COORDINATED STRATEGIC PLAN TO ADVANCE DESALINATION FOR ENHANCED WATER SECURITY

A Report by the

DESALINATION SCIENCE AND TECHNOLOGY TASK FORCE

SUBCOMMITTEE ON WATER AVAILABILITY AND QUALITY

COMMITTEE ON ENVIRONMENT

of the

NATIONAL SCIENCE & TECHNOLOGY COUNCIL

March 2019

About the National Science and Technology Council

The National Science and Technology Council (NSTC) is the principal means by which the Executive Branch coordinates science and technology policy across the diverse entities that make up the Federal research and development enterprise. A primary objective of the NSTC is to ensure science and technology policy decisions and programs are consistent with the President's stated goals. The NSTC prepares research and development strategies that are coordinated across Federal agencies aimed at accomplishing multiple national goals. The work of the NSTC is organized under committees that oversee subcommittees and working groups focused on different aspects of science and technology. More information is available at http://www.whitehouse.gov/ostp/nstc.

About the Office of Science and Technology Policy

The Office of Science and Technology Policy (OSTP) was established by the National Science and Technology Policy, Organization, and Priorities Act of 1976 to provide the President and others within the Executive Office of the President with advice on the scientific, engineering, and technological aspects of the economy, national security, homeland security, health, foreign relations, the environment, and the technological recovery and use of resources, among other topics. OSTP leads interagency science and technology policy coordination efforts, assists the Office of Management and Budget with an annual review and analysis of Federal research and development in budgets, and serves as a source of scientific and technological analysis and judgment for the President with respect to major policies, plans, and programs of the Federal Government. More information is available at http://www.whitehouse.gov/ostp.

About the Desalination Science and Technology Task Force

The Desalination Science and Technology Task Force (DST) was established on August 18, 2017, under the Subcommittee on Water Availability and Quality (SWAQ), by the action of the NSTC Committee on Environment, Natural Resources, and Sustainability (subsequently renamed the Committee on Environment). The purpose of DST was to assist OSTP in the preparation of a strategic plan that identifies opportunities and mechanisms for increased coordination and cooperation to support the development, access, and application of science and technology for the use of desalination to meet water availability needs. The purpose of SWAQ is to advise and assist the NSTC on policies, procedures, plans, issues, scientific developments, and research needs related to the availability and quality of water resources.

About this Document

This document addresses the Federal coordination activities required by the Water Infrastructure Improvements for the Nation (WIIN) Act, Pub. L. No. 114-322, 130 Stat. 1628, 3801 (2016). The WIIN Act reauthorizes the Water Desalination Act of 1996 and directs OSTP to develop a coordinated strategic plan for Federal investments in desalination research and development.

Copyright Information

NATIONAL SCIENCE & TECHNOLOGY COUNCIL

Chair

Kelvin Droegemeier, Director, OSTP

Executive Director

Chloé Kontos, NSTC

COMMITTEE ON ENVIRONMENT

Co-Chairs

Deerin Babb-Brott, OSTP
RDML Timothy Gallaudet, NOAA
Jennifer Orme-Zavaleta, EPA

OSTP Liaison

Stacy Aguilera-Peterson, OSTP

SUBCOMMITTEE ON WATER AVAILABILITY AND QUALITY

Co-Chairs

Michael Dunlevy, OSTP
Diana Bauer, DOE

Executive Secretary

Adrienne Bartlewitz, USGS

Members

David Babson, USDA
Gerald Bawden, NASA
Benita Best-Wong, EPA
Donald Cline, USGS
Peter Colohan, NOAA
Sandra Connors, EPA
James Dusenbury, TARDEC
Marlen Eve, USDA
Thomas Graziano, NOAA
Stephanie Hooker, NIST
David Lesmes, DOE
Guillermo Mendoza, USACE
Jayne Morrow, NIST
Martin Page, USACE
Chandra Pathak, USACE
Lina Patino, NSF
James Petro, DOD
David Raff, USBR
Jennifer Saleem Arrigo, USGCRP
Aaron Salzberg, DOS
Thomas Torgersen, NSF
Suzanne Van Drunick, EPA

Strategic Plan Writing Team

Paul Armistead, ONR
David Babson, USDA
Robert Bastian, EPA
Diana Bauer, DOE
Benita Best-Wong, EPA (DST Co-Chair)
Gilbert Bindewald III, DOE
Breton Bruce, USGS
Donald Cline, USGS (DST Co-Chair)
Peter Colohan, NOAA
Robyn Colosimo, TARDEC
Andre Defontaine, DOE
Saied Delagah, USBR
Jim Dobrowolski, USDA
Michael Dunlevy, OSTP
James Dusenbury, TARDEC
Erica Folio, DOE
Gerald Geernaert, DOE
Thomas Graziano, NOAA
Karen Grimmer, NOAA
Sally Gutierrez, EPA
David Hardy, DOE
Clayton Hays, DOS
Douglas Hedberg, TARDEC
Robert Ivester, DOE
William James, USACE
Melissa Klembara, DOE
Christin Kjelland, DOS
David Lesmes, DOE
Robert Lewis, DOE
Myrna Lopez-Ortiz, USACE
Carol MacCurdy, DOS
Marissa K. McInnis, DOD
Elena Melchert, DOE
Guillermo Mendoza, USACE (DST Co-Chair)
Karen Metchis, EPA
Avra Morgan, USBR
Jayne Morrow, NIST
Jennifer Moyer, USACE
Martin Page, USACE
Cherilyn Plaxco, USACE
Yuliana Porras-Mendoza, USBR
David Raff, USBR
Karl Rockne, NSF
Aaron Salzberg, DOS
Brandi Schottel, NSF
Tom Torgersen, NSF
Terferi Tsegaye, USDA
Deborah Vacs Renwick, EPA
Suzanne Van Drunick, EPA

Table of Contents

Abbreviations and Acronyms

DOD	Department of Defense
DOE	Department of Energy
DOS	Department of State
DST	Desalination Science and Technology Task Force
EERE	DOE's Office of Energy Efficiency and Renewable Energy
EPA	Environmental Protection Agency
EW	extracted water
MEDRC	Middle East Desalination Research Center
MEM	Middle East Multilaterals
NASA	National Aeronautics and Space Administration
NIST	National Institute of Standards and Technology
NOAA	National Oceanic and Atmospheric Administration
NSF	National Science Foundation
NSTC	National Science and Technology Council
ONR	Office of Naval Research
OSTP	Office of Science and Technology Policy
PPP	public-private partnerships
PW	produced water
R&D	research and development
TARDEC	U.S. Army Tank Automotive Research, Development, and Engineering Center
UNESCO	United Nations Educational, Scientific, and Cultural Organization
U.S.	United States
USACE	United States Army Corps of Engineers
USBR	United States Bureau of Reclamation
USDA	United States Department of Agriculture
USGCRP	United Stated Global Change Research Program
USGS	United States Geological Survey
WIIN	Water Infrastructure Improvements for the Nation Act

Executive Summary

Forty out of fifty State water managers expect freshwater shortages to occur in their states in the next 10 years.[1] Many of the states and regions with the most severe declines in water availability are also those expected to have the highest population growth in the coming decade.[2] In most cases, increased water conservation efforts by both utilities and users are the most cost-effective way to reduce demand and improve water security (the capacity of a population to safeguard sustainable access to adequate quantities of acceptable quality water). Beyond conservation, continued development is needed of technologies that support access to clean, potable water in order to ensure rural and urban prosperity, national and economic security, and health for all Americans. This *Coordinated Strategic Plan to Advance Desalination for Enhanced Water Security* presents the challenges and opportunities posed by the use of desalination technologies as a source of water resources for future needs.

