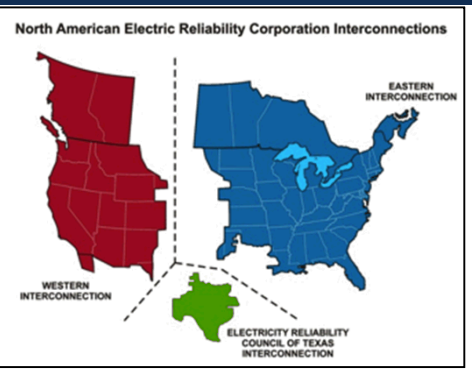
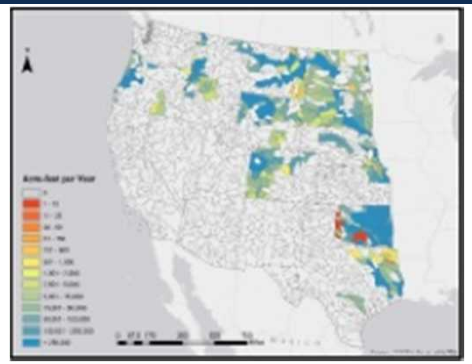
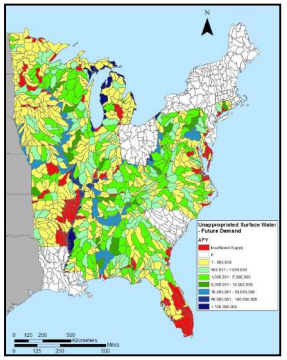
SAND2015-9243C

Exceptional service in the national interest

Sandia National Laboratories







Exploring Energy-Water Issues in the United States

Peter H. Kobos, Vince Tidwell, Barbie Moreland (SNL) &
Haibo Zhai, Edward S. Rubin and Hari Mantripragada (CMU)

U.S. DEPARTMENT OF ENERGY

National Nuclear Security Administration

Sandia National Laboratories is a multi-program laboratory managed and operated by Sandia Corporation, a wholly owned subsidiary of Lockheed Martin Corporation, for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.

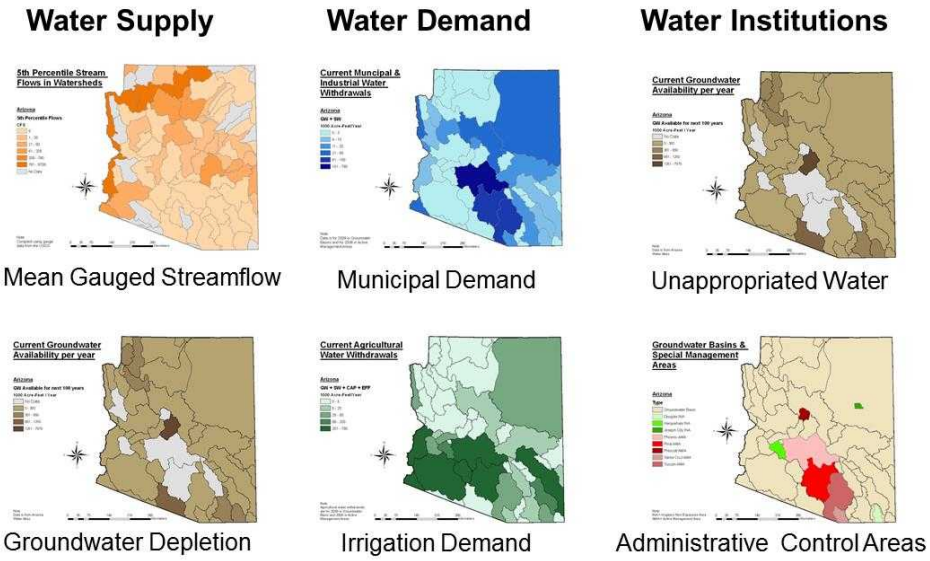
Technical background/motivation for the project

Sandia National Laboratories

- The objective is to develop both data and models to help better understand the linkage between thermoelectric power generation and water.
- SNL Objective: Development of a Water Atlas
  - Estimates of water availability, cost and projected future use at the watershed level in the 31 Eastern U.S. states, and compile into a Water Atlas for all of the lower 48 states of the U.S.
  - Water availability and cost metrics for four water sources:
    - surface water (unappropriated)
    - groundwater (potable)
    - municipal wastewater
    - shallow brackish groundwater
  - Integrate Water Atlas information with the Integrated Environmental Control Model (IECM) water use data to identify potential combined water-energy issues

Potential significance of the results of the work

- Increasing demand for electricity requires expansion of generating capacity.
- Availability of water is a key consideration; however, there is a lack of supporting information. States are key to filling this gap as:
  - The states have full authority over how water is managed and allocated within their state,
  - Acquiring data directly from the states is needed to properly capture the administrative controls that individual states employ to manage and allocate water
  - The states are also in the best position to project growing demands placed on their water resources.



