



Integrated DOE Approach for Resilient Energy-Water Systems of the Future

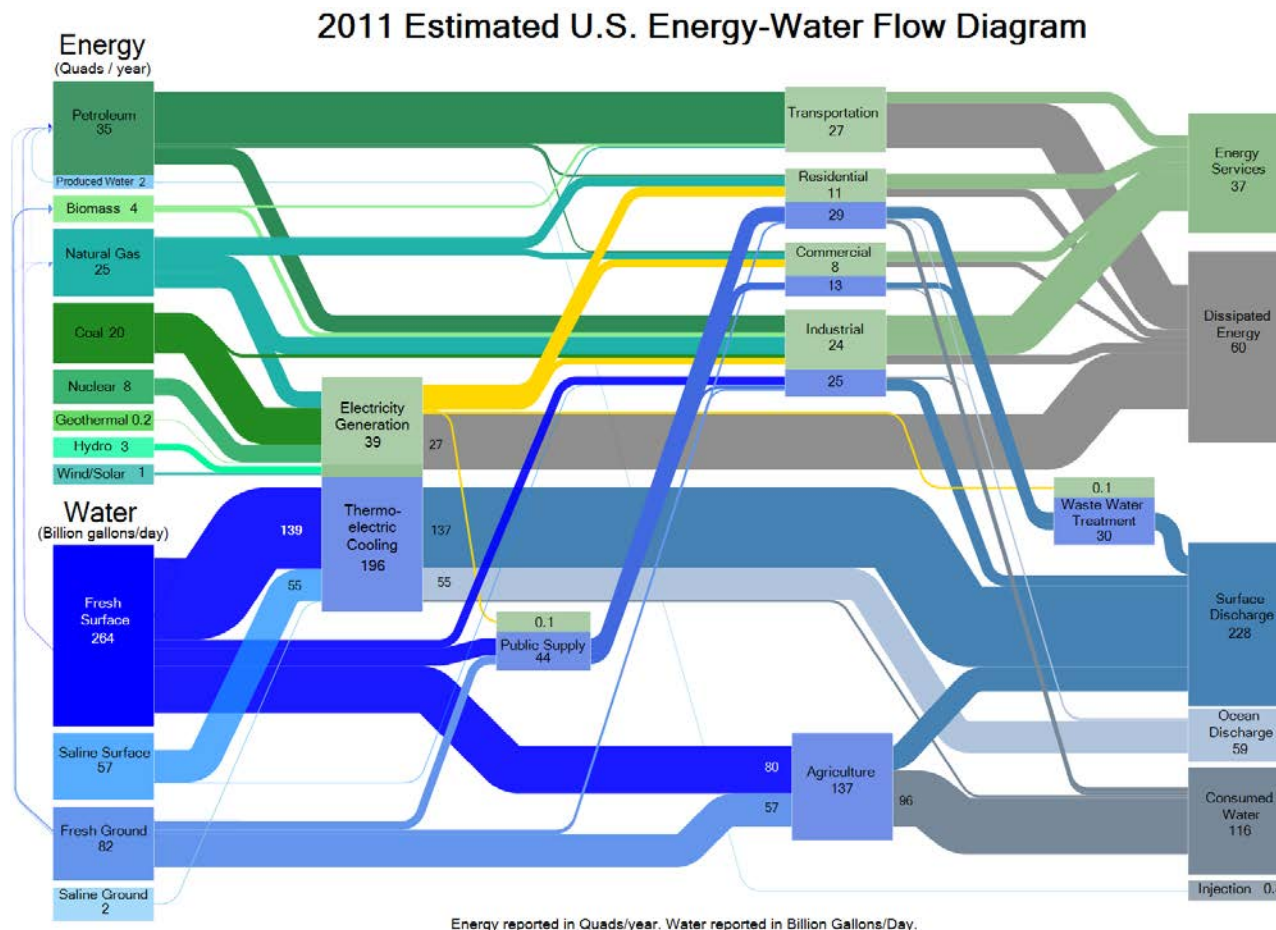
DOE FY17 Energy-Water Nexus Crosscut

March 21, 2016



Interconnected Energy and Water Systems

- 40% of water withdrawal is for thermoelectric cooling at power plants
- 4% of electricity consumption is for water treatment, distribution, and conveyance (significantly higher in some regions)