This plan responds to Congressional direction outlined in the 2016 Water Infrastructure Improvements for the Nation (WIIN) Act (Public Law 114-322, § 9(b)). In accordance with the WIIN Act, a multi-agency Desalination Task Force was created to establish desalination priorities, coordinate relevant Federal Agencies, strengthen research and development (R&D) cooperation with our international partners, and to promote public-private partnerships in the area of desalination technology. This strategy identifies three overarching goals to support desalination efforts in the United States. Goals 1 and 2 highlight five R&D priorities identified by the Task Force to enhance water security. Goal 3 discusses three operational priorities to encourage international and private sector collaboration:

Goal 1: Reduce Risk and Streamline Local Planning to Support Desalination

Priority 1: Assess water resources and future needs

Priority 2: Develop desalination tools and best practices

Goal 2: Reduce Technical and Economic Barriers to enable Desalination Technology Usage

Priority 3: Encourage early-stage R&D

Priority 4: Develop small scale modular desalination systems

Priority 5: Advance technologies to reduce ecological impact

Goal 3: Encourage National and International Cooperation to Innovate and Develop Desalination Technologies

Priority 6: Improve Federal agency coordination

Priority 7: Promote public-private partnerships

Priority 8: Cooperate with international partners

The combination of these three goals provides a framework that could enhance the United States' capacity and capability to use desalination to combat the risk of future water scarcity (the lack of fresh water resources to meet water demand) in both communities and industry.

[1] https://www.gao.gov/assets/670/663343.pdf

[2] https://www.brookings.edu/research/in-times-of-drought-nine-economic-facts-about-water-in-the-united-states/

Introduction

Access to potable water is of critical importance across the United States. Eighty percent of State water managers expect freshwater shortages to occur in their states within the next 10 years — a trend that will likely impact American economic growth and social well-being.[3] As noted in the United States Geological Survey's (USGS) Professional Paper 1883, *Brackish Groundwater in the United States,*[4] the demand for water may stress supply as the United States' population and economy grow.

Severe water shortages are already found all around the world, such as California's drought that started in 2011 and has been the driest in its recorded history and may result in agricultural losses up to $1.8 billion;[5,6] Australia's devastating millennium drought in the 2000s;[7] and Cape Town, South Africa's need for water rationing in 2018.[8] Droughts will continue to stress water supply systems around the world, and natural disasters, such as hurricanes, can result in temporary water shortages by compromising source quality or treatment infrastructure. Overall, water scarcity presents a significant economic and social vulnerability for the world.

Reductions in available fresh surface and ground water can stress operations of municipal water utilities and pose a threat to U.S. water security (for the purposes of this report, the definition of water security was adapted from the United Nations and is the capacity of a population to safeguard sustainable access to adequate quantities of acceptable quality water[9]). Specifically, in some regions, groundwater withdrawals exceed the rate of recharge and seawater intrudes into coastal aquifers, both of which reduces the availability of potential sources of potable water.[10] Technological solutions along with conservation and other water management strategies are needed to increase the reliability of water supplies in water scarce regions to meet future demands and alleviate episodic shortages. Expanding a community's water supply portfolio to include desalination can help to enhance water security by reducing competition for water with other communities and water demand sectors, such as agricultural irrigation or energy generation.

Desalination of seawater, estuary, and brackish groundwater (types of water with varying levels of salinity) provides opportunities to enhance water security by converting non-consumable saline water into drinkable water in regions where freshwater resources are becoming limited due to droughts or increases in demand. Desalination can also be used to provide sources of water for non-potable uses, such as mineral extraction, reuse in the oil and gas industry, and in manufacturing processes, offsetting demand for potable sources.

Water desalination plays an important part in the water security portfolio of the United States. As of 2010, there were 649 active desalination plants in the United States with a capacity to treat 402 million

[3] https://www.gao.gov/assets/670/663343.pdf

[4] https://pubs.usgs.gov/pp/1833/pp1833.pdf

[5] https://www.drought.gov/drought/states/california

[6] http://www.cobank.com/-/media/files/ked/general/california-drought-report---may-2016.pdf

[7] https://www.environment.sa.gov.au/topics/river-murray/about-the-river/millennium-drought

[8] http://www.capetown.gov.za/Family%20and%20home/Residential-utility-services/Residential-water-and-sanitation-services/critical-water-shortages-disaster-plan

[9] http://www.unwater.org/publications/water-security-global-water-agenda/

[10] https://water.usgs.gov/edu/gwdepletion.html

gallons of water per day. The majority of domestic municipal water desalination facilities are sourced from brackish groundwater;[11] in contrast, the international community primarily uses seawater for desalination. Given the diversity of water sources and technologies, greater international R&D cooperation should be encouraged to facilitate the sharing of desalination approaches and expand our Nation's water source options.

Desalination technologies can and should be adapted to meet different local demand characteristics. The specific desalination processes and related water systems that are most cost-effective, reliable, and technically viable depend upon the quality of the source water, types of water collection and distribution systems, population density, and other local factors. A number of challenges limit the adoption of desalination to augment water supplies in the United States, especially in low population density areas where desalination is not currently affordable, and in many cases, where centralized water systems may be unavailable or not cost effective. Challenges with implementing desalination facilities for water supply include:

- Higher energy requirements than traditional fresh surface water treatment facilities.
- High capital investments and operating costs compared to traditional fresh surface water treatment facilities.
- Design requirements, such as operational flexibility to account for changes in freshwater production demand, temperature, or salinity concentration; or facility size, siting, and target water production.
- Reliability and durability of components and materials in the desalination process that affect operation and maintenance costs.
- Environmental impacts, including concentrated brine discharge and various effects of ocean water intakes on marine ecosystems.
- Non-technical barriers such as complex State and Federal regulatory and permitting processes, municipal funding, and public acceptance of non-traditional water sources.

R&D can help address several of these challenges, but adoption of desalination technology is ultimately a local issue, where decision makers must also consider a portfolio of other alternative water supply options, including: diversions (transporting water from other locations), improving efficiencies, water conservation and reuse, reallocation of water from other sectors, and improving operations.

