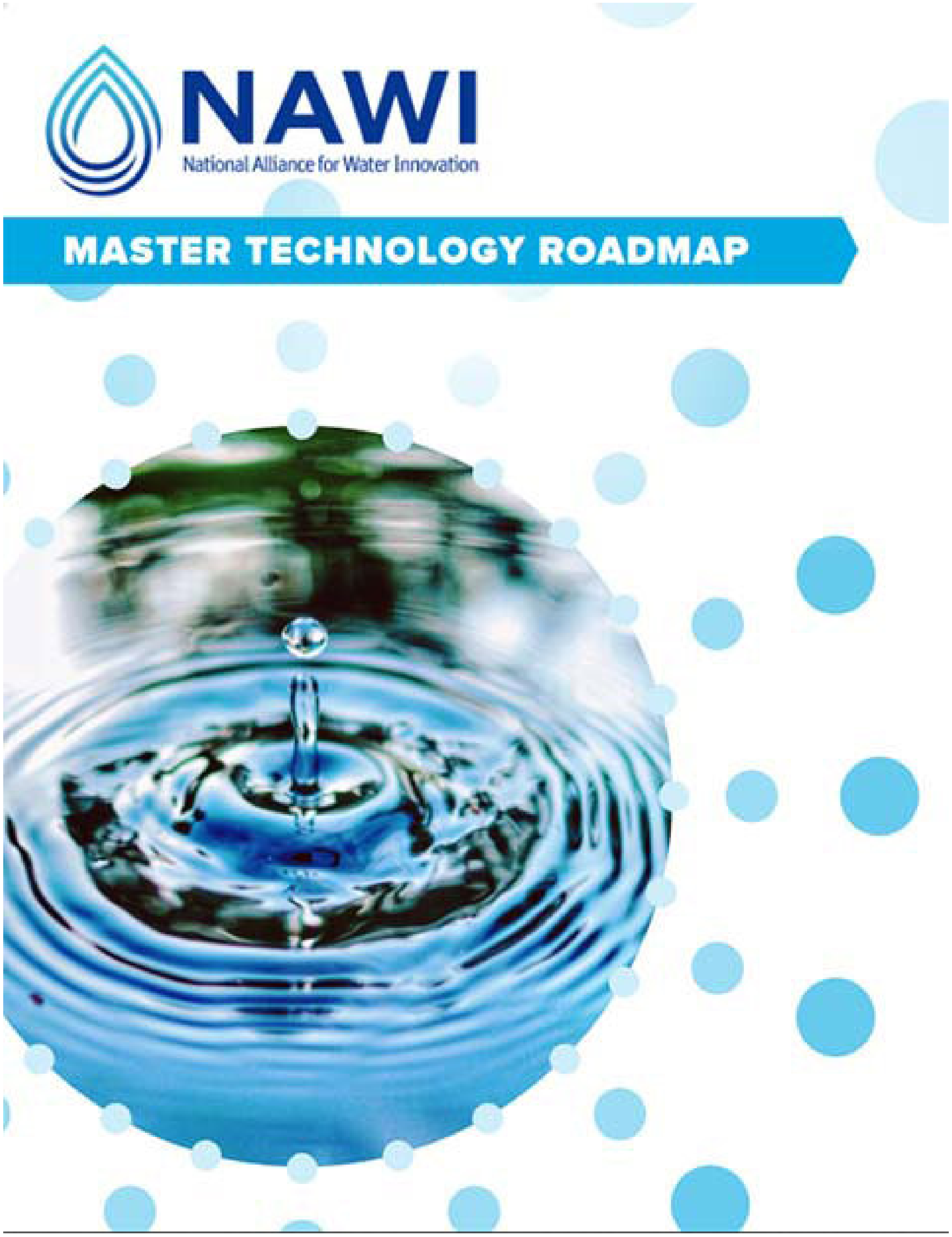
New roadmap guides industries to invest in low-cost, low-energy salt water treatment and recycle wastewater

September 10 2021



Growing demand for clean water will create shortages—and soon. Now, the National Alliance for Water Innovation's new Master Technology Roadmap can guide industries to invest in the most promising technologies, so we can recycle salt water, wastewater, and other waste products again and again. Credit: National Alliance for Water Innovation

Agriculture accounts for about 90% of total water consumption in the western United States and around 80% in the rest of the country.

This year, droughts, ferocious wildfires, and extreme heat waves are turning farmlands dusty and ranchlands into grass stubble too short to feed livestock. Without adequate water supplies, farmers and ranchers are suffering, facing unprecedented restrictions on water supplies they have relied on for decades.

But even without historic droughts, growing demand for clean water will create shortages—and soon. Water managers in 40 U.S. states expect some portion of their community to experience shortfalls by 2024. But there is a solution waiting in runoff drains, farmlands, and even the ocean.

