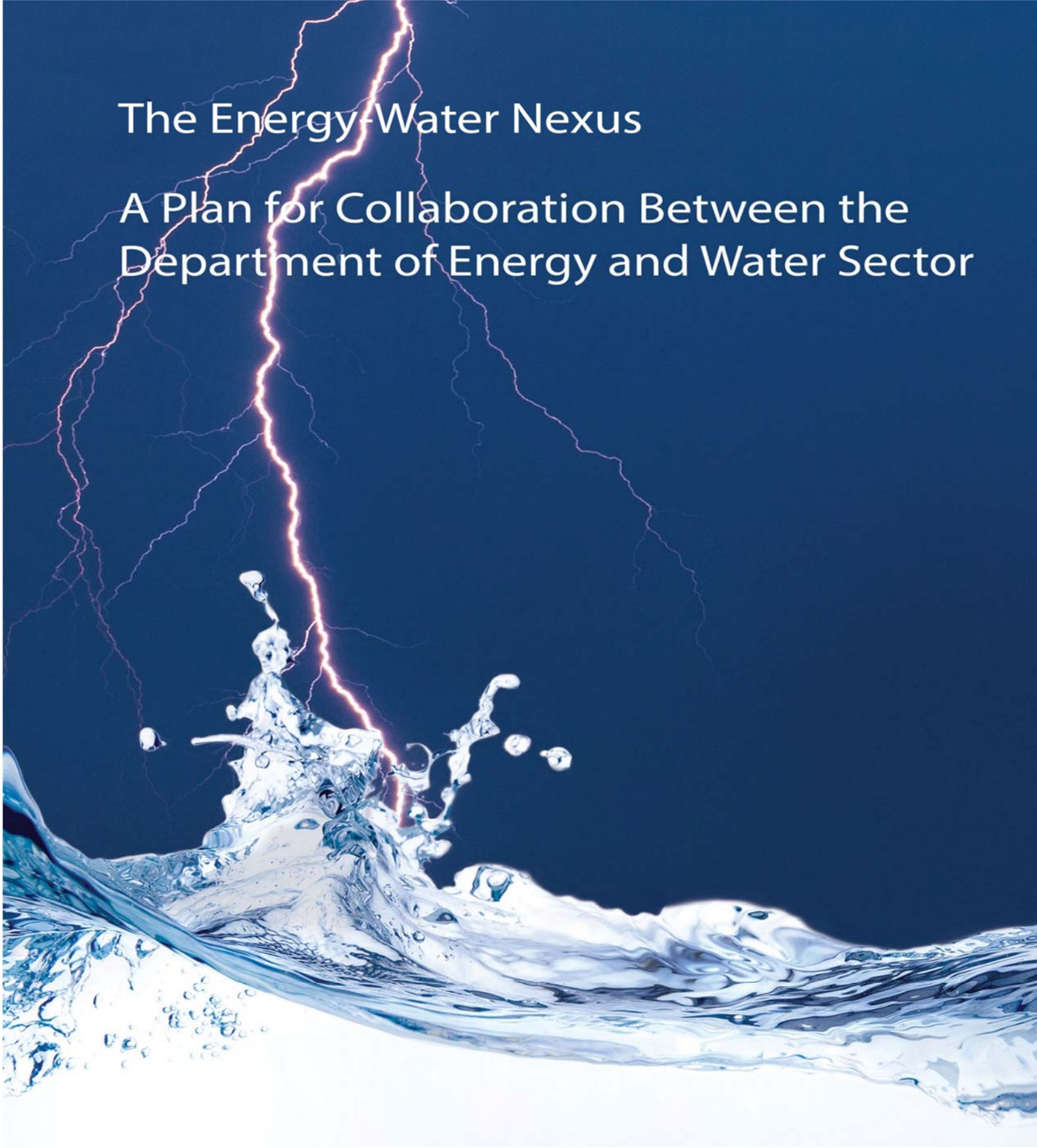
The Energy-Water Nexus

A Plan for Collaboration Between the Department of Energy and Water Sector



Water Research Foundation Celebrating 50 Years 1966-2016 | American Water Works Association | Water Environment Federation the water quality people | NACWA A Clear Commitment to America's Waters | Association of Metropolitan Water Agencies | WE&RF | NAWC National Association of Water Companies | US Water Alliance

EXECUTIVE SUMMARY

Energy and water are critical and mutually dependent resources. Research and collaboration between the energy and water sectors will result in reliable, resilient, and sustainable systems that create jobs as well as stimulate energy efficiency, resource recovery, and water conservation to benefit the customers we serve, public health, the economy, and the environment.