[11] https://pubs.usgs.gov/pp/1833/pp1833.pdf

Goal 1. Reduce Risk and Streamline Local Planning to Support Desalination

Water utility infrastructure investments are largely non-Federal and managed by local entities. However, risk reduction and streamlined local planning should be a shared responsibility across communities as well as State and Federal agencies. Local institutions understand their system vulnerabilities and redundancies, and Federal agencies can complement local institutes with their research capabilities and resources. This section outlines and discusses two priorities for future Federal investments that support local assessments and best practices in desalination planning, with the goal of promoting American water security.

Priority 1. Assess water resources and future needs

To improve our Nation's water security, Federal capabilities should be coordinated to better understand regions vulnerable to water scarcity. Water scarcity information could then be used to better determine situations where desalination would be a viable option to improve water security and would help identify technology improvements needed to increase desalination deployment in these regions.

Understand future water availability

Understanding water quantity and quality needs across the United States is critical for planning our Nation's long-term water security. Existing Federal and State data should be coordinated and enhanced to assess projected imbalances of water supply and demand at local and regional scales. Federal agencies usually have the technical resources and missions to support water availability studies, particularly at large spatial and long temporal scales. However, water balance studies at the local level are needed to improve water availability projections that serve the needs of local utilities. This is especially relevant with respect to assessing future stresses and finding opportunities to use desalination technologies to improve water security.

Developing best practices to ensure an accurate understanding of future water availability is enhanced by integrating research and sharing data among Federal, State, Tribal, academic, and private sector institutions. Improved forecasts can identify changes in water supply due to stressed aquifers, water table declines, variability of supply (e.g., snow melt dependent areas), coastal seawater encroachment, and competing demands.

Federal agencies should strive to ensure that data and tools that are developed are discoverable, accessible, and usable by relevant stakeholders, including water utilities, investors, and the R&D community. These data should also be periodically updated to take into account changes in industrial demands as industries grow and change over time. Local communities should then be able to utilize these data and tools to develop strategic plans that will improve their ability to assess future water needs and improve the resiliency of their community.

Hydrological data and modeling is central to understanding water availability, and a number of Federal agencies collect, analyze, and share this information. For example, USGS's Water Resources Mission Area provides an assessment of the status of water resources in the U.S. and identifies long-term trends in water availability and quality; the Department of Energy's (DOE) Sandia National Laboratory has developed a Water Report[12] of the contiguous 48 States illustrating projections of future water

[12] https://www.osti.gov/servlets/purl/1411877

availability and demand; and National Oceanic and Atmospheric Administration's (NOAA) National Water Center is used to leverage expertise and investments across Federal agencies and academia to improve water prediction and coordinate development of the National Water Model[13], which is a hydrologic model that simulates observed and forecasted streamflow over the continental United States. While the Federal Government is developing multiple data sets to support water availability projections, more work is needed to systematically integrate Federal data to support local and State stakeholder needs and to help them determine whether desalination is an economically viable method to improve the water security of their jurisdiction.

Improving forecasts of water availability is also consistent with priorities outlined in Presidential Memorandum, *Promoting the Reliable Supply and Delivery of Water in the West*, issued by Donald J. Trump on October 19, 2018. This memorandum highlights the need to facilitate greater use of forecast-based management and use of authorities and capabilities provided by the Weather Research and Forecasting Innovation Act of 2017. The memorandum also calls for the development of an action plan to improve the information and modeling capabilities related to water availability and water infrastructure projects. Overall, the initiatives and future work outlined above will enhance water security in America.

Map brackish groundwater systems

According to a 2010 report by USGS[14], almost a quarter of total U.S. water withdrawals were from groundwater, of which almost 5% were saline. Mapping groundwater systems, especially as salinity levels increase or groundwater tables become depleted, is important to prepare communities for evolving water security conditions.

Monitoring and characterizing groundwater flows is expensive and assessments require a systems approach because surface-groundwater interactions and their impacts to saline water table gradients can be complex. Independent wells present further complications, as they affect groundwater table gradients, but are not often monitored. Moreover, lag-times between surface and groundwater recharge can range from hours to decades.

The goal of brackish groundwater R&D should be to estimate the size of potential brackish sources, the source replenishment rate, the extent and nature of source salinity, and other physical characteristics of different source types. These estimations can help decision makers better determine sustainable production rates and desalination requirements. Furthermore, such analysis needs to be useful for and accessible to water utilities or other local institutions for conducting water security vulnerability assessments.

To help improve the understanding of available water resources, the USGS is conducting a national assessment of brackish water aquifers. This assessment is designed to identify and characterize brackish water availability and assess the national ability to meet both existing and future demands for water supply. Further, the United States Bureau of Reclamation (USBR) and USGS are collaborating to develop a web-platform where interested entities can find tools to better utilize the brackish water aquifer data that USGS has been collecting. This effort is currently ongoing and it will integrate not only the data collected in terms of water quantity and quality, but will also provide guidance as to the type of water treatment technology that would be useful to treat the specific groundwater in a given

[13] http://water.noaa.gov/about/nwm

[14] https://pubs.usgs.gov/circ/1405/pdf/circ1405.pdf

location. Once complete, this platform will allow water resource managers to better understand whether desalination technology is viable for their community.

Assess local water vulnerabilities

Vulnerability assessments allow water utilities to plan and prepare for future water shortfalls. These assessments should be driven at the local level, but Federal agencies can provide data, tools, and models that help estimate current and future water availability.

The Federal Government conducts ongoing work focused on assessing water vulnerabilities. For example, the National Aeronautics and Space Administration's satellite and Earth system models provide insight into water basin hydrology, drought extents, and forestry and irrigation consumption estimates. The National Water Model has capabilities that can forecast streamflow across the United States and helps water resource scientists model different scenarios that allows them to better understand and forecast the water availability in regions across the United States. DOE has mapped regional water availability and makes annual estimates (through 2030) of appropriated and unappropriated water. This data has been integrated into a version of the National Energy Modeling System[15], which provides a framework for the comprehensive assessment of the impacts of water availability on projections of energy generation, and thereby the energy economy.

Public water utilities and local agencies have critical data and information external to Federal activities, including local water redundancies, visions for growth, and possible alternative sources of water. Therefore, effective water vulnerability assessments require combined local and Federal information and resources. Federal information needs to be useful, useable, and accessible to local users for analysis, while data from local agencies needs to be accessible by Federal agencies for use in National models. This integration of local and Federal data is fundamental to conducting water vulnerability studies. Local utilities and communities can improve their resiliency by assessing local water supply vulnerabilities. Building a culture of preparedness and improving community resilience is a priority action for the Administration, as outlined in the 2017 National Security Strategy.

