Water Availability for Cooling Systems: Assessing Demands, Constraints, and Alternative Sources for Thermoelectric Plants and Data Centers

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Focal Area

This white paper addresses Water for Energy by focusing on improving water management to provide additional cooling water to further thermoelectric energy production and support data center deployments. It aims to assess existing demands and constraints on cooling water and to identify alternative sources of water to meet growing needs of large-scale water and energy users.

Existing Challenge

Rapidly growing electricity demand—driven by manufacturing, industrial expansion, and the rise of AI-powered data centers—requires a significant increase in baseload generation. Failure to meet this need could compromise grid reliability and undermine U.S. economic and national security (US DOE 2025a). Thermoelectric power plants supply most of the country's baseload electricity and account for about 41% of total national water withdrawals (Dieter et al., 2018; EIA, 2023). In some states, such as New York and Maryland, thermoelectric power plants account for over 70% of total water withdrawals. In water-stressed regions like Texas and California, they also compete directly with agriculture and other sectors for limited resources.

Current and future thermoelectric generation in the U.S. power grid depends on adequate water availability and is vulnerable to water scarcity and stress (Ganguli et al., 2017). As the U.S. scales up baseload generation to meet rising demand, expanding thermoelectric capacity will be essential, making water availability critical to the nation's strategic outlook.

In addition to thermoelectric generation, the rapid expansion of data centers is placing new demands on water resources. Many large-scale data centers use water-based cooling systems, intensifying competition for limited supplies. U.S. data center demand is expected to more than triple by 2030, with AI workloads driving much of this growth (McKinsey & Company 2025). Data centers consume water directly for cooling and indirectly through electricity, projected to reach 6.7-12% of total U.S. electricity by 2028 (Shehabi et al. 2024). In some areas, data center have already faced backlash due to water availability concerns (Solon 2021; Manning 2022).

Near-Term Opportunity

Building an energy-abundant future for the United States requires urgent, coordinated action to modernize water-energy management. Currently, thermoelectric and data center developers operate independently, missing opportunities to improve efficiency, reliability, and water security. A unified framework that connects infrastructure investment, water resource planning, and policy design is essential to enable the competitive deployment of critical technologies

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while ensuring long-term water resilience and minimizing impacts on food production, ecosystems, and other sectors.

The Department of Energy (DOE) is well-positioned to lead national coordination on energy-water strategies for data centers and thermoelectric facilities, drawing on the diverse expertise of its national laboratories. Idaho National Laboratory's long history of nuclear demonstrations, large-scale infrastructure, and integrated energy systems provides a valuable testbed for piloting advanced cooling and water-management technologies. In collaboration with other labs, these efforts can support regional planning and accelerate scalable, cross-sector solutions. A range of near-term strategies should be pursued to address these challenges:

1. *Strengthening cross-sector collaboration between water utilities and developers*

Partnerships between water and utilities, technology developers, and other stakeholders can unlock new opportunities for water conservation, infrastructure upgrades, and long-term water resilience. For example, Florida Power & Light's use of treated wastewater from Miami-Dade County for cooling at Turkey Point demonstrates how collaboration can reduce aquifer withdrawals, meet regulatory goals, and create cost-effective reuse solutions.

Developing flexible partnership models and tools to quantify shared value across sectors can help align infrastructure investments, streamline permitting processes, and support integrated planning. Demonstrating the effectiveness of collaborative approaches that promote data sharing and coordinated investment can accelerate adoption and scale solutions across regions.

2. *Expanding the use of alternative water sources, e.g., wastewater, brackish water, water from retired plants for cooling*

Alternative water sources such as urban wastewater, brackish water, and water infrastructure from retired coal and gas plants offer untapped potential to support cooling and other energy applications. These resources can reduce pressure on freshwater supplies while enabling the siting of emerging energy projects like nuclear facilities and data centers.

Developing tools to evaluate the suitability of nontraditional water sources—based on quality, availability, and regulatory constraints—can help identify viable options for reuse. Establishing a national water-energy siting framework would improve regional coordination, streamline planning processes, and support the efficient deployment of alternative water resources.

3. *Advancing planning and siting tools and demonstrations that integrate water considerations*

Planning tools that incorporate water availability, quality, and infrastructure constraints can significantly improve siting decisions for thermoelectric facilities, data centers, and other water-intensive developments. These tools can also identify existing facilities best suited for upgrades to less water-intensive cooling technologies, helping reduce permitting delays and support long-term resource planning.

Integrating water data into energy system models and geospatial platforms can enable more informed, regionally tailored decisions. Field-testing emerging technologies and benchmarking their performance, reliability, and integration under real-world conditions would help validate solutions and accelerate their deployment across diverse energy systems.