Collectively, the Water Research Foundation, Water Environment Federation, American Water Works Association, National Association of Clean Water Agencies, Association of Metropolitan Water Agencies, Water Environment & Reuse Foundation, National Association of Water Companies, and the U.S. Water Alliance represent utilities that provide service to **90% of the population in the United States** through drinking water, wastewater, resource recovery, reuse, and stormwater systems. We are the leading national water sector professional associations and research foundations with membership consisting of most of the large and medium water utilities in the United States, consulting, manufacturing, academia, government, and others.

The water sector stands ready to reinforce our partnership with U.S. Department of Energy (DOE) through the new administration and explore opportunities for collaboration by sharing the following:

- ✓ Overview of the Energy-Water Nexus
- ✓ Successful Energy-Water Programs and Partnerships
- ✓ Policy and Research Gaps in the Energy-Water Nexus
- ✓ Recommendations and Next Steps

OVERVIEW OF THE ENERGY-WATER NEXUS

Energy and Water are critical and mutually dependent resources. There are about 52,000 community (drinking) water systems and about 15,000 wastewater utilities in the United States, making this a large and diverse sector.[1,4] Around 2–4% of the nation's electricity is used by these utilities.[2,4] Likewise, approximately 27% of U.S. nonagricultural freshwater is consumed by the energy sector.[3] Between 1996 and 2011, energy use in public water supply and treatment rose 37% while energy use in wastewater treatment rose 74%.[4] The two greatest energy uses for public surface water systems are finished water pumping and water treatment. The single largest energy use in municipal wastewater treatment is aeration. Significant amounts of energy are also consumed in processing and managing wastewater derived biosolids.

Wastewater treatment facilities were constructed to protect public health and the environment, but utilities are now also focusing on recovering the resources contained in wastewater. Municipal wastewater contains nearly five times the amount of energy needed for the wastewater treatment process—the majority in the area of thermal energy.[5] The wastewater sector has the potential to generate 851 trillion BTU of energy annually, enough to heat approximately 13 million homes. By harnessing this energy and becoming more energy-efficient, the wastewater industry could potentially eliminate its net consumption, generating excess energy for other uses at a competitive price.

---

[1] EPA (U.S. Environmental Protection Agency). 2013. Drinking Water Infrastructure Needs Survey and Assessment Fifth Report to Congress. https://www.epa.gov/sites/production/files/2015-07/documents/epa816r13006.pdf

[2] DOE (U.S. Department of Energy). 2006. Energy Demands on Water Resources: Report to Congress on the Interdependency of Energy and Water. Washington, D.C.: DOE.

[3] Hightower, M. 2010. Energy and Water. In Energy Security: Water, Land, and Climate Issues. Presentation to Ground Water Protection Council. http://www.gwpc.org/sites/default/files/event-sessions/34Hightower_Mike.pdf

[4] Pabi, S., A. Amarnath, and R. Goldstein. 2013. *Electricity Use and Management in the Municipal Water Supply and Wastewater Industries.* Project #4454. Palo Alto, CA: Electric Power Research Institute (EPRI).

[5] Tarallo, Steve. 2014 *Utilities of the Future Findings*, Water Environment Research Foundation project ENER6C13

SUCCESSFUL ENERGY-WATER PROGRAMS AND PARTNERSHIPS

The water sector has been engaged in addressing energy-water nexus issues through research, practice, and collaboration for decades and is positioned to make significant advancements through increased collaboration with DOE and other stakeholders. Below are just a few examples:

Better Plants Program

Over the last few years, DOE has expanded the reach of the voluntary Better Plants program in the water sector, growing from a small pilot of wastewater utilities to a much larger number of both wastewater and drinking water utilities. This represents an important success in bringing a resource to the sector to meet common goals. There are many next-steps, including generating lessons learned across the program and finding ways to make it available to water utilities of all sizes and types.

Better Buildings Wastewater Infrastructure Accelerator

The DOE and the Water Environment Federation (WEF) have signed a Memorandum of Understanding (MOU) in support of the DOE Better Buildings Wastewater Infrastructure Accelerator. This initiative engages state, regional, and local agencies working with water resource recovery facilities (WRRFs) to accelerate innovative approaches to sustainable infrastructure. DOE staff attended the WEF Technical Exhibition and Conference (WEFTEC) in 2016 to make a formal presentation about the next steps in the program, which has already grown to almost 100 utility commitments.