Relevancy to Fossil Energy

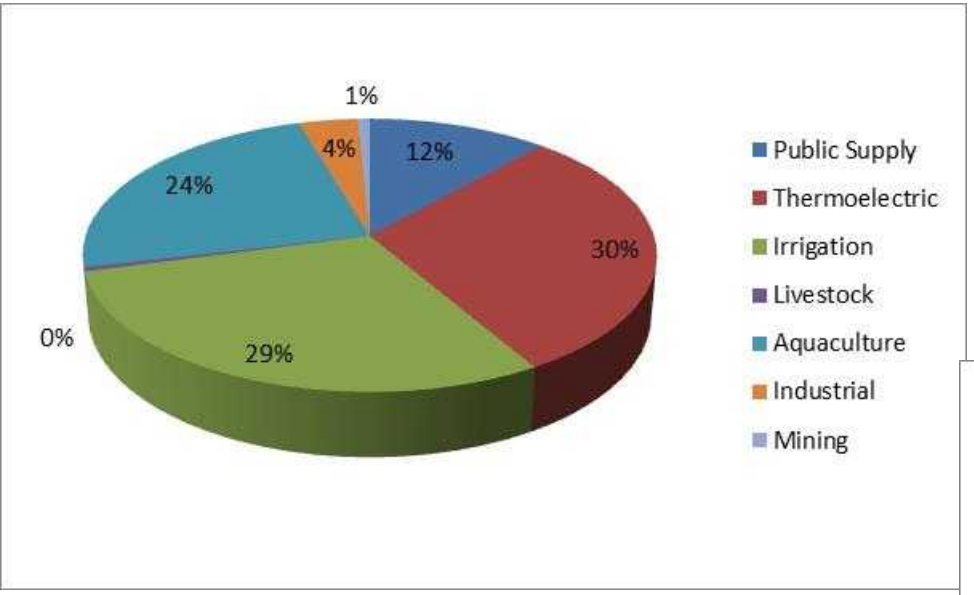
Sandia National Laboratories

- Water use by electric power plants is becoming an increasingly important issue in the U.S. in view of growing demands for water and increasing stresses on fresh water supplies
- Thermal power plants currently account for nearly 30 percent of all freshwater withdrawals in the U.S. (roughly equivalent to agriculture).
  - Water is used primarily for cooling and secondarily for operating environmental control systems such as sulfur dioxide control .
  - CO_2 Capture and Storage (CCS) technologies are also receiving considerable attention
- This raises the questions, *where will water for the growing demands of the thermoelectric sector come from,* and *how much water may actually be required?*