4. *Developing water policy that can adequately respond to water and energy needs*

Water and energy policies were designed in an era with fewer constraints on water availability and population growth. Today's demands require modernized frameworks that reflect current resource pressures and enable more efficient, adaptive, and sustainable infrastructure deployment.

Conducting research to develop alternative strategies such as water markets, valuation methods, and updated regulatory frameworks can help drive innovation and improve resource efficiency. Advancing targeted policy reforms, including streamlined permitting processes and incentives for water-efficient technologies, would enable faster deployment of critical infrastructure. Clarifying water rights procedures can also help energy developers access and convert existing rights for industrial use, supporting the siting of new facilities in water-constrained regions.

Success Measure

Integrated water-energy planning and the strategic use of alternative water sources will enable the deployment of thermoelectric and nuclear baseload generation while supporting the rapid expansion of water-cooled data centers. This coordinated approach enhances grid reliability, accelerates AI-driven and industrial electrification growth, and strengthens water resilience in resource-constrained regions.

Quantitative: The number of thermoelectric or data center facilities using alternative water sources, total volume of nontraditional water used for cooling, and reductions in freshwater withdrawals. Additional indicators include the number of agencies adopting integrated siting tools, the number of enacted water-energy policy reforms, and the formation of cross-sector partnerships that result in shared infrastructure or new revenue streams for water utilities. For new facilities relying on freshwater sources, identifying barriers to the adoption of alternative water sources will provide insights to inform future strategies.

Qualitative: Broader use of planning tools that integrate water constraints into energy siting, alignment of goals across water and energy sectors, and the emergence of flexible partnership models that support long-term water resilience. Progress is also reflected in the integration of water valuation into energy planning, reduced conflict with other water uses, and improved access to water resources for underserved and tribal communities.

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References

Cafferty, Kara G., Bastidas Pacheco, Camilo Jose, Davis, Dawn Dee, et al., "Analysis of Water-Energy Issues for Nuclear Power with Industry Perspective," (2023), https://doi.org/10.2172/2283068

Dieter, C.A., Maupin, M.A., Caldwell, R.R., Harris, M.A., Ivahnenko, T.I., Lovelace, J.K., Barber, N.L., and Linsey, K.S., 2018, Estimated use of water in the United States in 2015: U.S. Geological Survey Circular 1441, 65 p., https://doi.org/10.3133/cir1441

EIA 2023. What is U.S. electricity generation by energy source? https://www.eia.gov/tools/faqs/faq.php?id=427&t=3

Ganguli, P., Kumar, D. & Ganguly, A.R. US Power Production at Risk from Water Stress in a Changing Climate. Sci Rep 7, 11983 (2017). https://doi.org/10.1038/s41598-017-12133-9

INL, 2025. Accelerating Nuclear Energy. https://inl.gov/nuclear-energy/accelerating-nuclear-energy/

Manning, J. (2022, December 28). Google's water use is soaring in The Dalles, records show, with two more data centers to come. The Oregonian/OregonLive. https://www.oregonlive.com/silicon-forest/2022/12/googles-water-use-is-soaring-in-the-dalles-records-show-with-two-more-data-centers-to-come.html

McKinsey & Company. (2025, August 8). The data center balance: How US states can navigate the opportunities and challenges. https://www.mckinsey.com/industries/public-sector/our-insights/the-data-center-balance-how-us-states-can-navigate-the-opportunities-and-challenge

Miara, A., Macknick, J., Vörösmarty, C. et al. Climate and water resource change impacts and adaptation potential for US power supply. Nature Clim Change 7, 793–798 (2017). https://doi.org/10.1038/nclimate3417

Shehabi, A.; Newkirk, A.; Smith, S.; Hubbard, A.; Lei, N.; Siddik, M., et al. (2024). 2024 United States Data Center Energy Usage Report. Lawrence Berkeley National Laboratory. Report #: LBNL-2001637. http://dx.doi.org/10.71468/P1WC7Q Retrieved from https://escholarship.org/uc/item/32d6m0d1

Solon, O. (2021, June 19). Drought-stricken communities push back against data centers. NBC News. https://www.nbcnews.com/tech/internet/drought-stricken-communities-push-back-against-data-centers-n1271344

United States Department of Energy, 2025a. Resource Adequacy Report. https://www.energy.gov/topics/reliability

United States Department of Energy, 2025b. 9 Key Takeaways from President Trump's Executive Orders on Nuclear Energy. https://www.energy.gov/ne/articles/9-key-takeaways-president-trumps-executive-orders-nuclear-energy