Priority 2. Develop desalination tools and best practices

A culture of preparedness is fostered not only by local vulnerability assessments of future water security, but also by community access to state-of-the-art tools and best practices. The development of tools based on best practices and past experiences can facilitate the integration of desalination infrastructure in local and regional water portfolios. Federal R&D on siting and design could help local, State, and Tribal governments identify desalination supply opportunities, comply with environmental requirements, evaluate alternative design proposals, and justify resource investments in desalination technology. Providing education about these resources and how to use them is a critical factor in successfully integrating and disseminating resources, data, and tools across Federal, State, and local partners. Without education, many benefactors may not have the resources, staff, or technical expertise to fully leverage the tools and information presented in this Strategic Plan.

Establish best practices for local desalination facility planning

Best practices and tools created by Federal agencies to support desalination facility planning and development need to be relevant and accessible by local communities. These tools should help

[15] http://www.eia.gov/outlooks/aeo/nems/overview/index.html

synthesize information from a variety of sources and communicate uncertainty and potential variability in different parameters over time. The tools should consider site specific infrastructure requirements, social and economic factors, and treated water quality objectives, which are important in the planning and design of desalination facilities. Tools developed by Federal agencies should also assist communities in determining whether desalination is the most technically and economically viable option given future water security and scarcity risks.

Best practices can help private industry as well as State, local, and Tribal governments inform siting and design of desalination facilities, particularly regarding location, capacity, technology, storage, and delivery. Best practices should allow stakeholders to fully understand the supply chain of water (acquiring salt water, moving water, pre-treatment, treatment, removing residues, and managing the energy requirements) and identify and leverage coupled water-power facility opportunities. Best practices that help minimize unintended consequences of desalination is also important, as it requires a systems level of understanding. Potential consequences that should be considered include: the cumulative effects of pumping from groundwater aquifers over time, the effect of the chemical composition of desalinated water on pipelines and other water supply infrastructure originally built to accommodate traditional sources of water, the energy intensity of the desalination process, and the cumulative ecosystem effects of brine discharge from desalination facilities. A comprehensive approach that considers these best practices are essential to sustainable and resilient outcomes.

Providing local planners with best practices can be conducted through Federal or State planning resources. For example, the USBR offers various grants to State, local, and Tribal governments to develop strategies that establish or expand water markets or marketing activities between willing participants, in compliance with State and Federal laws.[16] Federal agencies should consider using similar types of programs that provide needed support to help State, local, and Tribal stakeholder's site desalination facilities.

Enhance environmental compliance resources and tools

Compliance with Federal and State environmental regulations is an important consideration when investing in desalination strategies, but multijurisdictional requirements can inadvertently create barriers to adoption of desalination technology. Federal, State, and local environmental concerns with desalination technology include impacts to marine life from seawater intakes, disruption of marine ecosystems from concentrate discharge, the energy intensity of the desalination process, and the potential degradation of water quality. Furthermore, potential ecosystem impacts depend on site-specific circumstances and local environmental conditions that may change over time, thereby requiring careful monitoring and management.

Efficient environmental compliance helps better manage the environmental risks of desalination facility siting, construction, and operations to marine, estuarine, and terrestrial environments. In order to make sure these processes are a focus when developing desalination operations, Federal agencies can recommend guidance to facilitate environmental compliance. For example, NOAA coordinated the use of best practices for siting and developing desalination projects with respect to environmental impacts and the regulatory process for a site in California.[17]

[16] https://www.usbr.gov/watersmart/

[17] https://nmsmontereybay.blob.core.windows.net/montereybay-prod/media/resourcepro/resmanissues/pdf/050610desal.pdf

More research into the impacts to marine life from desalination water intake structures and concentrate discharge systems is needed. Intake and discharge systems can affect marine organisms directly through impingement and entrainment or indirectly through disruption of ocean currents and other mechanisms. Quantifying these impacts requires an understanding of the local life cycle of fish, invertebrate eggs, and larvae, which vary widely and are influenced by location-specific parameters. Discharge from desalination facilities is also a concern due to salinity dispersion, effects of chemicals used during pretreatment, and leaching of metals from piping. As a result, a monitoring protocol and a marine ecosystem health baseline should be integrated into the planning process for desalination facilities.

Technical guidance tools can improve understanding of the effectiveness and economic viability of various measures to minimize the environmental impacts of desalination systems. For example, USBR is developing a concentrate management toolbox[18] focused on informing and providing guidance to water utilities regarding the technologies available for concentrate management and their levels of readiness. USBR partnered with the private sector and two water utilities in California and Texas to develop and test the toolbox. However, in order for environmental compliance resources and tools to remain effective, they must be constantly updated reflecting new guidance, regulations, and research into the environmental impact from desalination technology.

If utilized, these tools will allow communities to evaluate the effectiveness of competing water security strategies, as well as help them understand the economic impact and regulatory requirements for implementing a desalination strategy. Similarly, it is critical for communities to have the ability to compare alternative options for brine management, concentrate disposal, and water recovery technologies. Federally developed tools are needed that can evaluate and compare the cost and environmental risk of different technological and management approaches for concentrate disposal. These tools would help desalination plant designers, owners, and operators select which technology fits best with their needs.

[18] https://www.usbr.gov/research/projects/detail.cfm?id=5239

Goal 2. Reduce Technical and Economic Barriers to Enable Desalination Technology Usage

Early research on desalination technology began during World War II to address the challenges of providing reliable fresh water in remote locations under difficult logistical conditions. The Saline Conversion Act of 1952 established the Office of Saline Water, which later became USBR's Office of Water Research and Technology. The Federal Government sponsored research conducted by companies on different materials for membrane (a semi-permeable material that allows passage of water and inhibits passage of salts) development to support desalination and by the 1960s, commercial use of thin-film reverse osmosis technology was introduced. This cutting-edge research provided ancillary benefits, such as technologies for kidney dialysis and flue gas desulfurization to reduce air pollution.[19] The effective and innovative Federal research of that era ensured that by the early 1970s, the United States was the undisputed global leader in desalination technology. During this time, the first practical membrane for desalination was developed, and groundbreaking discoveries were made on pressure driven membrane technology that could be applied commercially. Despite U.S. investment in desalination technologies for the past 65 years, there are still technical and economic barriers to widespread adoption of desalination technologies.

A number of initiatives to enable the use of desalination technology are in the early-stages of development. Specifically, President Donald J. Trump's Presidential Memorandum, *Promoting the Reliable Supply and Delivery of Water in the* West, highlighted the need to improve the use of technology to increase water reliability. The memorandum states, "the Secretary of the Interior shall direct appropriate bureaus to promote the expanded use of technology for improving the accuracy and reliability of water and power deliveries. This promotion of expanded use should include: investment in technology and reduction of regulatory burdens to enable broader scale deployment of desalination technology." While outside of the scope of this Strategic Plan, the Presidential Memorandum also highlights the importance of streamlining complex regulatory processes, which would help enable the adoption of desalination technology.