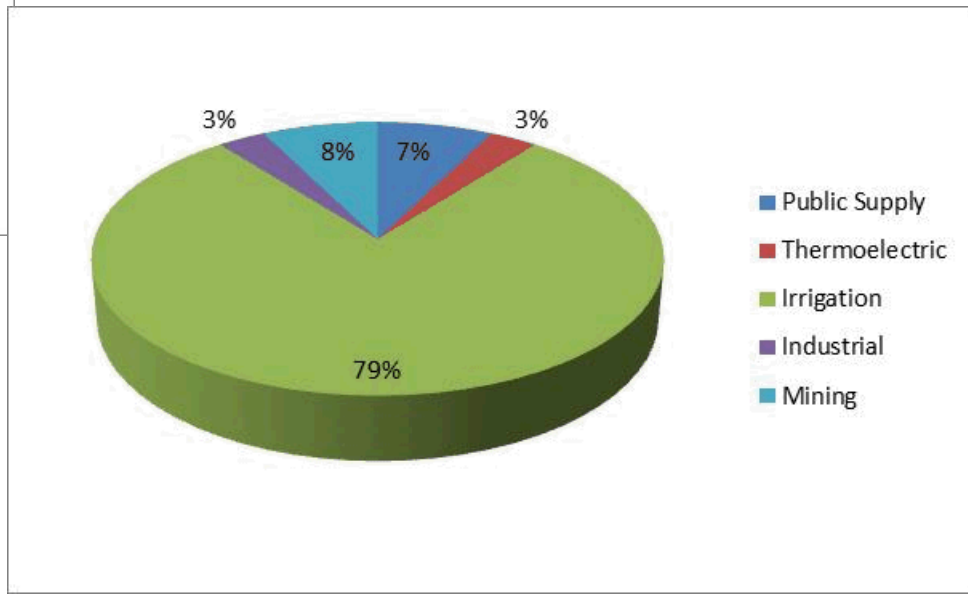
Relevancy to Fossil Energy

Sandia National Laboratories

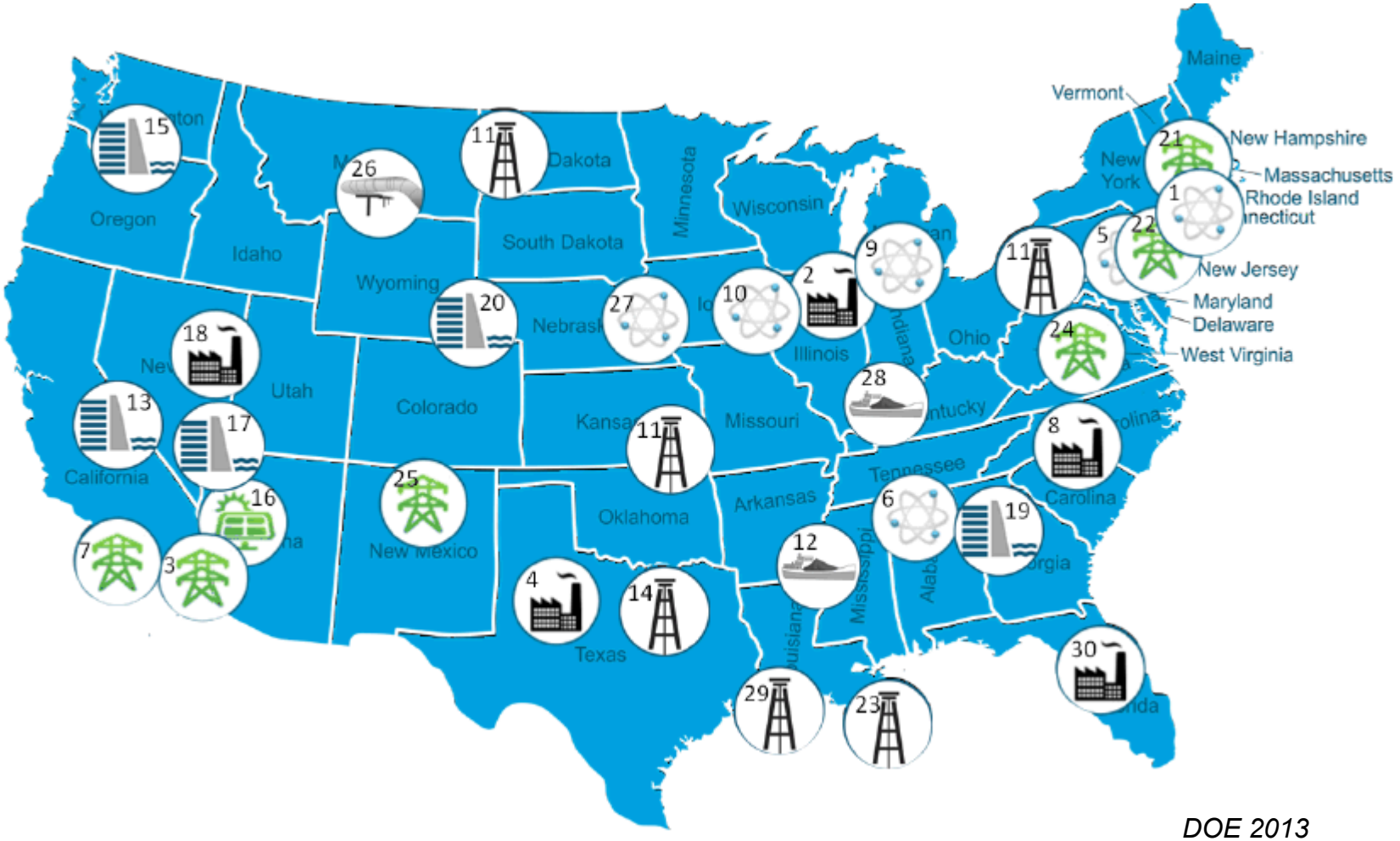
Water Withdrawal (306 BGD) 2010



Water Consumption (106 BGD) 1995



Relevancy to Fossil Energy

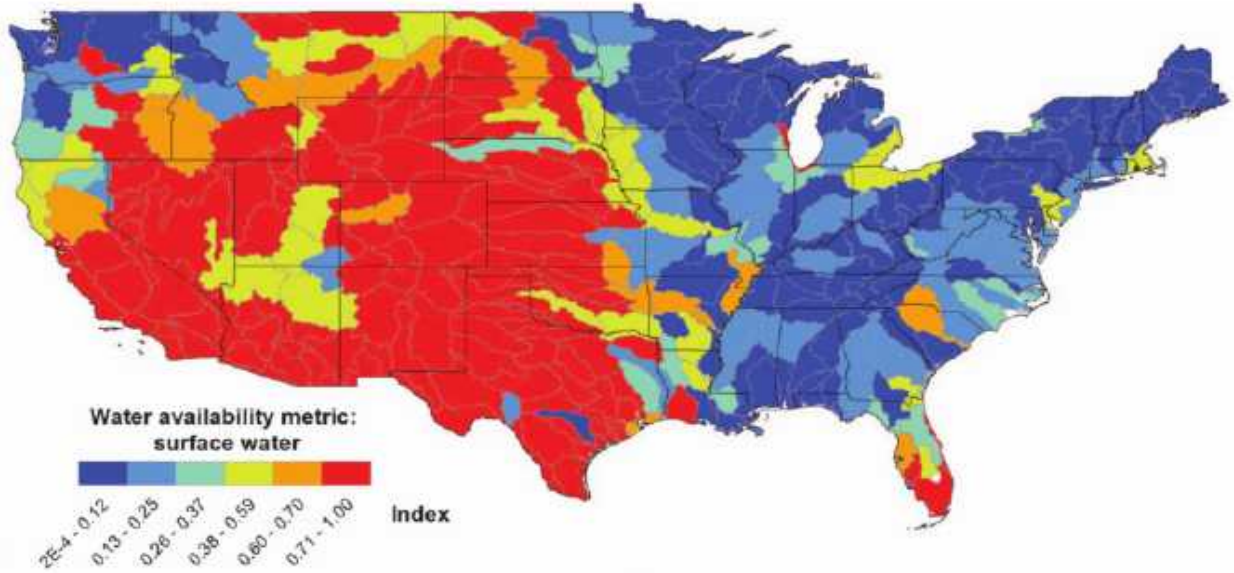


DOE 2013

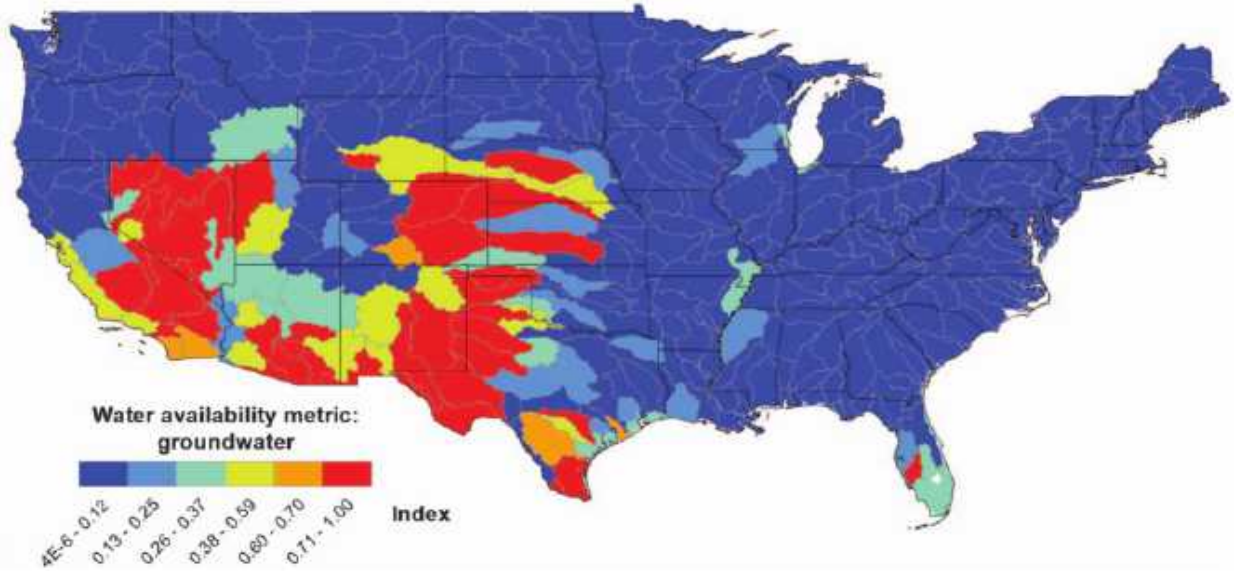