WRF and WE&RF Collaborate with DOE on Research

The Water Research Foundation (WRF) and Water Environment & Reuse Foundation (WE&RF) have been collaborating with the DOE on research for over 25 years. DOE has helped to guide the energy-water research agenda through partnerships, serving as technical advisors on research, and conducting innovative research for the water sector to build on. In addition, WRF, WE&RF and WEF have served as advisors and reviewers on important DOE efforts, such as the Waste-to-Energy Roadmap currently being developed by Bioenergy Technologies Office (BETO). Through these collaborations, WRF and WE&RF have made important strides in the areas of energy efficiency, renewable energy, and resource recovery.

State Energy Efficiency Programs

The American Water Works Association (AWWA) has been working with state energy efficiency programs to identify ways for the water sector to better fit into these programs to tap into the energy saving potential within their systems. DOE should help to foster this effort through developing standards of measurement and verification for the sector in its Uniform Methods Project and by continuing to fund innovative energy efficiency opportunities through state programs.

National Water Resource Recovery Test Bed Network

In 2015 and 2016, several industry workshops were jointly hosted by the DOE, EPA, NSF, and WE&RF. The participating stakeholders identified the need to establish a national network of test bed facilities. The National Water Resource Recovery Test Bed Network (www.werf.org/testbednetwork) was created to address a critical market barrier to technology commercialization. A business plan to support this concept is currently being reviewed by the DOE and the other federal partners.

POLICY AND RESEARCH GAPS IN THE ENERGY-WATER NEXUS

There are numerous policy and research gaps that the DOE and water and energy sectors can address to help promote water and energy conservation, energy recovery, and a healthy water supply.

Legislation, Policy, and Regulation that Supports Life Cycle Environmental Responsibility

- ✓ National policies are needed that can help heavily-regulated water and wastewater utilities increase efficiency, generate renewable energy, and recover energy (e.g., energy embedded in wastewater).
- ✓ Barriers need to be removed for small distributed energy generators at water and wastewater facilities to develop renewable energy projects (e.g., hydro, wind, biogas).
- ✓ Shared systems analysis would be valuable to the water, energy, and agriculture sectors.
- ✓ Rate reforms that encourage water efficiency and support revenue stabilization are needed.
- ✓ Economic incentives are needed, such as direct capital funding through grants and loan discounts, and market-based incentives, such as recognition of renewable portfolio standards.

Alternative Water Resources, Availability and Demand, Treatment

- ✓ Fit-for-purpose treatment and regulatory structure can be developed to support energy and water optimization.
- ✓ A watershed approach is needed for water supply planning, demand management, and treatment, accounting for all beneficial uses of water supply.
- ✓ For water supply planning, water and electric utilities can develop and test new hydrologic models that account for land use and climate change.

Energy Efficiency, Water Conservation, and Demand Response

- ✓ Opportunities exist to improve pump design and operation efficiencies, since pumping and aeration account for up to 80 percent of energy demand for water utilities.
- ✓ Improved demand management, energy tracking, and smart metering in water treatment facilities will help inform and manage energy use.
- ✓ Opportunities and incentives exist for investing in mutual energy and water conservation.
- ✓ Opportunities exist to improve and promote anaerobic wastewater treatment technologies, since aerobic treatment processes often account for over 50 percent of energy demand at wastewater treatment facilities.

Energy Generation

- ✓ Opportunities exist to develop and improve recovery of thermal energy from wastewater.
- ✓ Opportunities exist to develop and improve fuel production from wastewater, such as pipeline quality renewable natural gas and renewable diesel from biosolids.
- ✓ Research and demonstration of innovative wastewater solids to energy technologies can help transform a costly waste (i.e., sludge) into a valuable energy resource.
- ✓ Capturing tidal energy can be explored for use in desalination facilities.
- ✓ The Energy Information Agency should track data on biogas generation at wastewater plants in the same manner as other renewables (i.e., landfill gas).
- ✓ Drinking water utilities are seeking ways to generate their own energy by employing solar, wind, and other forms of onsite and inline power generation.

- ✓ Water resource recovery facilities with appropriate location can be used as sites for other renewable energy systems, such as solar and wind.

Climate Change Impacts

- ✓ Development and testing of new hydrologic models that integrate different climate change scenarios should be responsive to challenges faced by both the water and energy sectors.
- ✓ Climate change is impacting the availability, quality, and quantity of water supplies, which affects energy systems and needs to be effectively addressed with new approaches.

