

Energy-Water Nexus at Sandia

Developing advanced technologies and integrated data modeling and analysis frameworks that create new water supplies, reduce the dependence of thermoelectric power on water, and inform energy-water system planning for decision makers and water infrastructure security.

The Need

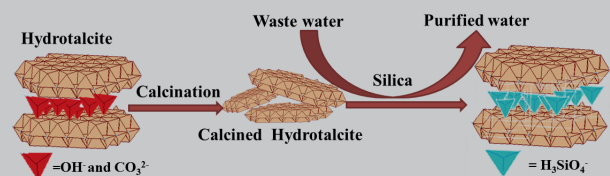
The continued security and economic health of the United States depends on a sustainable supply of energy and water. The availability of adequate water supplies has a profound impact on the availability of energy, while energy production and power generation activities affect water availability and quality. The United States faces increasing water supply challenges in the form of aging water infrastructure, overdrawn aquifers, increasing demands, growing environmental regulation, and more frequent and intense extreme events. In the early 2000s, Sandia National Laboratories initiated its Energy and Water Program to increase the safety, security, and sustainability of energy and water infrastructure through the development of advanced technologies that create new water supplies and provide decision-making tools to manage energy-water nexus challenges.

Our Goals

Solutions to unique, energy-water challenges in the U.S. require a broad range of science and technology research efforts that include modeling and analysis, pilot demonstration and testing, and performance validation. Priority efforts identified include:

Water Treatment: Sandia addresses the national security challenges associated with the growing limitations on water availability through novel technology development and simple, low-cost solutions to complex water-treatment hurdles. Partnering with industry and universities, Sandia's research and development has focused on developing and piloting new technologies for inland desalination, produced-water treatment, in-situ groundwater remediation, and power plant water treatment.

Water Treatment



Examples of novel water treatment technologies developed at Sandia include the R&D100 award-winning high-permeability biomimetic membranes, graphene oxide membranes, fouling resistant treatments for commercial RO membranes, and designer sorbants, such as easily recyclable hydrothermalite for silica removal, shown above.



Sandia has conducted field-scale pilot tests for water treatment technologies of both coal-bed methane produced water and cooling tower water, shown above.

Data Modeling & Analysis: The sustainable delivery of resources—including fresh water, energy, and food—is the foundation for stable and secure social, economic, and political systems around the world. Through collaboration with experts across multiple fields and sectors, Sandia develops modeling and analysis tools to inform decision makers on the dynamic multi-scale interactions among energy, water, land, critical infrastructure, and other sectors to ensure a secure and resilient energy future.

Water Security: Water distribution systems face multiple challenges, including aging infrastructure, water quality concerns, pipe breaks, uncertainty in supply and demand, natural disasters, environmental emergencies, and terrorist attacks. Reliable, resilient, and secure water infrastructure is critical to protect water sources and water distribution systems. Sandia's water security software packages, such as WNTR and the R&D 100 award-winning CANARY, can help decision makers design more effective monitoring, response, and restoration strategies for water distribution systems.

National Benefits

Sandia's energy-water expertise bridges the gap between existing knowledge and technology. Science-based, engineering solutions, guided by a robust understanding of natural and human engineered systems, foster informed decision-making, more efficient water use, and fewer water distribution network disruptions. Sandia draws from deep science and engineering experience to anticipate, innovate, create, and inform a safe, secure, and sustainable energy-water future.

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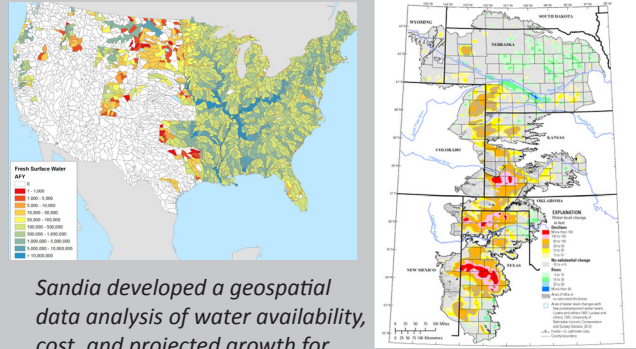
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Data Modeling & Analysis



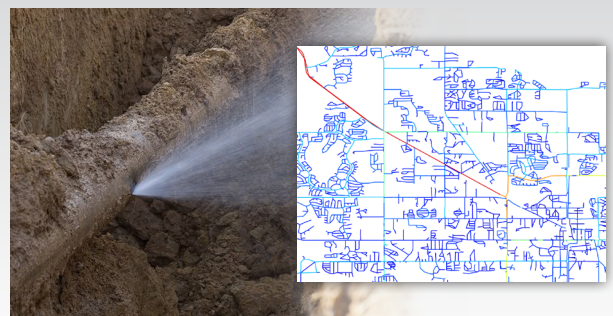
Sandia developed a geospatial data analysis of water availability, cost, and projected growth for the continental United States. Five water sources were mapped: unappropriated surface water, unappropriated groundwater, appropriated surface/groundwater, municipal wastewater, and brackish groundwater. This information is used to integrate water supply constraints into the long-term transmission planning of the Eastern, Western, and Texas interconnections such as when planning the following:

- siting new power plants,
- expanding transmission capacity,
- expanding utilization of renewables, and
- incorporating environmental concerns into the planning process.

Water Security



The Sandia-developed, R&D100 award-winning software package CANARY monitors water quality data for drinking water utilities. CANARY performs real-time, multivariate, event detection using water quality sensors. The analysis helps water utilities adjust facility operation to maintain water quality standards and quickly respond to possible contamination events.



The Sandia-developed Water Network Tool for Resilience (WNTR) software simulates and analyzes the resilience of water distribution networks. Increasing resilience to hazards such as pipe breaks due to aging infrastructure, natural disasters, or terrorist attacks is essential to improving water security.