On October 25, 2018, the Secretary of Energy announced a Water Security Grand Challenge[20] "to advance transformational technology and innovation to meet the global need for safe, secure, and affordable water." One of the goals for the Grand Challenge is to "launch desalination technologies that deliver cost-competitive clean water." These initiatives coupled with the priorities outlined in this report will help promote efficient and effective desalination technology usage to support sustainable water supplies for urban and rural centers, as well as for military, disaster relief, and humanitarian uses.

Priority 3. Encourage early-stage R&D

Federal support of basic research can improve the viability of desalination technology for use in many situations. R&D should address broad technological questions, including both treatment and pre-treatment technology development requirements. Moreover, it is important to facilitate the transfer of promising technologies from lab-to-market, which will ultimately result in further innovations, and is a component of the *President's Management Agenda.*[21] Further, Federal investment in early-stage applied

---

[19] https://www.nap.edu/catalog/12184/desalination-a-national-perspective

[20] https://www.energy.gov/water-security-grand-challenge

[21] https://www.whitehouse.gov/wp-content/uploads/2018/03/Presidents-Management-Agenda.pdf

research in innovative technologies, enhancing the transfer of technology from lab-to-market, and establishing public-private collaborations are R&D priority practices discussed in the *FY 2020 Administration Research and Development Budget Priorities* memorandum.[22]

Support Federal early-stage research

Developing new membrane desalination processes and improving existing membrane technologies will reduce energy and other costs associated with membrane based desalination. R&D is needed to increase membrane permeability and selectivity, decrease fouling and degradation, minimize maintenance, and increase membrane life expectancy for both steady state and intermittent operation. In addition to membrane based treatments, non-membrane approaches are being investigated. These include both thermal desalination as well as environmentally based approaches that rely on wetlands or bacterial based techniques, which could lead to alternative desalination technologies. Under certain conditions, these non-membrane systems may be more efficient and cost-effective than traditional reverse-osmosis systems. Different parts of the country will require different desalination technologies, and the technology choice should be assessed at the local level. Therefore, the development of cost effective desalination and treatment technologies need to align with the varying needs of diverse communities.

Nearly all approaches to desalination require some sort of pretreatment to remove suspended solids. While desalination costs and energy requirements have been reduced with better reverse osmosis membranes and energy recovery technologies, the costs of pretreatment remains high. Continued research into these complementary components of the desalination process is key to reducing technical and economic barriers to enable the adoption of desalination.

Opportunities also exist to reduce energy costs by co-locating desalination facilities with power plants and other energy facilities. Other examples for system integration include the development of energy recovery systems, combined energy-water production, landfill gas-to-energy facilities, and other onsite sources of renewable energy.

Federal R&D should be flexible so that it can address special desalination technology needs that are important to national economic, social, and environmental interests. One area of interest involves produced water (PW) [water produced as a byproduct of oil and gas production], as it represents the largest volume of waste associated with oil and gas extraction.[23] PW contains a wide variety of contaminants, including oil and grease, suspended solids, heavy metals, and radionuclides and is typically not considered appropriate as a source of drinking water. However, after processing, multiple industries can reuse PW, which would preserve freshwater resources for other uses. Technological advances for the treatment of PW could save the energy industry more than $40 billion annually in treatment and disposal costs.[24] Similarly, a significant amount of extracted water (EW) results from carbon dioxide injections into deep saline aquifers. Reusing PW and EW provides opportunities to improve our Nation's water security, which is consistent with the 2017 National Security Strategy[25] to "improve America's technological edge in energy [through] opportunities at the energy-water nexus."

---

[22] https://www.whitehouse.gov/wp-content/uploads/2018/07/M-18-22.pdf

[23] https:/www.usbr.gov/research/dwpr/reportpdfs/report157.pdf

[24] http://www.spe.org/industry/challenges-in-reusing-produced-water.php

[25] https://www.whitehouse.gov/wp-content/uploads/2017/12/NSS-Final-12-18-2017-0905-2.pdf

R&D focused on PW and EW treatment and desalination can contribute to PW and EW becoming a viable water source for various industries, which improves the Nation's water security. Cost-effective desalination of these sources could offset water demand from agriculture, mineral extraction and processing, oil and gas production, and manufacturing processes. Currently, DOE and USBR[26] are conducting R&D to reduce the cost of treating PW and EW. These targeted R&D goals would complement innovations in desalination technology, which is consistent with a goal from the Water Security Grand Challenge to "transform the energy sector's produced water from a waste to a resource."

More R&D is needed to identify added value along the desalination supply chain, such as markets for sellable byproducts from the concentrated brine, which would help improve the economic viability of desalination technologies and reduce potential environmental risks from brine disposal. Investing in R&D in these areas could improve the economic case for using desalination technologies, which would provide the private sector with the confidence needed to invest in these technologies.

In order to effectively leverage existing R&D in desalination technologies, more coordination is needed between the Federal Government and other stakeholders. To help improve coordination, grants that support joint research partnerships with academia, Federal labs, public utilities, and relevant industries are necessary to support the diverse regional challenges associated with desalination technology. Federal agencies do offer grants that support collaboration; specifically, the National Science Foundation (NSF) accepts proposals for collaboration between academia and industry on early-stage technologies through its Grant Opportunities for Academic Liaison with Industry mechanism. Additionally, NSF also funds research centers that involve groups of universities and, when appropriate, industry partners, such as the Nanosystems Engineering Research Center for Nanotechnology-enabled Water Treatment.

In order to improve early-stage research, existing Federal research programs should support foundational or high impact advanced technologies, use project diversity to spread risk, target nationally important innovations at critical decision points, and contribute to quantifiable energy savings. Every agency has unique capabilities that can be leveraged in coordinated R&D to advance desalination technology.

Operationalize early-stage technology

One immediate challenge to operationalizing early-stage desalination technology is the significant life-cycle gap that exists between initial demonstration of a new technology and its commercial implementation at the end of development. Newer technologies are often at lower technical readiness levels and require more time, effort, and resources to integrate with existing components. Often, scaling up pilot trials to full-scale is exceedingly complex and expensive, especially with new membrane technologies. It is important not to underestimate the complexity and challenge of integrating and scaling up new technologies. Accordingly, there is a need to use existing facilities for pilot and full-scale testing in order to capitalize on R&D investments and maximize commercialization of promising technologies. Currently, USBR has several facilities[27] and the U.S. Navy utilizes the Seawater Desalination Test Facility for R&D, testing, evaluation, and training, which can be made available to industry and other organizations. These are critical Federal capabilities, given that full-scale testing is often the key to successful lab-to-market transitions and private sector adoption. Successfully

[26] https://www.usbr.gov/research/projects/detail.cfm?id=1601

[27] https://www.usbr.gov/research/labs-facilities/index.html

translating laboratory R&D to the commercial market is an R&D priority practice, as outlined in the *President's Management Agenda* and the *FY 2020 Administration R&D Budget Priorities* memorandum.