Congressional Direction in the Energy-Water Nexus

- **Energy Policy Act of 2005**

The Secretary shall carry out a program of research, development, demonstration, and commercial application to—

- (1) address energy-related issues associated with provision of adequate water supplies, optimal management, and efficient use of water;
- (2) address water-related issues associated with the provision of adequate supplies, optimal management, and efficient use of energy; and
- (3) assess the effectiveness of existing programs within the Department and other Federal agencies to address these energy and water related issues.

- **GAO Report on the Energy-Water Nexus 2012**

“GAO is recommending that DOE take the actions necessary to establish a program to address the energy-water nexus, with involvement from other federal agencies, as described in the Energy Policy Act of 2005.”

- **Bipartisan Congressional Letter 2013**

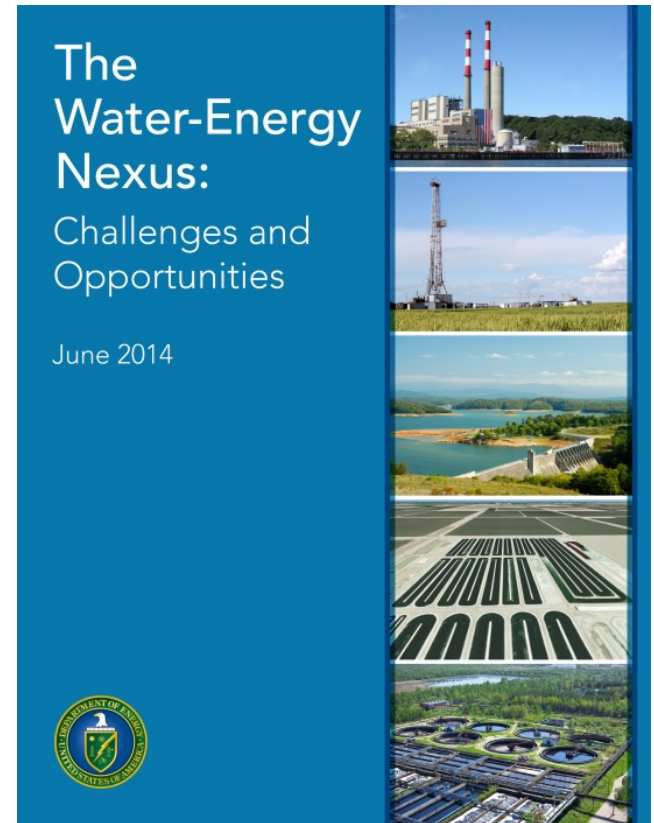
- **Energy and Water Development Appropriations Bill 2016**

"The Committee recognizes there is a clear need to obtain reliable, current, and comprehensive data on energy for water and water-for-energy use ... More accurate data and analysis can improve informed decision making; help prioritize investments in energy-water infrastructure; contribute to the research and development of related technologies; and lead to more efficient and sustainable water and energy practices."