Relevancy to Fossil Energy

Sandia National Laboratories

Surface Water Availability



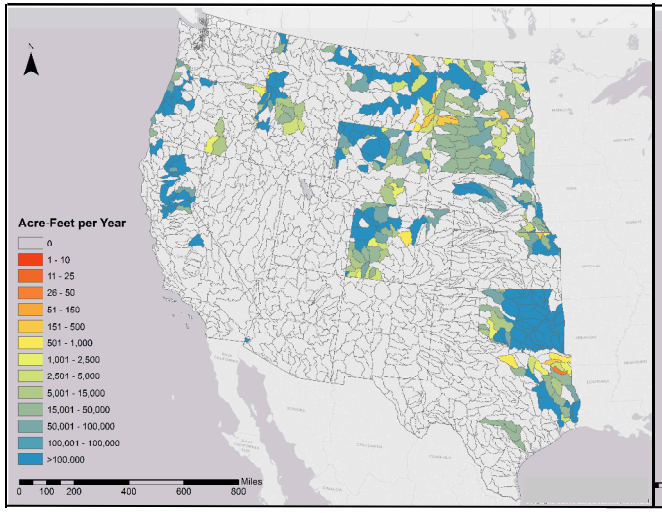
Groundwater Availability



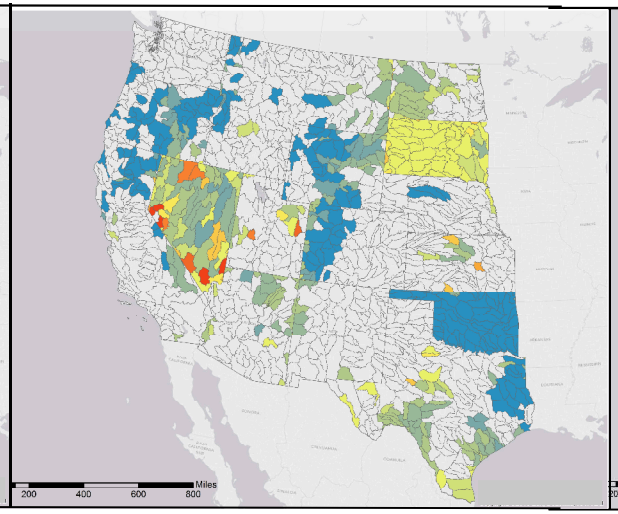
Example: Water Availability in West

Sandia National Laboratories

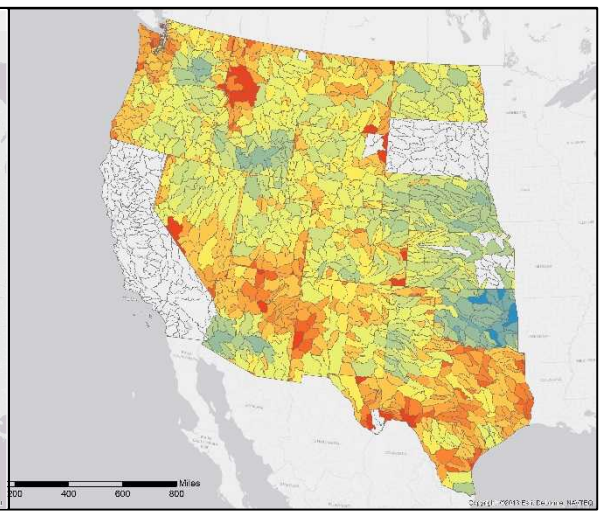
Unappropriated Surface Water