Priority 4. Develop small scale modular desalination systems

The United States is committed to modernizing rural water utilities to ensure rural communities have access to clean water, as noted in the response to Executive Order 13790, *Promoting Agriculture and Rural Prosperity in America*.[28] Lower population densities can result in poor incentives for modernizing water utilities, despite the potential for higher water scarcity in rural economic sectors (especially west of the Mississippi River), due to irrigation, mining, or industry that compete with household water consumption. As a result, more options to improve access to clean water are needed, such as the development of small scale modular desalination systems.

Small scale desalination technologies

The ability to downscale desalination technologies provides options for rural, island, and Native American communities that may face future water scarcity and have limited alternative sources of water. For areas where underserved and disadvantaged populations do not have reliable access to high quality and affordable drinking water, desalination may be a viable technological solution to help address ongoing water security challenges.

Developing and improving small, distributed, and/or portable desalination units have a number of uses outside of improving regional water security, such as deployment for emergency response, military, agriculture, and treatment of PW and EW from oil and gas extraction. Improvements in engineering design and pump efficiency for small scale units would increase desalination system efficiency, reduce costs, and enhance water system resilience. Therefore, early-stage R&D in desalination should address the specific challenges presented by applications in smaller communities.

R&D for downscaled desalination facilities should enhance reliability, reduce operational complexity, and prioritize self-sufficiency. In general, military R&D in desalination is very much in line with applications for disaster relief and water resiliency in isolated communities. The U.S. Army Tank Automotive Research, Development and Engineering Center, (TARDEC) is currently developing a 3,000 gallon per hour Tactical Water Purification System for the Army. This system incorporates new energy recovery technologies to improve energy efficiency. Although typical military desalination units, especially in the Navy, are designed with more expensive anti-corrosive and non-flammable materials for increased ruggedness, the designs for these units could be adapted for civilian use.

Overall, small, distributed, and/or portable desalination units have a number of potential uses, including improving access of rural and remote communities to potable water, deployment during emergencies to provide drinkable water, and for the treatment of PW and EW. More R&D is needed to reduce costs, evaluate residual brine management options, and improve the efficiency of these systems to make them a viable option for users.

Couple desalination with renewable energy

When considering adopting desalination technology, remote, rural, and island communities are often constrained by access to reliable and low-cost energy. Facilities that couple renewable energy production to desalination would provide opportunities for desalination in communities with limited

[28] https://www.usda.gov/sites/default/files/documents/rural-prosperity-report.pdf

sources of energy, and would also support the development of rugged desalination technologies that can handle disruptions in the electrical grid from events such as natural disasters. In isolated island communities, technologies that use solar, hydrokinetics, and marine power (the generation of power from marine tides, currents, and waves) can be harnessed to reduce the cost of desalination, where power is a limiting factor to implementation. R&D in coupling renewable energy with desalination should be geared towards identifying implementable technologies for remote or island communities that are cost effective and attractive to investors.

While most desalination plants in the United States utilize reverse osmosis technology powered by electricity, there may be opportunities for improved cost-competitive technologies that use solar-thermal energy directly. Using solar-thermal energy avoids the efficiency loss resulting from conversion of electricity to thermal energy, while also enabling off-grid operation. DOE's Office of Energy Efficiency and Renewable Energy (EERE) Solar Energy Technologies Office develops novel concentrated solar power technologies and concepts that convert solar energy to useful thermal energy primarily for electricity generation, but could be used to power desalination as well. Similarly, DOE's EERE Water Power Technologies Office funds early-stage R&D to in the emerging fields of hydrokinetic wave, current, and tidal energy technologies. Wave and tidal power technologies can provide locally-sourced and reliable energy to coastal communities and ocean industries. Further, wave energy is one of the few technologies that can produce clean water without the need to convert energy to electricity, which is advantageous in locations where grid-connected electricity is unreliable or costly, such as a remote island, during an emergency, or to support military operations. Direct coupling of desalination technology with renewable energy resources is still an emerging field of research. More research is needed that couple these technologies together in a cost effective manner that would allow for expanded use beyond early-stage prototypes.

Priority 5. Advance technologies to reduce ecological impact

Environmental and public health concerns are often a barrier to desalination adoption. The unintended impacts of brine disposal and desalination plant intake and discharge can be detrimental to local marine ecosystems and their reliant economies. Monitoring for desalination impacts on marine life is frequently limited. Encouraging R&D to assess the ecological impacts of desalination can safeguard our natural resources and guide responsible development in the future. Advances in technology can create more efficient systems to reduce the energy requirements and associated emissions of desalination. Mechanisms such as coupling existing electricity generation plants with desalination facilities, or linking desalination facilities with renewable sources of energy such as solar, could remedy desalination's high-energy requirements and reduce harmful ecological impacts. Capabilities at the Department of Defense, Department of the Interior, Environmental Protection Agency (EPA), DOE and NOAA should be coordinated to advance the R&D discussed in this section to help reduce the ecological impact of desalination technologies.

Minimize effluent

Early-stage Federal R&D can facilitate industry investments in the desalination process by determining innovative ways to manage concentrates or reduce the volume of brine generated from current inland desalination treatment processes. For example, USBR has been funding research into concentrate management for decades and has been performing full-scale testing of innovative technologies that enable zero liquid discharge. The U.S. Army Engineer Research and Development Center is developing an energy-efficient system for managing brine from reverse osmosis processes in deployed military settings. This system uses waste heat from electrical generators to rapidly dry brine concentrate streams while recovering the evaporated water. Several technologies developed by Federal agencies have already been adopted by industry, such as use of a novel non-thermal brine concentrator and technology that reduces crystal growth during the desalination process. The commercialization of these technologies developed from Federal R&D demonstrates the value of these types of projects.

Reduce environmental impact from water intake systems

Open water intake systems may have impacts on the marine environment, including directly through impingement and entrainment of aquatic organisms. Effects of intake systems vary due to site-specific circumstances and local environmental conditions. R&D is needed to improve technologies to reduce environmental impact from desalination water intake systems and to meet standards set by local, State, and Federal environmental regulations.

Monitor and minimize negative impacts on aquatic ecosystem health

Quantifying impacts on ecosystem health from desalination facilities requires an understanding of a broad range of effects, which vary widely and are affected by a number of location-specific parameters, such as the local natural mortality rate of fish, invertebrate eggs, larvae, animal reproductive rates, and other biological parameters and ecosystem functions. Future research should characterize, evaluate, and minimize the impact of seawater desalination discharge on marine ecosystems, including modeling salinity discharge and plumes, analyzing local effects of brine disposal at the point of discharge, sampling pretreatment chemical discharge, and developing sensing and communication tools for controls.

