U.S. DEPARTMENT OF
ENERGY

Office of
ENERGY EFFICIENCY &
RENEWABLE ENERGY

The Effects of Climate Change on Federal Hydropower

Third 9505 Assessment

Hydropower is a versatile resource that produces 6.3% of the nation's electricity and 31.5% of renewable energy. However, climate change is altering water availability across the United States, requiring changes in hydropower operations. Oak Ridge National Laboratory, with support from Pacific Northwest National Laboratory and Texas A&M University, examined how climate change may affect water availability for federal hydropower marketing and generation and its impact on future energy demand. The resulting Third Assessment of the Effects of Climate Change on Federal Hydropower provides stakeholders with state-of-the-art hydroclimate projections to support smart and informed energy planning.

Study Focus

Directed by the SECURE Water Act (SWA) of 2009, researchers conducted a series of assessments to evaluate the effects of climate change at 132 federal hydropower plants marketed by the four federal Power Marketing Administrations (PMAs): Bonneville Power Administration, Western Area Power Administration, Southwestern Power Administration, and Southeastern Power Administration.

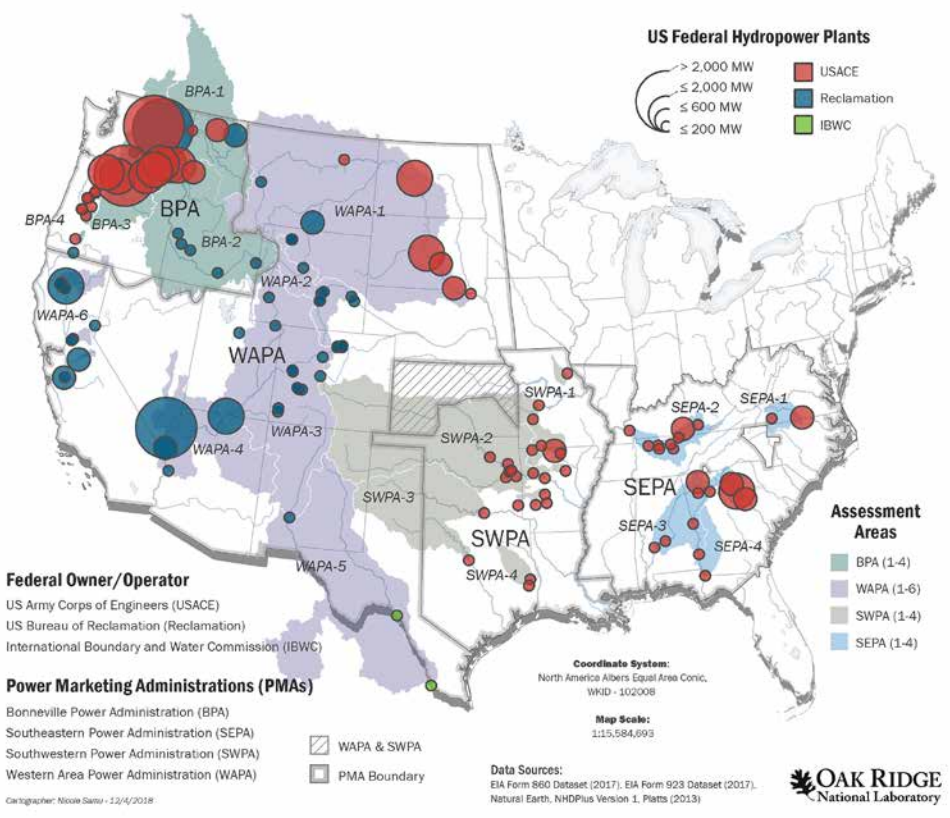
Shasta Dam and Lake in Shasta, California. *Image from the U.S. Bureau of Reclamation*

U.S. Federal Hydropower

- 132 plants (as specified by SWA)
- 36.9 gigawatts
- 46% of U.S. hydropower
- 14% of U.S. renewables
- 3% of U.S. electricity

Methodology

In this assessment, researchers projected near-term (2020–2039) and mid-term (2040–2059) climate conditions in each PMA region using historical and current climate observations and future climate scenarios derived from downscaled Coupled Model Intercomparison Project Phase 6 (CMIP6) information.



TO COMPLETE THIS ASSESSMENT, RESEARCHERS CONDUCTED THE FOLLOWING:

- Climate model evaluation and selection
- Climate model downscaling
- Hydrologic modeling
- Regional hydropower simulation
- Reservoir evaporation loss analysis
- Energy demand analysis

Findings

Climate change creates contrasting conditions that include increasing temperatures and both intensifying rainfall and drought, all of which affect hydropower operations. Rising temperatures from 1° F to 6° F may lead to increasing water evaporation from hydropower reservoirs, which decreases generation capacity because hydropower depends on a certain level, or head, of water supply.

While median annual rainfall is expected to change moderately across most of the continental United States (between -2% to 8%), more arid areas of the country—including California, the lower Colorado River Basin, and the Rio Grande Valley—will continue to face drought conditions. The increase in precipitation across the rest of the country will shift snowmelts to earlier in the winter and spring, changing the typical seasons for water runoff and resulting in lower water supplies in the summer months.

Aggregated over all PMAs, annual streamflow is projected to increase by 9%, and hydropower generation is projected to increase by about 4%. (However, these projections vary when analyzed by specific PMA region.) Total hydropower generation for all PMAs is projected to be about 120 terawatt-hours/year in both near-term (2020–2039) and mid-term (2040–2059) periods, slightly higher than the baseline (1980–2019) level but with higher variability as the result of more frequent extreme events.

Bonneville Lock and Dam in Multnomah, Oregon. *Source: U.S. Army Corps of Engineers*

Mitigation

Intensified climate conditions represent one of the most critical issues threatening power system and infrastructure resilience. Mitigation actions will be needed to reduce the effects of earlier snowmelt, changing timing of water supply/demand, and other extreme events. Conventional reservoir operation practices purely based on historic observations may need to be reexamined to account for changing climate conditions and energy demand.

Next Steps

Additional, more in-depth studies and data support activities are underway. For example, the U.S. Department of Energy issued a Request for Information to understand climate data and research needs among non-federal hydropower stakeholders, particularly smaller utilities that may not have dedicated, in-house resources for modeling and evaluating climate risks. Further workshops and stakeholder engagement meetings will be organized to discuss future research and development initiatives.

Report and Data Availability

View the assessment report at doi.org/10.2172/1887712 and data at doi.org/10.21951/SWA9505V3/1887469. More information is available on the project webpage accessible through this QR code: ■

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For more information, visit energy.gov/eere/water.

To contact DOE's Water Power Technologies Office, email WaterPowerTechnologiesOffice@ee.doe.gov.

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