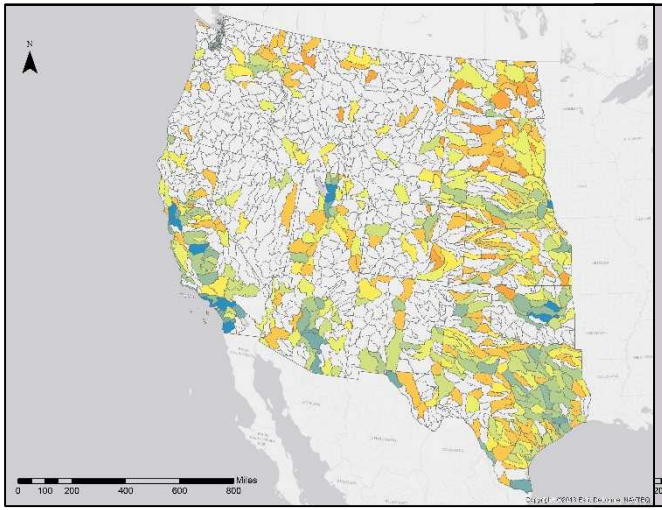
Unappropriated Groundwater



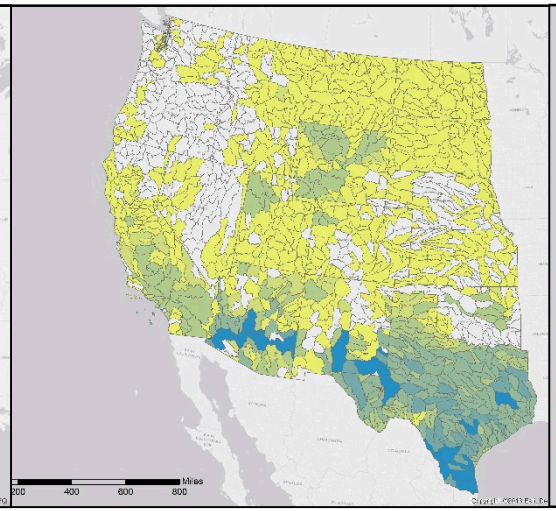
Appropriated Water



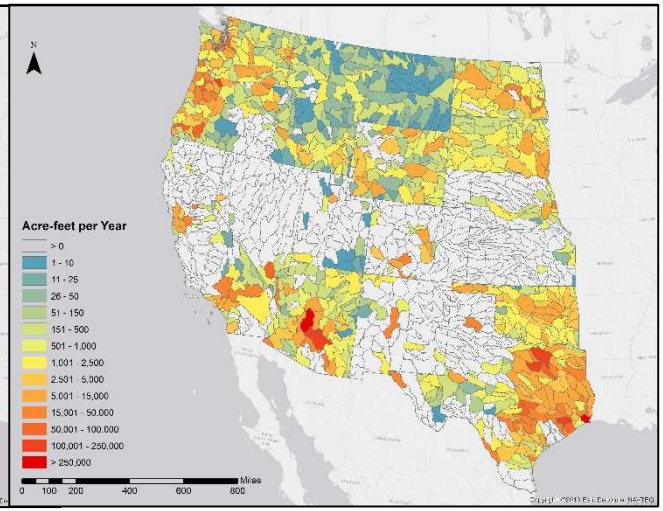
Municipal Wastewater



Brackish Groundwater



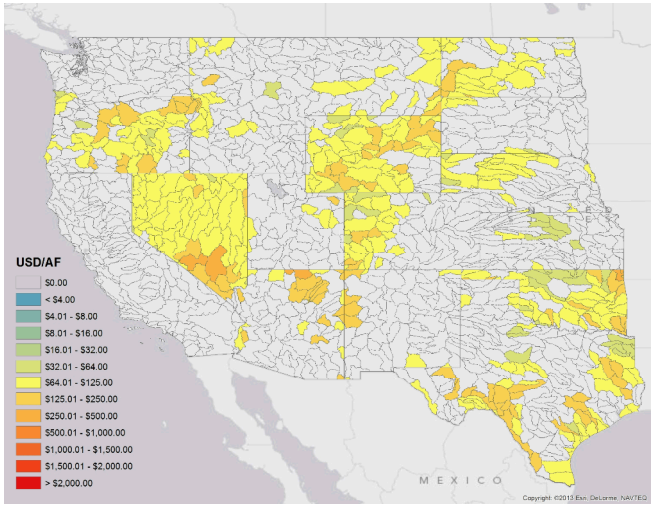
Consumptive Demand 2010-2030



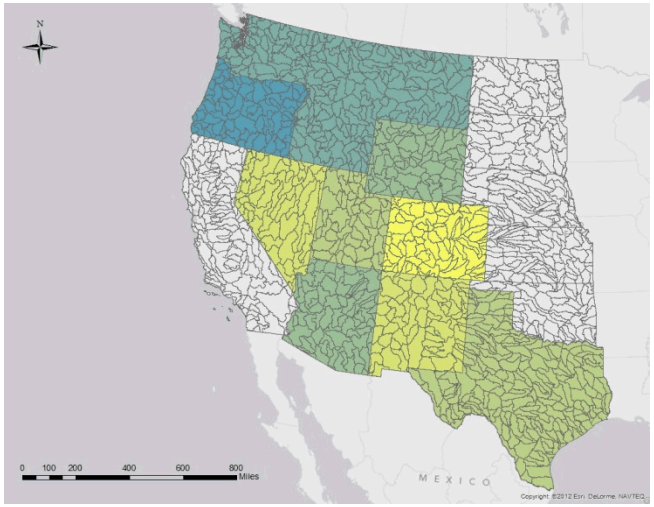
Example: Relative Cost of Water