Goal 3. Encourage National and International Cooperation to Innovate and Develop Desalination Technologies

Different parts of the United States and world have been forced to innovate and develop desalination technologies to ensure that their livelihoods and ways of life are not threatened by water scarcity. Every region that has developed a substantial desalination portfolio has unique experiences that contribute to a playbook of lessons that can be shared with others. Similarly, each U.S. Federal and State agency, local water utility, industry provider, non-profit organization, and research institution have unique missions, capabilities, experiences, and requirements that can be further coordinated for a more efficient R&D process. More effective collaboration is needed across national and international communities to share these experiences, best practices, and lessons learned, to further workforce readiness and the development and innovation of desalination technologies to promote global water security.

Priority 6. Improve Federal agency coordination

Experience has shown that strong coordinating frameworks between Federal agencies and other stakeholders involved in desalination result in effective and applicable R&D. Each agency has unique capabilities, resources, and networks that should be coordinated in support of utilizing desalination to enhance water security.

Federal agencies can use new or existing agreements to support coordinated cross-agency desalination R&D. There are several Federal agency working groups that are particularly relevant to desalination technology development, including the Water Treatment Working Group, which is coordinated by USBR and TARDEC and provides an existing framework for interagency coordination, networking, technical development, and technology transfer for water treatment and desalination related research; the National Nanotechnology Coordinating Office, which launched a Nanotechnology Signature Initiative on Water Sustainability;[29] and the National Science Technology Council, Committee on Environment, which provides a valuable venue for coordinating and aligning cross-agency efforts with U.S. science and technology policy. In addition to working groups, there are several short term interagency R&D agreements that have provided a successful mechanism for coordination, such as the Expeditionary Water Unit Purification Program framework that supported Navy research in desalination. In all research efforts, Federal agency coordination should be coupled with U.S. science and technology policy.

While interagency agreements are important to coordinate R&D on the national level, it is important to also coordinate with State, regional, local, and Tribal governments, and non-profit organizations, as the bulk of water infrastructure investment occurs at the local level. By partnering with the Federal Government, these groups can best organize the testing and implementation of innovative water technologies across multiple regions, as well as understand potential funding opportunities.

Streamlining investments and implementation require various avenues of coordination among Federal, non-Federal (public and private), and international partners. Desalination R&D efforts should encourage collaboration with agreed upon outcomes that support at least one of the priorities listed in this document, and the Federal Government should make federally funded desalination research results more accessible and useable by both private and public entities.

[29] http://www.nano.gov/nsiwater

Priority 7. Promote public-private partnerships

Public-private partnerships (PPP) can help the Federal Government enhance water security to create a streamlined, accountable, and more efficient government that works for the American people. PPPs play a critical role in meeting all of the R&D priorities outlined in this report. There are many different levels of public or private sector engagement in PPP contracts. For example, Federal agencies could engage the private sector to expedite siting and determine the most acceptable location for a new facility. The private sector could support the design of desalination facilities, such as devising the best mechanisms for operating and managing a newly created membrane in a water treatment plant. Federal agencies can leverage financial tools to stimulate private investment and further support local decision making to determine if desalination facilities are appropriate for their community.

Engaging the private sector

The Federal Government should establish more public-private R&D partnerships to engage the private sector, consistent with direction outlined in the *President's Management Agenda* and the *FY 2020 Administration R&D Budget Priorities* memorandum. DOE's Advanced Manufacturing Office provides good examples of successful public-private R&D Consortia, as it leverages scientific and technical expertise from national labs, universities, and private industry on high impact problems. In addition to partnerships, the private sector can be engaged through Federal prize and challenge competitions, such as those authorized by the America COMPETES Act.[30]

Competitions may produce technological, operational, policy, or commercial innovations by engaging a broad set of cross-disciplinary actors and driving new R&D partnerships. Prize competitions typically present little financial risk to the Federal Government because prize money is paid out only for successful outcomes. Continued conversations between experts and local decision makers beyond a grant or program can ensure long-term advancements and implementation success of desalination technologies, such as the work under the Water Security Grand Challenge.

One model to establish PPP and enhance research collaboration is through Cooperative Research and Development Agreements,[31] in which a Federal research lab and a non-Federal partner share knowledge, personnel, facilities, and equipment in a joint research project. If applicable, Federal agencies should consider participating in the Small Business Innovation Research program, a competitive avenue for seed funding to develop and mature technologies of interest. This program has previously aided the Navy in the development of desalination energy recovery pumps and pretreatment process improvements. The program also enables small businesses to explore their technical potential and provides extra incentives for commercializing new technologies.

Competitive funding mechanisms can also be used to encourage collaboration between domestic and international researchers. Specifically, the USBR can use the authorities of the Water Desalination Act of 1996 to provide grants under the Desalination and Water Purification Research Program, which allows non-Federal entities to fund innovative desalination technologies from early-stage development through full scale testing under operational conditions. USBR has also offered 'Pitch to Pilot' funding opportunity announcements to encourage entrepreneurs to compete for grants in a compressed timeline by forgoing extensive written technical proposals. This program was used to support an

[30] https://www.congress.gov/110/plaws/publ69/PLAW-110publ69.pdf

[31] https://www.gpo.gov/fdsys/pkg/STATUTE-100/pdf/STATUTE-100-Pg1785.pdf

operational water treatment facility in Alamogordo, New Mexico. To further stimulate the adoption of desalination technology, Federal agencies should consider offering similar programs in the future.

PPPs are important for transforming early-stage technology into deployable projects. An illustrative example is the Affordable Desalination Collaboration, which operated for 4 years and connected local, State, Federal, and private sector, including agencies such as the San Diego Water Authority, the Metropolitan Water District, the California Department of Water Resources, USBR and the U.S. Navy. This collaboration demonstrated the energy consumption of seawater desalination at various fluxes and recoveries and helped determine the optimal operating conditions for a large-scale seawater desalination plant. The study found that the energy cost for desalination was at or lower than the cost of pumping water from the Colorado River, furthering public acceptance of the project.

As noted above, PPPs provide unique opportunities to streamline and develop innovative desalination technologies, and Federal agencies should strive to develop more partnerships with industry, academia, and the international community.

Encourage data and information sharing

Data and information sharing mechanisms among water resource managers, regulators, engineers, and stakeholders can facilitate public and private investment, innovation, and help facilitate implementation of desalination technologies. However, within the water technology research community, desalination data is not always consistent and is often proprietary or lacks information regarding the underlying assumptions, which makes it difficult for researchers to aggregate and compare information across various sources. Using common platforms and data standards can help local and regional water management and planning bodies compare water supply alternatives and assess technical requirements, energy consumption, and costs of various desalination technologies. Accordingly, the Federal Government should work with stakeholders to help develop common data standards and platforms to improve data discoverability, accessibility, and usability.