Reliability and Resiliency

- ✓ Reliability and resiliency are critical for protection of public health and safety, the risks of which need to be assessed and mitigated in the context of water availability, climate change, a diverse energy portfolio, carbon footprint, and the interdependency of the water and energy sectors.

Systems Complexity; Regional Challenges

- ✓ Regional water and energy systems can be complex with local challenges specific to the region. Data and analysis are critical to inform understanding and opportunities of impact and interactions between the energy and water sector to identify regional solutions.

Infrastructure Renewal

- ✓ Encourage rate mechanisms that will allow for infrastructure cost recovery in a timely manner, providing additional incentive to replace older infrastructure with the added benefit of increasing energy efficiency. Water main replacement, in particular, increases the efficiency of water movement through pipes and by reducing embedded energy lost through leakage.

RECOMMENDATIONS AND NEXT STEPS

To begin to address these gaps, DOE should undertake the following actions:

- ✓ Convene leaders from major energy companies and water utilities to discuss critical areas where strategic planning and cooperation is needed to support climate resilience.
- ✓ Recognize sector leaders and develop robust sector energy data through supporting the Better Plants and Superior Energy Performance in the Advanced Manufacturing Office.
    - Catalog and advertise practices implemented by leaders to foster adoption.
    - Open these programs to more of the water sector: all utility types, ownerships, and sizes, particularly the numerous smaller utilities that may have limited resources.
- ✓ Develop efficiency savings protocols for the sector to facilitate performance and coordination through the Uniform Methods Project in the Energy Efficiency and Renewable Energy Office.
    - Recognize the need for water sector-specific measures due to the unique nature of distribution and collection systems and utility operations.
    - Launch a pilot for at least two sector-specific activities and a plan to develop more. Consider water loss control and protection from infiltration and inflow as possible pilots.
- ✓ Arrange for the Energy Information Agency to track data on biogas generation at wastewater plants in the same manner as other renewables (i.e., landfill gas).
- ✓ Grow water sector outreach from DOE's Industrial Assessment Centers (IACs).

- Direct the IACs to conduct outreach through the local affiliates available through several national water associations to encourage participation and share results.
- Aggregate both common and novel practices and data collected to enhance into the Wastewater Accelerator, Better Plants Program, and the Uniform Methods Project.

✓ Develop collaborative research opportunities with the water sector to advance research in:

- Lowering the cost and minimizing energy used for reuse of nontraditional water sources like wastewater, produced water, brackish groundwater, and stormwater.
- Estimating energy efficiency and demand response potential in the United States in water supply and drinking water systems and resource recovery facilities.
- Developing vehicle fuel and other beneficial products from wastewater.
- Enabling co-digestion of food wastes and organic waste streams with wastewater solids.
- Developing and demonstrating innovative membranes for water and wastewater treatment made of new materials that improve energy efficiency of processes.
- Demonstrating energy from wastewater technologies including hydrothermal liquefaction, microbial fuel cells, and anaerobic membrane bioreactors.
- Developing technologies to reduce the energy demand and cost of desalination.

CONCLUSION

The water sector has been engaged with DOE in addressing energy-water nexus issues through research, practice, and collaboration for decades and is positioned to make even greater significant advancements through increased collaboration with DOE. We wish to be strong partners with DOE and work together on these important issues. At the earliest opportunity, we look forward to speaking with you in more detail on the next steps we can take together to begin to address these critical needs.

CONTACT INFORMATION

Water Research Foundation Rob Renner Chief Executive Officer rrenner@waterrf.org p) 303-347-6150	**Water Environment Federation** Eileen O'Neill Executive Director eoneill@wef.com p) 703-684-2430
National Association of Clean Water Agencies Adam Krantz Chief Executive Officer akrantz@nacwa.org p) 202-833-4651	**American Water Works Association** David LaFrance Chief Executive Officer dlafrance@awwa.org p) 303-347-6135
Association of Metropolitan Water Agencies Diane VanDe Hei Chief Executive Officer vandehei@amwa.net p) 202-331-2820	**Water Environment & Reuse Association** Melissa Meeker Chief Executive Officer mmeeker@werf.org p) 571-384-2094
National Association of Water Companies Michael Deane Executive Director michael@nawc.com p) 202-379-2329	**U.S. Water Alliance** Radhika Fox Chief Executive Officer rfox@uswateralliance.org p) 415-921-9010