As water insecurity grows and populations continue to increase, the country could tap unconventional sources, like salt water and wastewater, for agriculture (including irrigation and animal management), thermoelectric cooling, mining, oil and gas extraction, industrial and manufacturing processes, care for city parks and cemeteries, and even drinking water.

Still, technological, economic, social, and cultural barriers staunch the flow of a circular water economy—where water can be recycled again and again. That is why the National Alliance for Water Innovation (NAWI) just published a master roadmap to help guide future national (and international) technology investments that will not only help keep crops watered and livestock well-fed but also make sure no one goes thirsty when devastating droughts sap our water supplies.

The U.S. Department of Energy formed NAWI in 2019 to accelerate the development of energy-efficient desalination technologies, which extract salts and other impurities from both salt water and wastewater. Their goal is for such devices to produce clean water with the same (or higher) quality as current water treatment methods for 90% of nontraditional resources within the next 10 years. Led by Lawrence Berkeley National Laboratory in Berkeley, California, the NAWI collaboration includes the National Renewable Energy Laboratory (NREL), Oak Ridge National Laboratory, the National Energy Technology Laboratory, and more than 250 industry and academic partners.

The master roadmap synthesizes the results of the 2020 NAWI Roadmapping initiative, which focused on technical challenges across five sectors: power, resource extraction (mining and oil and gas exploration and production), industrial, municipal, and agriculture. Though NAWI previously published individual roadmaps tailored to each industry, the master roadmap compiles research opportunities that span more than one industry and could speed the transition to a circular water economy.

"Sector-specific roadmaps gave us almost 90 different things we could focus on," said Jordan Macknick, NREL's lead energy-water-land analyst and NAWI's topic-area lead for data, modeling, and analysis. "There's no amount of money in the world that can address all those in one project in one coherent way."

The master roadmap distills those 90 options into a smaller list of those with the greatest impact potential. One of those areas is cost.

Desalination devices that filter contaminants out of salt water or wastewater are not cheap. "We're currently using these very big bulk separation technologies, like reverse osmosis, which use a lot of energy and are also very expensive, to remove trace contaminants," Macknick said. "It's almost like you're using a sledgehammer to put a tack in a bulletin board."

He and the broader NAWI team are researching ways to extract contaminants faster, cheaper, and smarter. For example, bulk separation technologies are not necessary to extract microscopic contaminants, like selenium or boron. Smaller, more precise technologies could perform the same job for less money and energy input.

Their goal is something called pipe parity. In Denver, Colorado, for example, if traditional water sources run out, what happens then? The city could pump water over the mountains, but that method gets expensive fast. If the NAWI team can design technology that makes recycled water the cheapest back-up option, that is a win.

But cost is not the only barrier.

"The traditionally conservative water industry is understandably risk averse," Macknick said. "In general, that's a good thing for our health. But it also makes the pace of innovation more challenging." To incentivize the water industry to incorporate nontraditional water sources into their current infrastructure, Macknick and the cross-institutional team need to bring the costs down but also ensure the science is "bulletproof," Macknick said.

And the water industry is not the only group that needs some convincing. Some consumers still balk at the idea of drinking recycled water.

"There's a major perception issue when we talk about recycling or reusing water that, somehow, it's not clean enough or as pure as the water we might get from a river and treat, when in fact, we're oftentimes treating it to a higher standard than the water that we might pull directly from a river," Macknick said.

Changing perceptions might take time, but, in the meantime, NREL can help speed the development of more efficient, cost-effective technologies that edge recycled water closer to widespread use. No single technologic breakthrough will get the job done; water treatment often uses a dozen different processes strung together. But with NREL's deep knowledge of systems analysis, the laboratory's researchers can analyze these processes as a whole and determine which changes might have the biggest impact.

NREL also previously led the development of an analytical tool called the Water Technoeconomic Assessment Pipe-Parity Platform (Water-TAP3), which evaluates water technology costs, energy use, environmental impacts, and resiliency trade-offs. NREL researchers also developed a data repository called the Water Data Analysis and Management System (Water DAMS), a national go-to for water technology and treatment data. And the laboratory does not just collect and analyze data. NREL's advanced manufacturing researchers can help design entirely new materials to extract contaminants with greater speed and reduced cost.

NAWI's new master roadmap will help guide future research at NREL and beyond. "The master roadmap is what is guiding our future investments," Macknick said. "As the field advances, not only in the United States and with NAWI but also internationally, we want it to be a living document that changes as the sector advances and adapts."

New technology, developed with guidance from the NAWI master roadmap, could allow farmers to reuse wastewater and even some of its extracted contaminants—phosphorous and nitrogen—as fertilizer. As climate change incites more droughts, wildfires, and extreme heat waves, farmers and ranchers could stay afloat with unconventional water sources.

Despite its name, wastewater need not be wasted.

Provided by National Renewable Energy Laboratory