In addition to sharing technical desalination data, more community outreach is needed to discuss the benefits of desalination technology and to address public concerns about desalination water systems. Federal agencies should support outreach through the development of educational resources and ongoing coordination with stakeholders to share information about desalination processes and their environmental and public health impacts. This would allow communities to make informed decisions whether desalination is the right technology for their community to address their water security needs.

Federal agencies should consider working with professional societies, standards bodies, non-profit organizations, or similar groups to effectively share data, information, and educational resources. However, Federal agencies should ensure that data and results of federally-funded research are made available to the public when access to these groups is restricted via membership requirements.

Stimulate investments

Financial risk is one factor that inhibits private sector investment in desalination R&D. To incentivize non-Federal R&D investments, the Federal Government should drive domestic desalination R&D through several different mechanisms. Federal agencies should provide private sector investors and water utilities easy access to reliable information about innovative financing opportunities and programs offered for desalination infrastructure investments.

Many different Federal agencies have programs designed to stimulate investments in water treatment technologies, including state-of-the-art desalination technologies. For example, the EPA Clean Water and Drinking Water State Revolving Funds provide communities with a source of low-cost financing for resilient and sustainable water quality infrastructure projects. EPA's Water Infrastructure Resilience Finance Center[32] helps communities identify financing options for resilient and sustainable infrastructure projects. The Water Infrastructure Financing Innovation Act[33] program is a Federal credit mechanism administered by the EPA to accelerate investment in water and wastewater infrastructure, including desalination applications, by providing long-term, low-cost supplemental credit assistance under customized terms to creditworthy projects of national and regional significance. In addition, the United States Department of Agriculture's (USDA) Rural Utilities Service administers grants and loans for rural community utility infrastructure and improvements, which include developing reliable and affordable rural water supply systems.[34] These programs have been effective in promoting water treatment technologies, including desalination, and should be maintained.

Priority 8. Cooperate with international partners

Federal researchers routinely collaborate with international partners to advance research into scientific topics of shared interest. For example, the Office of Naval Research's Naval International Cooperative Opportunities Program funds collaborative basic research grants between an international and U.S. principal investigator; the NSF has collaboration agreements with international partners, including the U.S.-Israel Binational Science Foundation[35] on research cooperation; and USDA has funded desalination-related R&D through the U.S.-Israel Binational Agricultural Research and Development Fund.[36] Federal agencies can also engage with international research centers through existing agreements with U.S. universities or through participation in international research networks. The International Center for Integrated Water Resources Management, a U.S. Government-funded, United Nations Educational, Scientific, and Cultural Organization (UNESCO) center housed at the USACE Institute of Water Resources, provides a mechanism for international networking and cooperation between U.S. agencies and universities and counterpart UNESCO water centers around the world to support research into best practices for integrated water resource management. U.S. institutions may also establish a memorandum of understanding with other countries' institutions to promote the exchange of scientific and technical knowledge and capabilities related to desalination, such as the NSF and USDA's solicitation for *Innovations at the Nexus of Food, Energy, and Water Systems.* International technology challenges and prize competitions can provide another venue for technical innovation through international cooperation. Accordingly, DOE recently partnered with Israel's Ministry of National Infrastructure, Energy, and Water Resources[37] to encourage the design and development of a novel integrated energy and desalination system.

Although domestic technical agencies do collaborate with foreign counterparts on desalination R&D, the State Department can further strengthen R&D cooperation with international partners and play a central role in facilitating U.S. researcher access to foreign facilities, expertise, and data. Accordingly, the State Department has regular bilateral science meetings and exchange programs with international

---

[32] https://www.epa.gov/waterfinancecenter

[33] https://www.gpo.gov/fdsys/pkg/USCODE-2015-title33/pdf/USCODE-2015-title33-chap52.pdf

[34] https://www.rd.usda.gov/about-rd/agencies/rural-utilities-service

[35] http://www.bsf.org.il/BSFPublic/Default.aspx

[36] http://www.bard-isus.com/

[37] https://energy.gov/policy/downloads/us-israel-integrated-energy-and-desalination-design-challenge-lab-call

partners. Greater collaboration with these partners would foster improved understanding that boosts American technical capability and knowledge in desalination technologies.

In addition to improving R&D, examination of the ecological and environmental quality consequences of various types of seawater intake and brine disposal methods from desalination in places like Australia, South Africa, Spain, and Iraq could prove instructive in reducing environmental harm in the United States. Morocco and the United Arab Emirates are also developing technologies to desalinate seawater powered entirely from renewable energy. Lessons learned from these experiences could contribute to enhanced U.S. energy and water security.

Current U.S. State Department and U.S. Agency for International Development desalination cooperation efforts strengthen the capacity of our international partners to secure reliable and sustainable access to water. This in turn supports American foreign policy objectives and enhances economic and regional stability and security. While these programs are not designed to directly enhance American technical capabilities, desalination cooperation has been an abiding element of the American pursuit of comprehensive Middle East peace. A key component of U.S. engagement has been the strengthening of Arab-Israeli relations. The Middle East Multilaterals (MEM) program was established after the 1991 Madrid Peace Conference as part of the multilateral track of the peace process. This program fosters peaceful engagement among Israel, the West Bank and Gaza, and neighboring Arab States. Funding via MEM provides financing and technical expertise for cooperative projects that support important aspects of a comprehensive peace, such as joint water management, sustainable environmental management, and coordination on infectious diseases.

The U.S. State Department manages a portion of the Economic Support and Development Funds, which constitute the bulk of the MEM program budget. The Bureau of Near Eastern Affairs has used these funds to support training programs and projects, principally through the Middle East Desalination Research Center (MEDRC) to advance a regional approach to sustainable development in a water-scarce region. The MEDRC conducts regional workshops on water management and desalination to facilitate regional cooperation with an important goal of creating the conditions to facilitate direct negotiations between Israel and Palestine. In addition to promoting information exchange, this program is one of the only non-security channels bringing Israeli and Palestinian stakeholders together for constructive problem-solving on a variety of topics, including desalination. The United States also provides expertise to the MEDRC by supplying technical experts to support meetings, and by helping initiatives such as the recently launched MEDRC Prize Competition on small hand-held desalination systems.[38]

Through partnerships, programs, and cooperation with our national and international partners, the United States will be better aligned to optimize R&D efforts to yield the highest possible return on investment in desalination technologies.

Conclusion

Desalination is an important part of a comprehensive approach to improve water availability, resiliency, and security in the U.S. This National Strategy outlines three overarching goals and eight underlying priority areas that will support the advancement of desalination technologies to enhance our Nation's water security. This report also responds to Congressional direction outlined in the WIIN Act to identify desalination priorities, coordinate relevant Federal Agencies, strengthen R&D cooperation with our international partners, and to promote public-private partnership.

[38] http://www.medrc.org/medrc-launch-700-000-challenge-prize/

THE WHITE HOUSE