

The Big Picture: Nationwide Drivers and Strategies for Water-Energy Savings





PRESENTED BY

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National Governors Association Water-Energy Nexus Learning Lab September 1, 2020



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ELECTRIC POWER

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Serving the Governors of 19 States and 3 US-Flag Pacific Islands

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Water for Energy

Water Consumption by County



Source: USGS 2018

322 BGD Total Withdrawals ~7-8 BGD Total Consumption



Unconventional Oil and Gas







Source: Tidwell et al. 2016

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Energy Consumption by County

Water Sector Consumes 4-8% of Total U.S. Energy Production



Source: Tidwell et al. 2014

Water for Electric Power

Current Impacts

Climate Extremes Impact Power Production



Water Scarcity Impacts Plant

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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 typ of coal-fired power plants. Idaho is the only Western state currently without any coal-fired power plants. The moratorium does not prohibit construction o 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 Inte ology, develops a e on Energy, Er comprehensive state energy plan.

Practices Experience Locations News and Events

The legislation was inspired in part by a controversial plan by California-based eration to build a 600 mega-watt plant in Jerome County. approximately 120 miles southeast of Boise. Following the Senate's passage of 701. Sempra announced that it would end efforts to construct the Jerome County project and a similar project in northern Nevada. Craig D. Rose, tiff Opposition, San Diego Union Tribun (March 30, 2006). In a letter to Idaho Governor Kempthorne, Sempra state that it withdrew from the Idaho project because it was focusing on its natura gas related business. Id. Sempra plans on seeking buyers for the developmen 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* '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 protect 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,

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THE VALLEY

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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.

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

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• Power generation at risk from drought.

- Elevated water temperatures can necessitate plants to limit their generation.
- Shown is the potential impact on current generation capacity:
 - Under current climate, and
 - Under future climate conditions.

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 lowwater use technology:

- Natural gas combined cycle
- Wind
- Solar PV



Ranges reflect minimum and maximum water-use values.

Systems are Moving to Less Water Intensive Forms of Cooling





Open-loop "once-through" cooling cycle

Source: EPRI 2002

Closed-loop cooling cycle

Integrated Planning



Analysis platform included:

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

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



Climate Impact on Planning



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



Pacific Northwest NATIONAL LABORATORY

Generation Expansion Profiles



Source: Tidwell et al 2020

Implications for System Reliability and Cost

Climate Impact on Planning

Implications for Future Water Use



Source: Tidwell et al 2020

Climate Effect on 2038 Capacity (GW)



Combined influence of climate and water availability influence siting decisions



Integrated Plant-Level Planning

Techno-economic assessment of water options for the Palo Verde Nuclear Power Plant, Phoenix, AZ



Source: Middleton and Brady 2020

There are many dimensions to a power plant's water footprint:

- Water supply reliability and cost.
- Variable/changing chemistry of water supply.
- Changing cost of cooling and water treatment technology.
- Wastewater management options and costs.

Integrated Plant-Level Planning

Interactive Decision Platform to Support Water Planning



Presents tradeoffs in plant economics due to:

- Alternative cooling technologies,
- Water usage and treatment,
- Water disposal options, and
- Influent water chemistry



Source: Middleton and Brady 2020

Water for Oil and Gas Production

DANGER

Current Impacts

Water extremes impact oil and gas production:

- Water policy,
- Water cost.



Source: Stevens and Torell 2018

20

40

Drought Intensity

60

80

100

CNN Money Companies Markets Tech Media **Drought strains U.S.** oil production By Steve Hargreaves @CNNMoney July 31, 2012: 4:55 AM ET

67

Excavators prepare water for the oil industry in Kansas. The drought is restricting water available for fracking, which could harm U.S. oil production.

Intensifying Demands

Projected Increases in Production



Treated produced water

Source: Zemlick et al. 2018

natural gas reserves

Much of Production in Water-**Limited Regions**



Water choices are complicated:

- Alternative water sources,
- Water disposal options,
- Intensity of production, and
- Produced water use options.

Produced Water Solutions

Recycle produced water



Source: American Oil and Gas Reporter 2020

- 25BG of water used in unconventional oil production each year
- Over one trillion gallons of produced water generated in 2012
- \$40B in annual disposal costs

Fit-for-use treatment: Reclaiming well pads

G 3



Source: Dwyer and McDonald 2016

Energy for Water

Supply and Demand

AFY

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1.000 - 5.000

5,000 - 10,000

10.000 - 50.000

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Groundwater Area of

<figure>

Fresh Groundwater

Appropriated Water



Wastewater





Growth in Demand 2015-2035



Source: Tidwell et al. 2018

Intensifying Demands

Projected Change in Energy Demand for Water Services 2015-2030



Source: Tidwell and Moreland 2020

7-13% increase projected over 15 yrs.





Existing and Proposed Western Water Supply Projects

Advanced Treatment Technologies



DOE Water Security Grand Challenge

- **Goal 1:** Desalination
- Goal 2: Produced Water
- **Goal 3:** Cooling Water
- Goal 4: Energy Recovery
- **Goal 5:** Modular Systems

Resource Recovery

Water Resource Recovery Facility of the Future

Biogas Potential



Clean water.

Officials, industry, and the public will manage demand and waste better, support resource recovery goals, and contribute to integrated solutions for water, energy, and food supply.

I. Energy-Water-Climate issues are affecting energy and water 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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