

NATIONAL WATER REUSE ACTION PLAN

COMPLETED ACTION



Action 4.6 Implement and Manage the National Alliance for Water Innovation (NAWI) Energy-Water Desalination Hub

Background

In 2020, the U.S. Department of Energy (DOE) established an Energy-Water Desalination Hub (Hub) as part of a family of Energy Innovation Hubs to address water security issues in the United States. The Hub represents a five-year, \$110 million investment by DOE in early-stage applied research involving U.S. universities, industry, and national labs. The Hub focuses on research and development (R&D) for energy-efficient and cost-competitive desalination technologies including manufacturing challenges, and for treating non-traditional water sources for multiple end-use applications.

Energy and water systems are interconnected. Energy is required to extract, treat, and deliver water. On the other hand, water is used in multiple phases of energy production and electricity generation, from irrigating crops for biofuels to providing cooling water for thermoelectric power plants. Purifying water for these processes can be energy intensive and becomes more difficult as levels of saline increase.

The strategic goal for the Hub is to conduct early-stage research on technology solutions to develop new water sources that are cost-competitive with existing water sources and end-use applications ("pipe parity"). The Hub uses several performance metrics and analysis tools to measure and assess its impacts.

DOE selected the National Alliance for Water Innovation (NAWI) to lead the Hub through a competitive funding opportunity process. The ongoing five-year research program is guided by an iterative road-mapping process designed to engage stakeholders from the water-treatment and water-use ecosystem and inform future funding opportunity announcements to solicit research ideas through a competitive, peer-reviewed evaluation and selection process. The NAWI team identified six challenge areas (called APRIME) for distributed water desalination and reuse that should motivate the research agenda for the Hub. These APRIME challenge areas are Autonomous water, Precision separations, Resilient treatment and transport, Intensified brine management, Modular membrane systems, and Electrified treatment processes.

Accomplishments/Impact

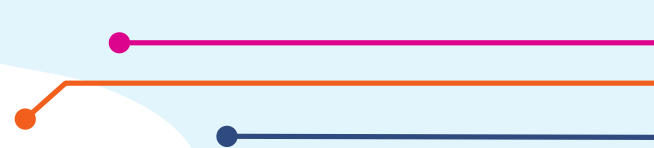
NAWI released a [Master Roadmap](#) in August 2021, which guides NAWI investments that could have transformative impacts on desalination in five end-use sectors that are critical to the U.S. economy, collectively known as PRIMA: Power, Resource Extraction, Industry, Municipal, and Agriculture. In addition to the Master Roadmap, NAWI developed individual PRIMA roadmaps that focus on the role of the five end-use sectors, provide an overview of each end-use sector, outline key technical challenges and associated knowledge gaps, and detail the research priorities and areas of interest that span early-stage research through deployment. The Master Roadmap and five PRIMA roadmaps ([power](#), [resource extraction](#), [industrial](#), [municipal](#), and [agriculture](#)) provide baseline analyses to support the research priorities of NAWI.

NAWI has defined and tracked progress towards achieving pipe parity in the highest impact areas by creating a

Action Team

Action Leaders

- **U.S. Department of Energy (DOE)**
 - Mark Philbrick
(mark.philbrick@ee.doe.gov)
- **National Alliance for Water Innovation (NAWI)**
 - Peter Fiske
(pfiske@lbl.gov)
 - Meagan Mauter
(mauter@stanford.edu)



central, strategic, and integrated data and analysis platform that aligns research across all topic areas with the [Water Data and Analysis Management Systems](#) (WaterDAMS) and [Water Technoeconomic Assessment Pipe-Parity Platform](#) (Water-TAP) tools.

The Water DAMS software provides access to foundational water treatment technology data that enable researchers and decision-makers to identify and quantify opportunities for technology innovations to reduce the cost and energy intensity of desalination. It is the submission point for all data generated by research conducted by the NAWI Alliance and is designed to be used by the broader water research community.

The WaterTAP is an analytically robust modeling tool that can be used to evaluate water technology cost, energy, environmental, and resiliency tradeoffs across different water sources, sectors, and scales. The model simulates steady-state water treatment train performance and costs including flow and constituent mass balance across unit processes, based on source water conditions, configurations of treatment technologies, and system-level technoeconomic assumptions.