Energy-Water Nexus: DOE's Role

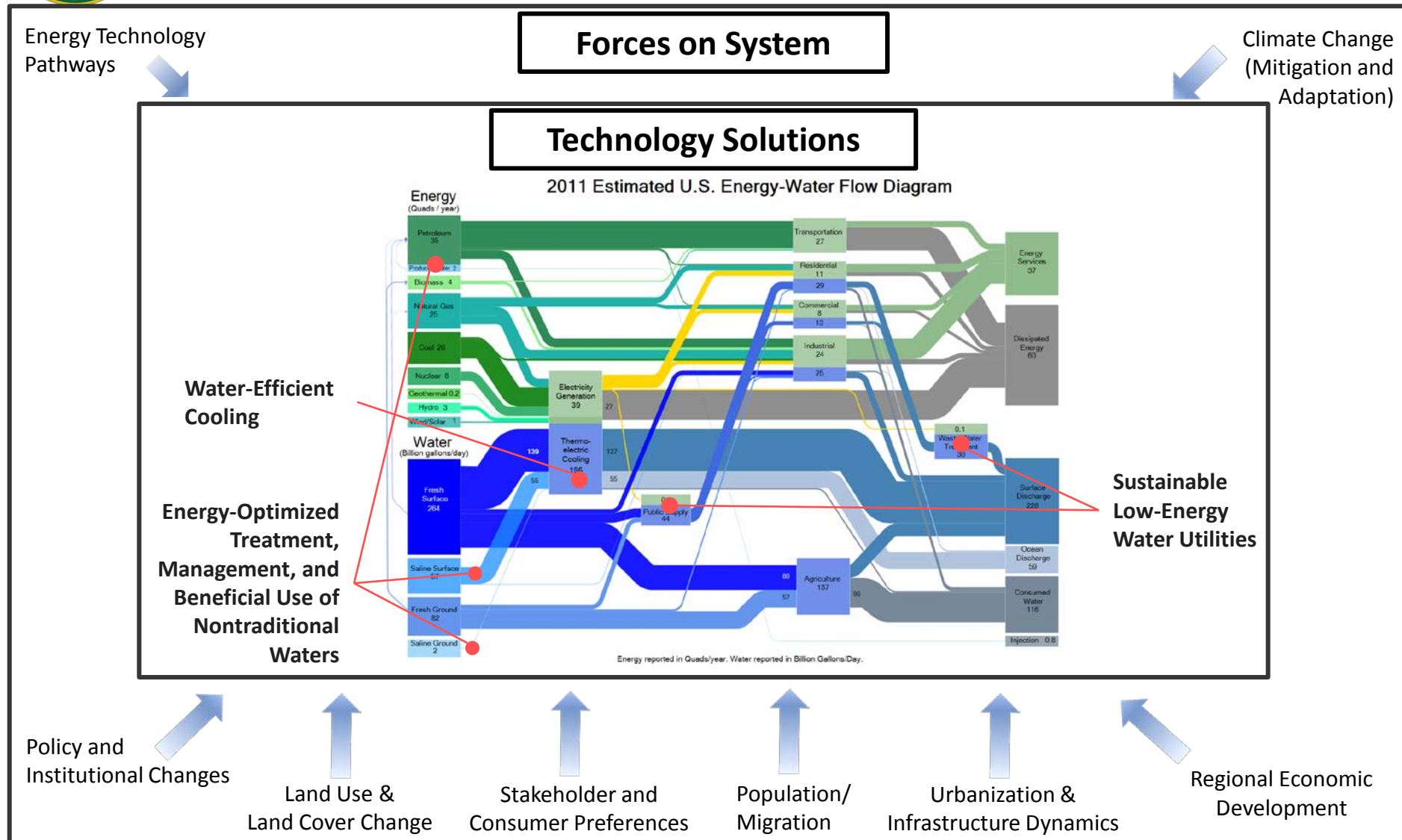
- DOE can approach the diffuse water area strongly from the energy side
 - Focus on our technical strengths and mission
 - Leverage strategic interagency connections
- We have strong expertise in technology, modeling, analysis, and data and can contribute to understanding the issues and pursuing solutions across the entire nexus.
- Our work has broad and deep implications
 - User-driven analytic tools for national decision-making supporting energy resilience with initial focus on the water-energy nexus
 - Solutions through technology RDD&D, policy analysis, and stakeholder engagement



