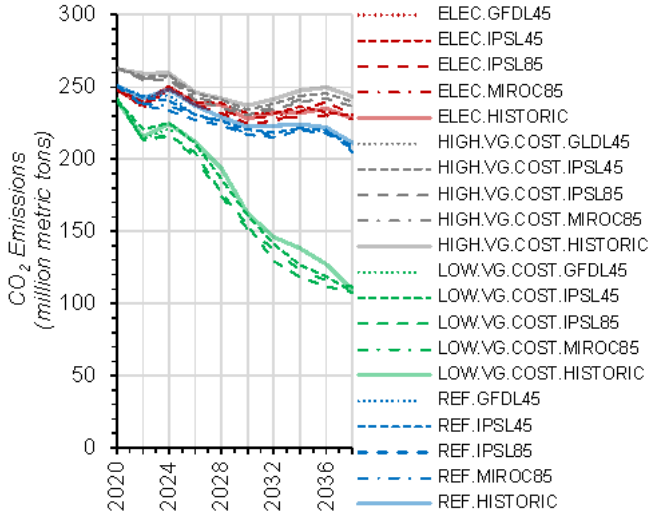

## Unserved Load and Reserve Margins

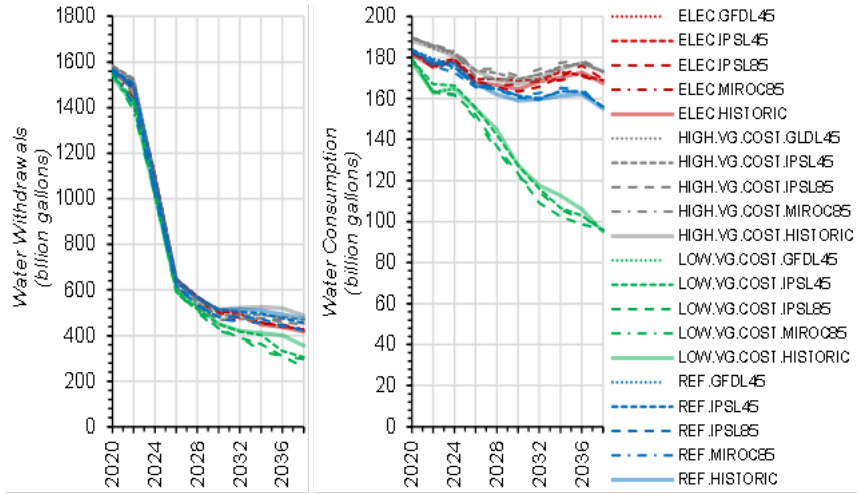



IPSL 2090 Hydro Load Base

IPSL 2053 Drought Load High

## Emissions



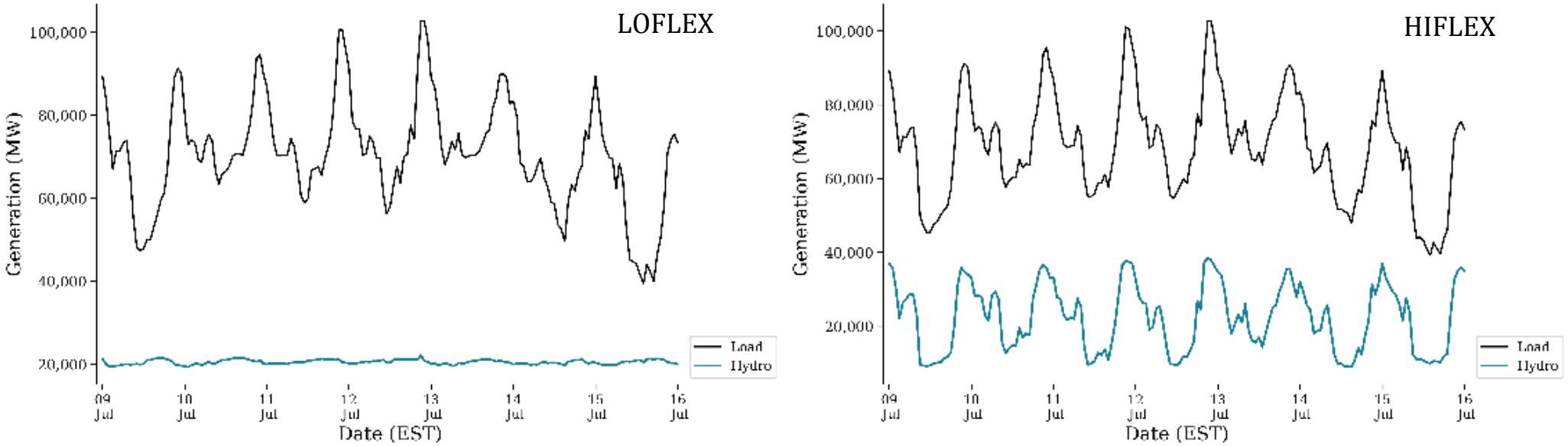

## Water Withdrawals and Consumption

# Climate Impacts on Hydropower Dispatch

Scenarios represent bounding cases of increased (HIFLEX) or decreased (LOFLEX) flexibility of the dispatchable (non-run-of-river) hydropower fleet.

HIFLEX: Dispatchable hydropower can vary power output from zero to its maximum rated capacity at any time of the year.

LOFLEX: Dispatchable hydropower produces constant output across a representative season (ReEDS) or month (PLEXOS) within energy limits.




Net load and hydro dispatch for LOW.VG.COST in PLEXOS, showing impact of hydropower flexibility on hourly dispatch.

Vincent Tidwell

Sandia National Laboratories

vctidwe@sandia.gov

(505)844-6025

http://water.sandia.gov