Sandia National Laboratories

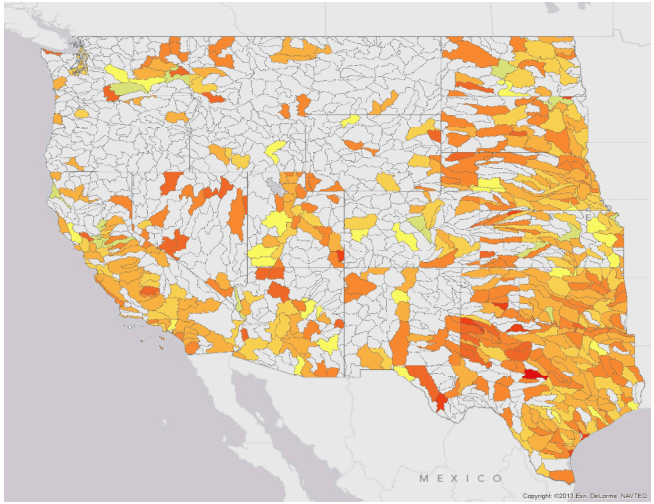
Unappropriated Groundwater



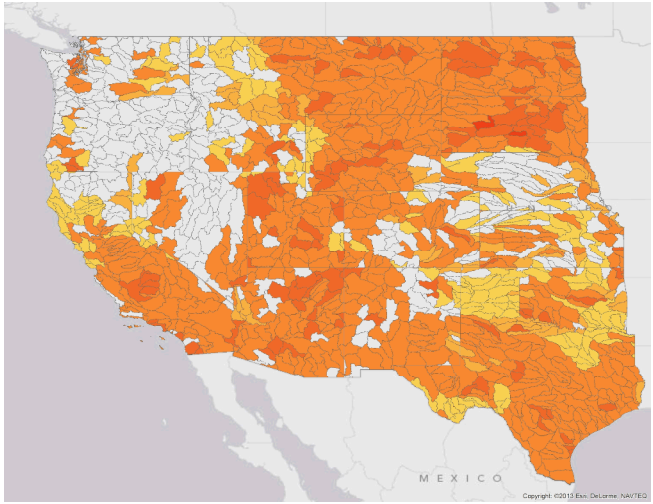
Appropriated Water



Municipal Wastewater



Brackish Groundwater

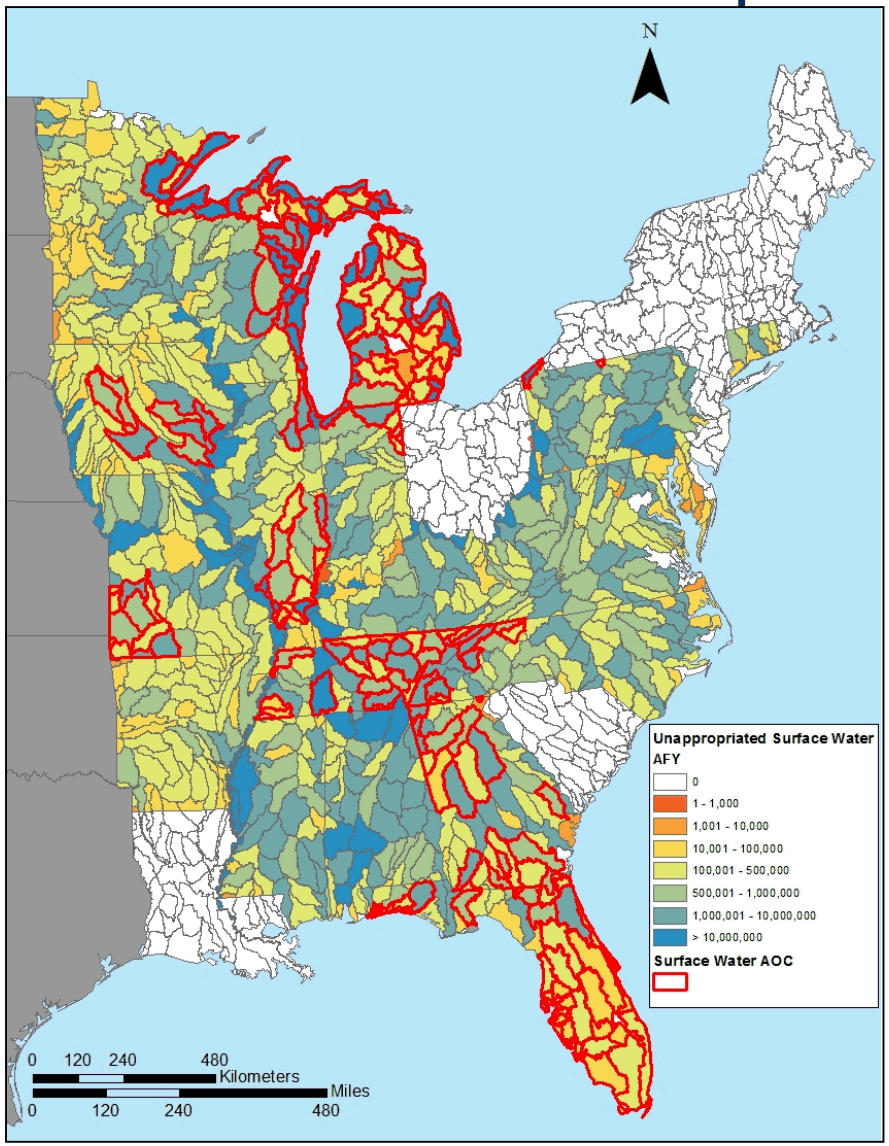


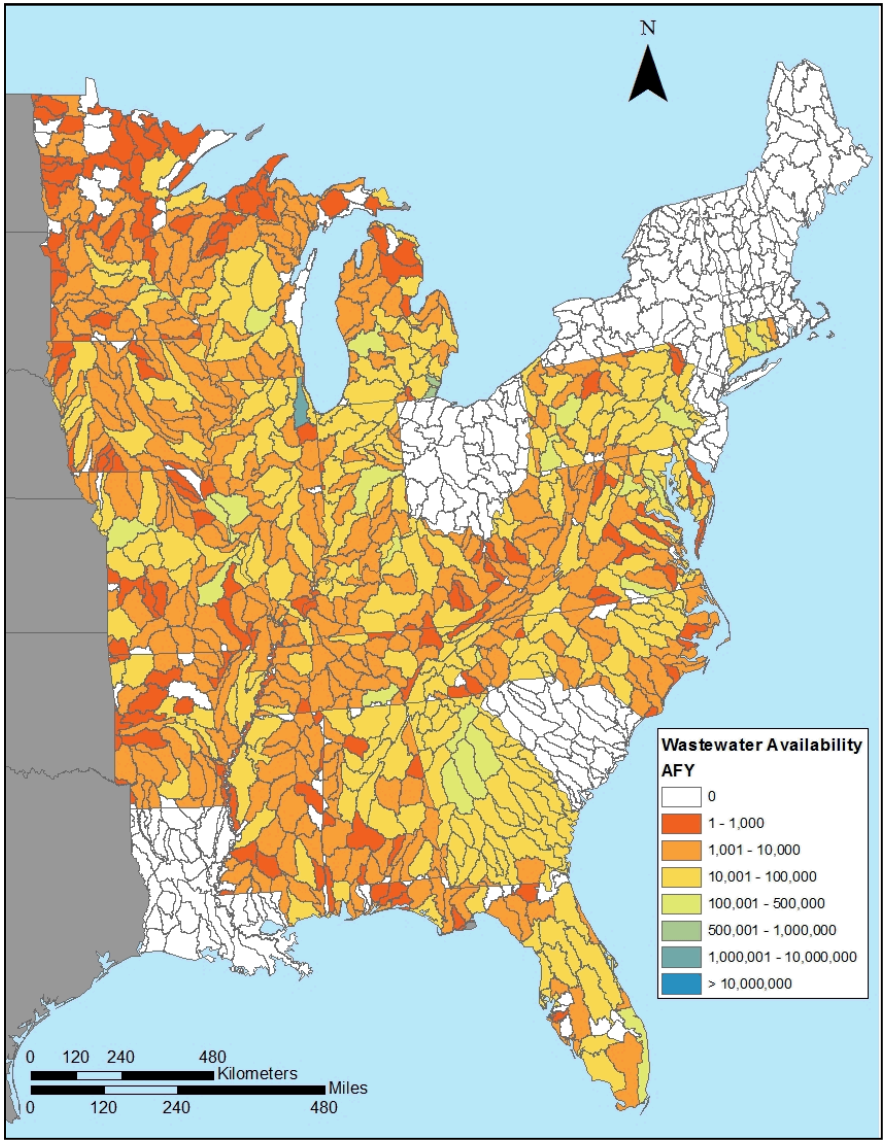
Current Research: Eastern States Water Atlas