Download the full report at
energy.gov

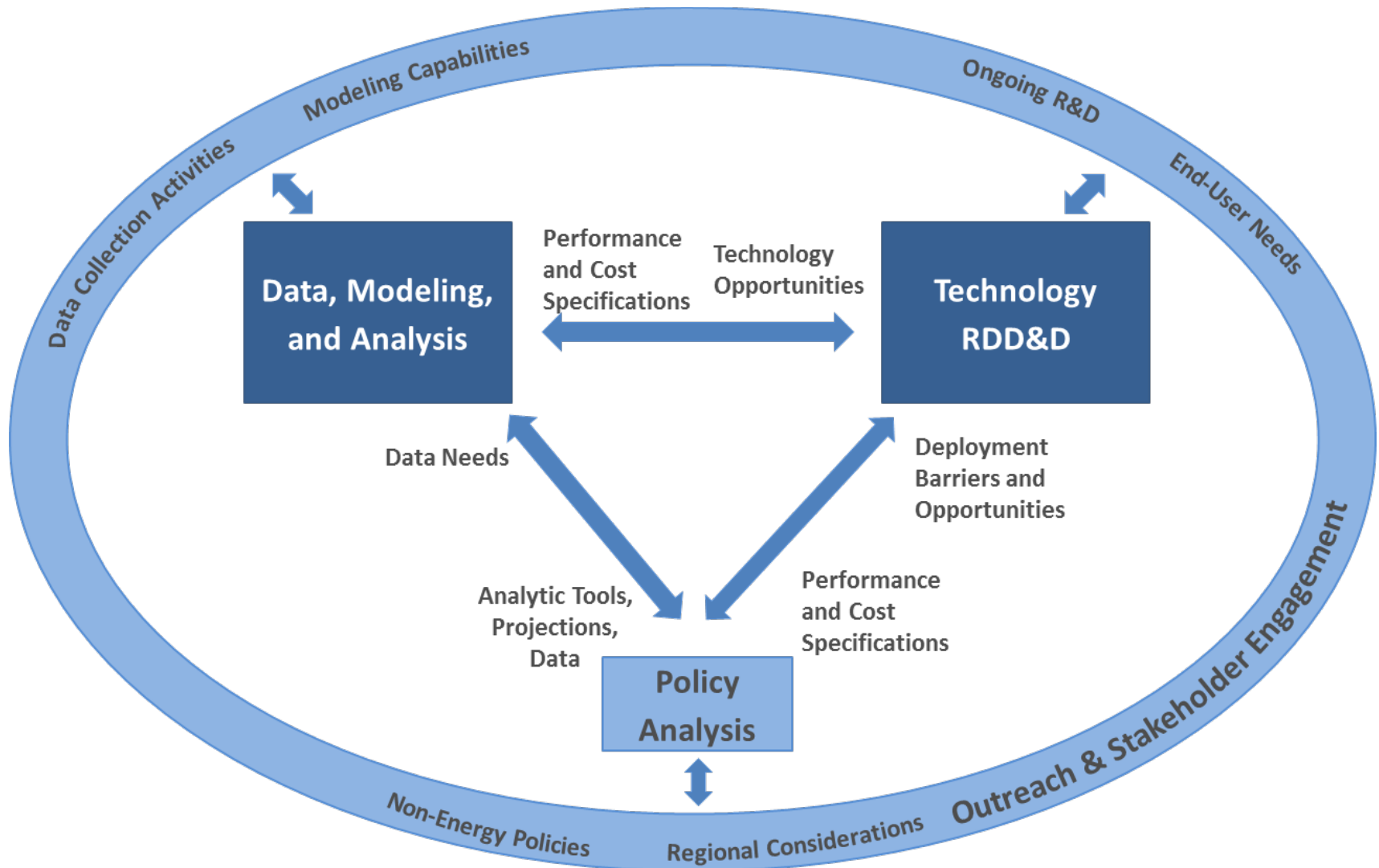


Responding to Challenges in the Energy-Water System





DOE's Programmatic Thrusts for the Energy-Water Nexus