In addition to the development and release of the WaterDAMS and WaterTAP tools, NAWI has awarded more than \$50 million to date to develop desalination and water treatment technologies to secure affordable and energy-efficient water supplies. The awards were focused on the following key topic areas:

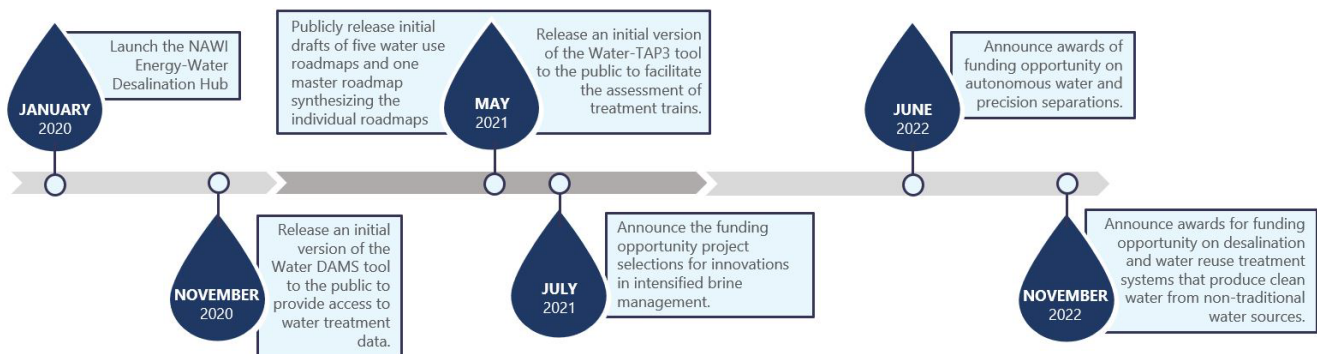
- [Intensified brine management technologies to bring freshwater supplies to communities across the nation](#) (\$5 million);
- [Innovative desalination technologies that can treat non-traditional water sources \(e.g., brackish water, seawater, and industrial wastewater\) and shrink the carbon footprint of the water treatment industry](#) (\$17.7 million);
- [Automation and creation of smart water systems and precision separations](#) (\$9.47 million);
- [Pilot systems that design, build, operate, and test desalination and water reuse treatment systems that produce clean water from non-traditional water sources](#) (\$5 million); and
- [Advanced pre-treatment, reverse osmosis concentrate treatment, brine valorization and grid-responsive desalination systems](#) (\$9 million)

Lessons Learned

NAWI identified and discussed challenges and knowledge gaps associated with desalination and advanced water treatment through its effort to develop the Master Roadmap. The Master Roadmap divides the challenges and knowledge gaps into two categories: technical challenges and non-technical challenges. Technical challenges include infrastructure integration, system variability, and residual management issues, and are the primary focus of NAWI's research to promote the use of non-traditional water. Non-technical challenges, including social challenges, regulatory challenges, and environmental challenges, are not the primary focus of NAWI; however, non-technical issues are important considerations in efforts to create desalination and advanced water treatment technologies. NAWI's subsequent research investments have spawned a range of breakthroughs in desalination including new membranes for ultrahigh pressure reverse osmosis, advanced electrocoagulation technologies that remove turbidity and can remove contaminants such as viruses and arsenic, and novel methods to reduce the formation of biofilms in reverse osmosis systems. The funded areas listed above represent the most impactful development opportunities that will ultimately motivate subsequent industry investments required to further enable the use of non-traditional water sources in a cost-effective manner.

The interconnection of the WaterDAMS and WaterTAP informs comprehensive calculations of technology performance and pipe-parity metrics. With publicly accessible contributions from a variety of academic industrial partners, WaterDAMS enables data discoverability, improves accessibility, and accelerates collaboration that contributes to pipe parity and innovation in water treatment technologies. The results obtained from Water TAP3 can help identify trade-offs among system performance metrics, with insight on how particular technologies or systems promote pipe-parity. The flexibility and comprehensive scope of the tools make them promising solutions to industry-wide water technoeconomic evaluations, leading to more informed water investment decisions and technologies.

Action Implementation Process



Potential Future Activity

NAWI's Master Roadmap is intended to guide future R&D investments throughout the duration of the research program. NAWI will update its roadmap periodically and encourages stakeholders to provide feedback on the forward-looking Master Roadmap via the NAWI [website](#). In successive roadmap iterations, the feedback will be used to assess the relevance of each research priority and evaluate progress toward enabling a water circular economy, while considering all relevant pipe-parity metrics.

NAWI will continue to provide funding opportunities for universities, industry, and national labs to advance NAWI's strategic goals of improving the energy efficiency of water treatment technologies and the diversification of water supply through the cost-effective utilization of non-traditional water sources across the United States. The technology advancements developed by the NAWI research program are geared to help domestic suppliers of water desalination systems to design and manufacture critical equipment, components, and small-modular and large-scale systems.

NAWI has the potential to be renewed for a second 5-year term starting in 2025. This second phase of the NAWI program would further develop and refine key water treatment technologies and field novel desalination and water reuse systems in field pilots around the U.S.

Additional Resources

- [Press Release: Department of Energy Announces \\$100 Million Energy-Water Desalination Hub to Provide Secure and Affordable Water](#)
- [Press Release: Department of Energy Selects National Alliance for Water Innovation to Lead Energy-Water Desalination Hub](#)
- [National Alliance of Water Innovation \(NAWI\) website](#)