Sandia National Laboratories

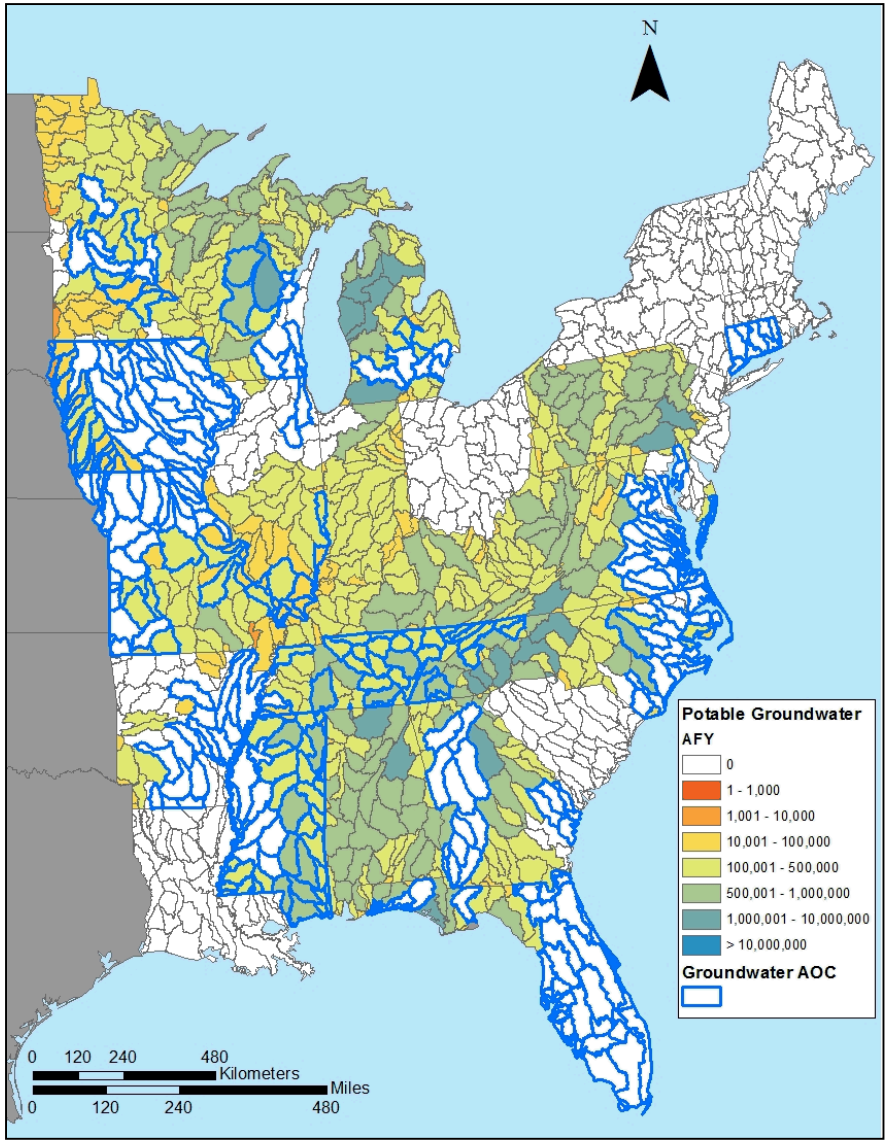
- The objective of the proposed work is to develop both data and models to help better understand the linkage between thermoelectric power generation and water.
- This effort will involve two broad areas of research
  - Development of a Water Atlas (Sandia National Laboratories)
  - Develop water use requirement assessment of fossil-fueled electric power plants (Carnegie Mellon University (CMU))
  - Integration of Water Atlas and CMU's Integrated Environmental Control Model (IECM) data to identify water-energy nexus issues

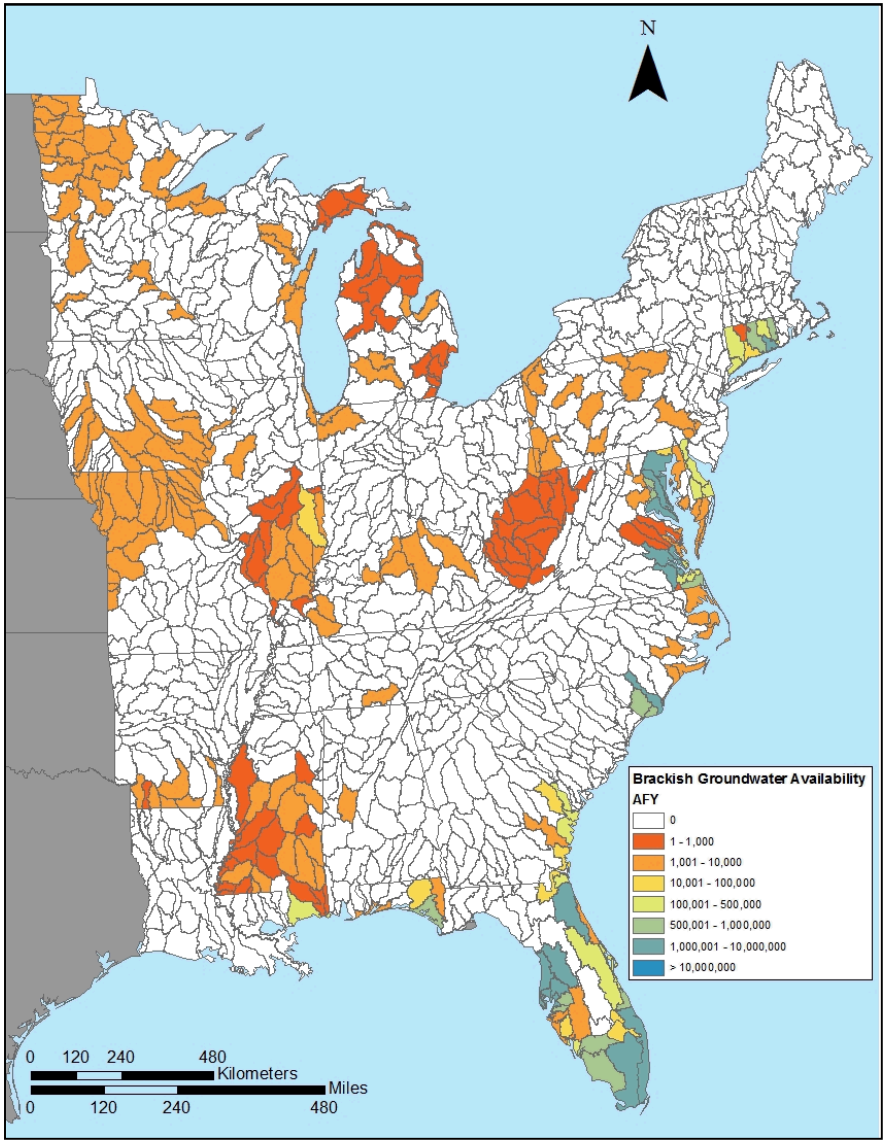
Water Availability: Unappropriated Surface Water and Municipal Wastewater