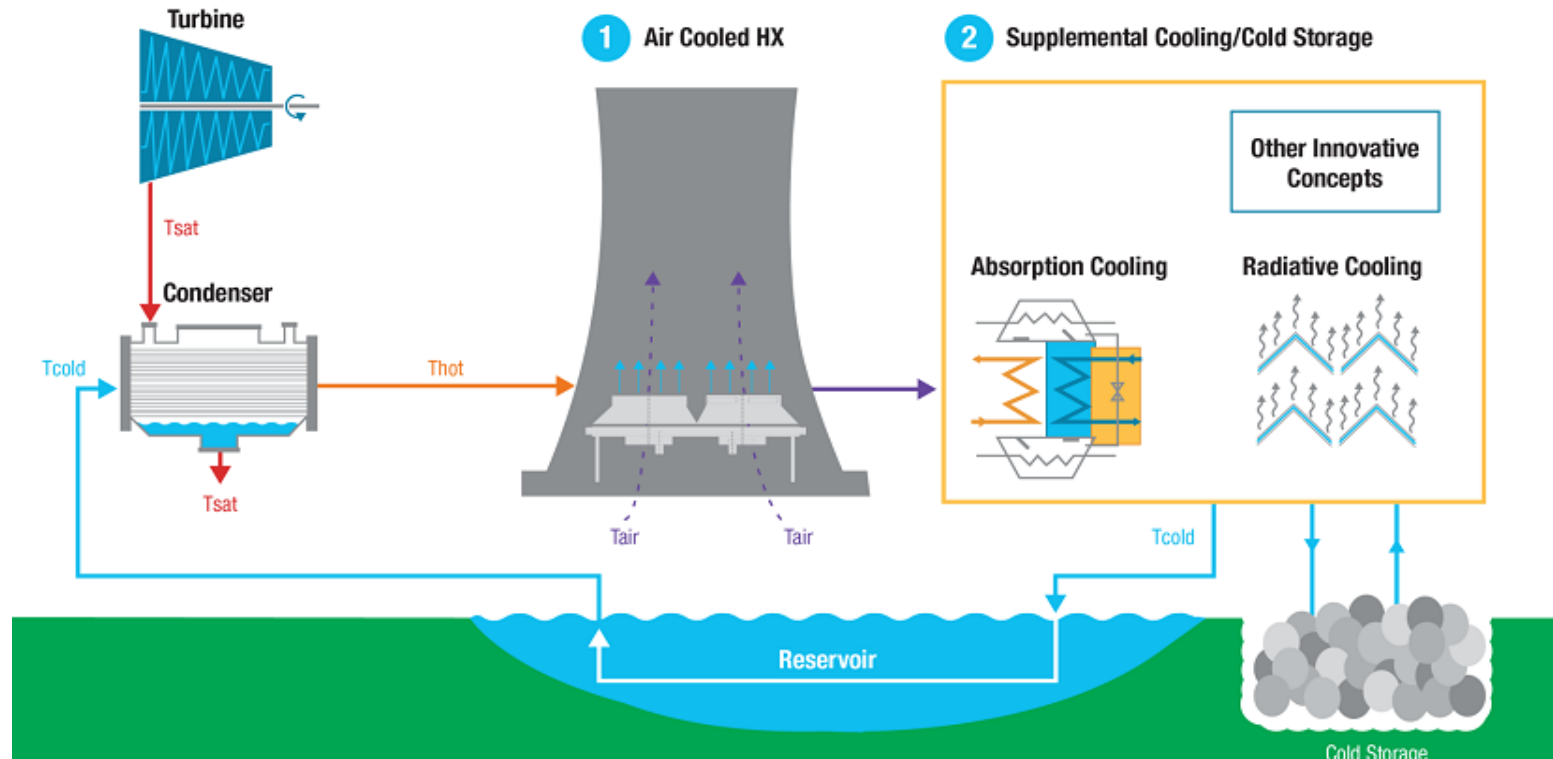


Dry Cooling for Electricity Generation

ARPA-E's Advanced Research in Dry Cooling (ARID) Research Solicitation is funding 14 projects for a total of \$30 million:

