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Integrated Energy-Water Data for Cross-Sector Resilience

January 2026

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U.S. DEPARTMENT of ENERGY

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Integrated Energy-Water Data for Cross-Sector Resilience

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Focal Area(s): This white paper primarily focuses on "energy-for-water", addressing the urgent need for integrated, empirical data to support regional management, benchmarking, and research on improving efficiency and developing technologies for water and wastewater systems. However, consolidating, connecting, and expanding data sources on water systems will inform many water-for-energy and cross-sectoral research projects.

Existing Challenge

Disjointed management of water and energy systems has created systemic vulnerabilities in the United States, particularly as aging infrastructure, population and industrial growth, and severe weather events strain both sectors. Disruptions to the energy supply can trigger cascading risks that threaten critical water and wastewater services, yet water and energy systems are often managed in isolation. Failure to acknowledge the interdependence of water and energy systems is reflected in current data collection, management, and distribution practices, which are often disorganized and inefficient.

High-quality, standardized datasets, such as those maintained by the Energy Information Administration (EIA) for the energy sector, are essential for addressing present-day vulnerabilities and planning for long-term energy security. Unfortunately, the water sector lacks a comparable national data infrastructure.[1] This deficiency limits the nation's ability to assess baseline and future water-related energy demands, evaluate opportunities for efficiency improvements and technological innovation, assess and mitigate risks from interdependent failures, manage water to maximize economic benefit and minimize ecosystem impacts, and plan for emerging needs such as increased water demand from resource-intensive facilities like data centers and semiconductor manufacturers.[2,3] Lack of standardized data also hampers our capacity to understand how evolving policies, treatment technologies, demand-side technologies, and consumption patterns may reshape the sector in the future.

Unlike the relatively robust and centralized data collected by the EIA, data on water and wastewater systems (including but not limited to water sources; system capacity; throughput; leakage; chemical and energy use; operational costs; customer pricing; end uses by sector, location, and purpose; discharge points; and influent/effluent water quality) are often fragmented and inconsistently reported. While utility data can sometimes be obtained through state-level open records laws, the lack of a centralized platform leads to siloed research efforts, unnecessary administrative burden on utility staff, and inconsistent reporting, making benchmarking across utilities and geographies challenging. Furthermore, some sectors, such as manufacturing, rely largely on self-supplied sources without reporting withdrawals.[4] Datasets on energy consumption, treatment technology, and tariffs at some U.S. water and wastewater facilities can be found through individual research initiatives,[5-8] and the authors of this white paper are aware of several similar data collection efforts that are not yet released publicly. Additional data exists at the local level through Supervisory Control and Data Acquisition (SCADA) systems, on-site metering, and utility bills, but access is often restricted due to operational, privacy, or security concerns. Demand information can sometimes be gleaned from withdrawal and discharge permits; however, these are not uniformly reported across states, have varying degrees of accessibility, report permitted capacity rather than treated volume, and can be out-of-date.

Existing datasets capture just a snapshot of the water and wastewater sectors, representing a limited number of utilities during a specific data collection period. For example, one of the most recent large-scale water-energy data collection efforts dates back to 2012,[5] with few updates since. Even energy benchmarking data from the American Water Works Association is based on relatively small samples and aggregated at scales that limit their applicability for detailed analysis. These one-off data collection efforts are rarely linked to federal water data systems such as the Safe Drinking Water Information System (SDWIS), the Clean Watersheds Needs Survey (CWNS), and the Integrated Compliance Information System - National Pollution Discharge Elimination System (ICIS-NPDES), or other studies built upon federal datasets,[6,8] reducing their value for broader policy and planning efforts. Similar issues exist with demand-side datasets, with problems in the manufacturing sector highlighted by McCall et al. (2021).[3] This uncoordinated approach to data collection and management hampers the efficiency, scalability, impact, and, in some cases, feasibility of integrated energy-water research. Based on our experience leveraging these datasets, the reach and effectiveness of past and future research are limited without a more integrated and comprehensive data framework.