- Air-cooling heat exchangers (3 projects)
- Sorption & other supplemental cooling (4 projects)
- Radiative cooling and cool storage (3 projects)
- Flue gas H_2O recovery & cool storage (2 projects)
- Combined ACC & cool storage (2 projects)

Sample Indirect Dry-Cooling System that Satisfies ARID Program Objectives





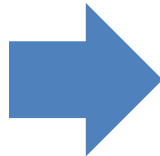
Low Cost, Low Carbon Desalination Systems RDD&D Hub

New technology platforms can be applied to a variety of water sources (brackish groundwater, seawater, grey water, produced water, etc.) and end uses (power plant cooling, oil and gas extraction, agriculture, etc.).

Energy Resources

• **Thermal**

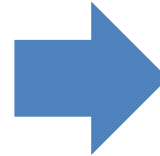
- Solar thermal
- Geothermal
- Fossil
- Waste heat



Desalination Technologies

Thermal Input

- Membrane Distillation
- Forward Osmosis
- Dewvaporation
- Multi-Effect Distillation



RDD&D Opportunities (ex.)

Low-cost / corrosion resistant new materials for pre-treatment and water intake system and effluent management

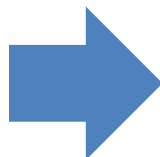
Intelligent and robust (non-fouling and non-scaling) membranes

Broaden potential energy inputs

Operational models and controls to maximize water productivity (gal/BTU)

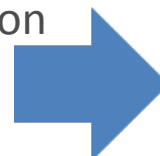
• **Electricity**

- PV/CSP
- Wind/water
- Fossil



• **Electric Input**

- Reverse Osmosis
- Capacitive Deionization
- Nanofiltration



Increase membrane and materials lifetimes, pressure and fouling limitations

Increase limits on TDS input; Systems for high TDS water

Test-bed for minimum viable process to technology scale-up

Alternative pre-treatment combined with other desal. tech. testbeds



Hybridized technologies

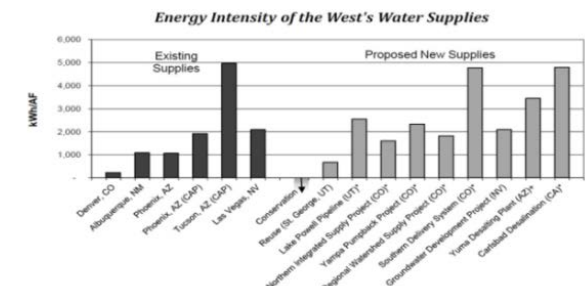


Groundwater Desalination Facilities

This map illustrates the distribution of groundwater desalination facilities across the United States. The facilities are marked with black dots. A high concentration is visible along the West Coast, particularly in California and Arizona. Other notable clusters are found in Texas, the central United States (e.g., Nebraska, Kansas), and the Northeast. The map includes insets for Alaska and Hawaii, which show no facilities.



Abbreviation	Project Name
Cal. Aqu.	California Aqueduct
CAP	Central Arizona Project
Carisbad Desal.	Carisbad Desalination Plant
CUP	Central Utah Project
GDP	Groundwater Development Project
LPP	Lake Powell Pipeline Project
NISP	Northern Integrated Supply Project
RWSP	Regional Watershed Supply Project
SDS	Southern Delivery System
S-J-Chama	San Juan-Chama Project
WG	Windy Gap Farming Project
Yampa	Yampa Pumpback Project
YDP	Yuma Desalting Project





Policy Analysis and Stakeholder Engagement

- **Policy Analysis**

- Multi-scale systems analyses for improved understanding: water and energy flows; energy infrastructure and technology deployment; markets and finance; regulatory landscape
- Future policy scenarios that bridge between energy and water domains
- Region-specific integrated technology, economic, and policy analyses

- **Outreach & Stakeholder Engagement**

- Disseminate and exchange information
- Inform design and effective use of data systems, models, and analysis
- Inform policy analysis and program design
- Develop collaborative domestic and international relationships