Near-Term Opportunity

A unified data infrastructure is essential for building more reliable water and energy systems, as well as for understanding cross-sector dependencies. More specifically, a comprehensive database is the necessary foundation for assessing regional water-energy cascading failures in support of the National Risk Register detailed in Executive Order 14239, as well as informing the creation of a critically needed Emergency Support Function (ESF) for water.[9] However, given the fragmented nature of the water sector (148,000 public water systems and 15,000 wastewater treatment facilities in the United States, all of varying sizes), data collection and standardization at a national scale would be an immense undertaking, perhaps a reason why prior efforts to implement such a program have not been fully successful.

The long-term implementation of a Water Information Administration (WIA) is likely beyond the scope of national labs and universities, as individuals or a consortium. However, there is a near-term opportunity for researchers to develop a framework that defines the data needs, proposes data collection strategies (e.g., frequency, sample size, format – direct outreach and/or web scraping), and establishes consensus around useful parameters (e.g., supply, end uses, energy demand, chemical consumption, production, costs), units, and boundaries for data collection efforts. These standardization efforts could be followed by piloting a limited, publicly accessible database that consolidates existing information on U.S. energy-water infrastructure for a subset of states to seed a federally-deployed WIA. Actualizing a living resource for energy-water nexus research and strategic projects, such as journal articles, fact sheets, and data dashboards, would demonstrate the value of a WIA for integrated, cross-sector planning and encourage more substantial investment through public or private entities.

This near-term research effort aims to establish standardization and periodic data update protocols to better support risk and resilience objectives across both the water and energy sectors, while also minimizing the reporting burden on water utility professionals, particularly those operating small systems. Wherever reliable and feasible, data will be gathered from existing publications, gray literature, state and federal initiatives, and by crowdsourcing unpublished datasets from researchers and institutions already working in this space. This work can be assisted by emerging large language models for web scraping and literature synthesis. To ensure usefulness for a wide variety of stakeholders, any centralized accounting agency would need to collaborate with relevant federal and state-level agencies, industry organizations (e.g., the Water Research Foundation), non-governmental organizations, and academic institutions to develop this resource.

This work would support numerous research efforts within the water–energy nexus space, including those described in other white papers such as "Building Resilient Energy–Water Systems: Near-Term Decision Support, Collaboration, and Deployment Pathways" and "A Standardized Siting and Risk Analysis Decision Support Tool for Water-Intensive Industries." It would also provide a foundational capability for many future projects involving artificial intelligence.

Success Measures

The proposed work would have many cross-sector benefits that advance energy and water security. Successful outcomes include, but are not limited to:

- Benchmarking and projecting the energy consumption and potential efficiencies of water and wastewater treatment facilities and conveyance systems;
- Understanding relationships between demand, treatment, end-use technologies/ processes, water quality standards, and energy consumption/recovery;
- Improving the efficiency of treatment facilities and water end-use facilities, resulting in cost savings for municipalities, rate payers, and industry;
- Identifying opportunities for high-impact interventions such as energy recovery technologies, alternative water sources, and advanced metering infrastructure;
- Developing more effective response strategies for hazards (e.g., hurricanes, floods) to ensure sufficient power for future water sourcing, treatment, and distribution;
- Coordinating upgrades across water and energy systems, investing in synergistic infrastructure, and reducing redundant capital expenditure;
- Enabling data-driven siting of water and energy-intensive facilities from other industries (e.g., data centers, semiconductor chip manufacturing);
- Providing policymakers with the basis to design effective policies and incentive programs that promote systemic efficiency and resilience;
- Minimizing repeated data requests to utilities and end-users, streamlining research processes while freeing up utility staff for operational priorities; and
- Offering a neutral, data-driven foundation for collaboration between government, academia, and the private sector on joint energy-water initiatives.

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