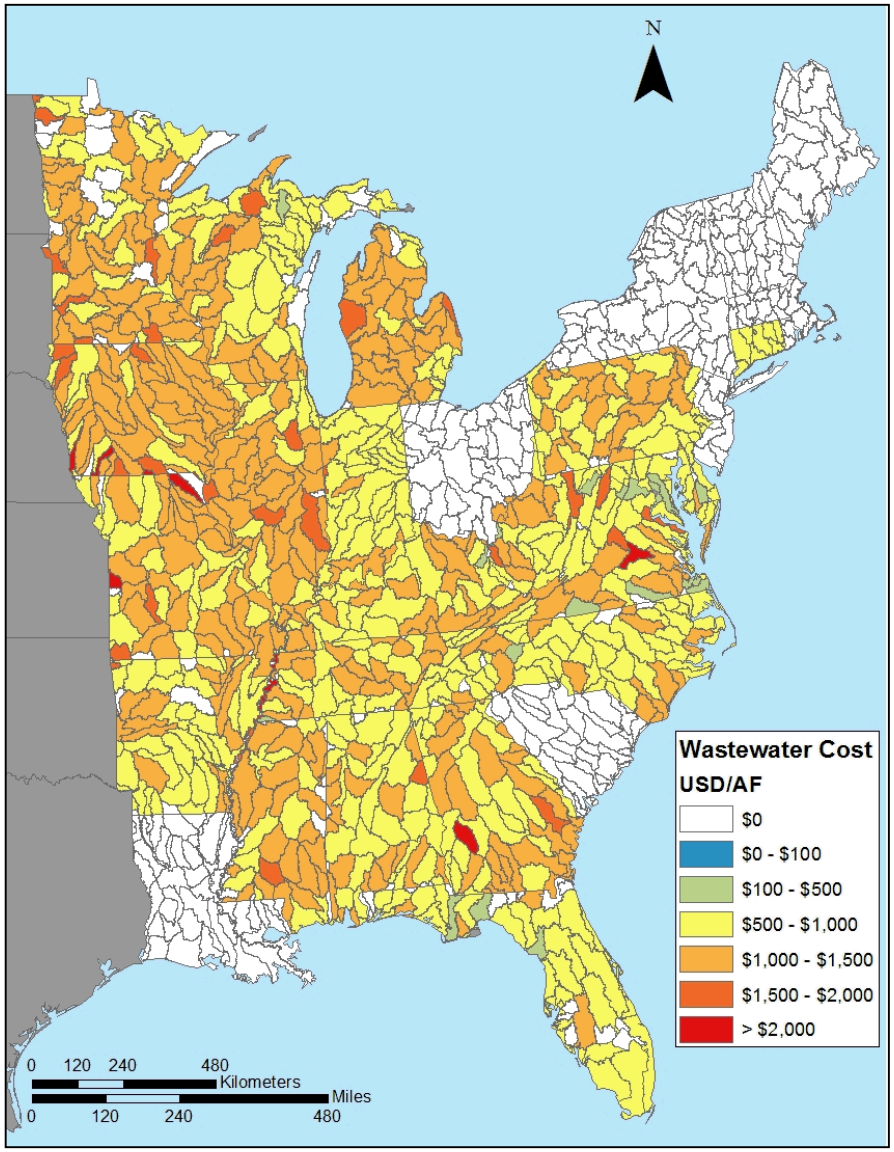


Water Availability: Potable and Brackish Groundwater



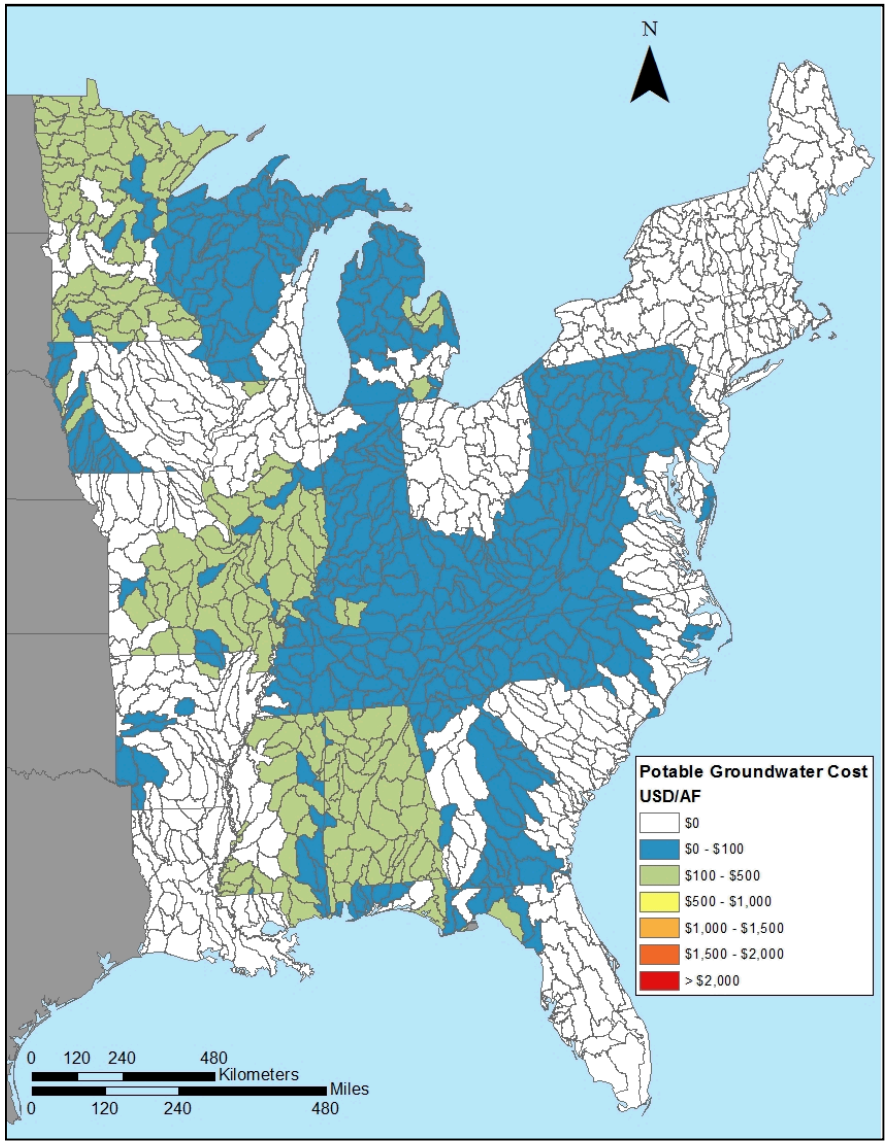


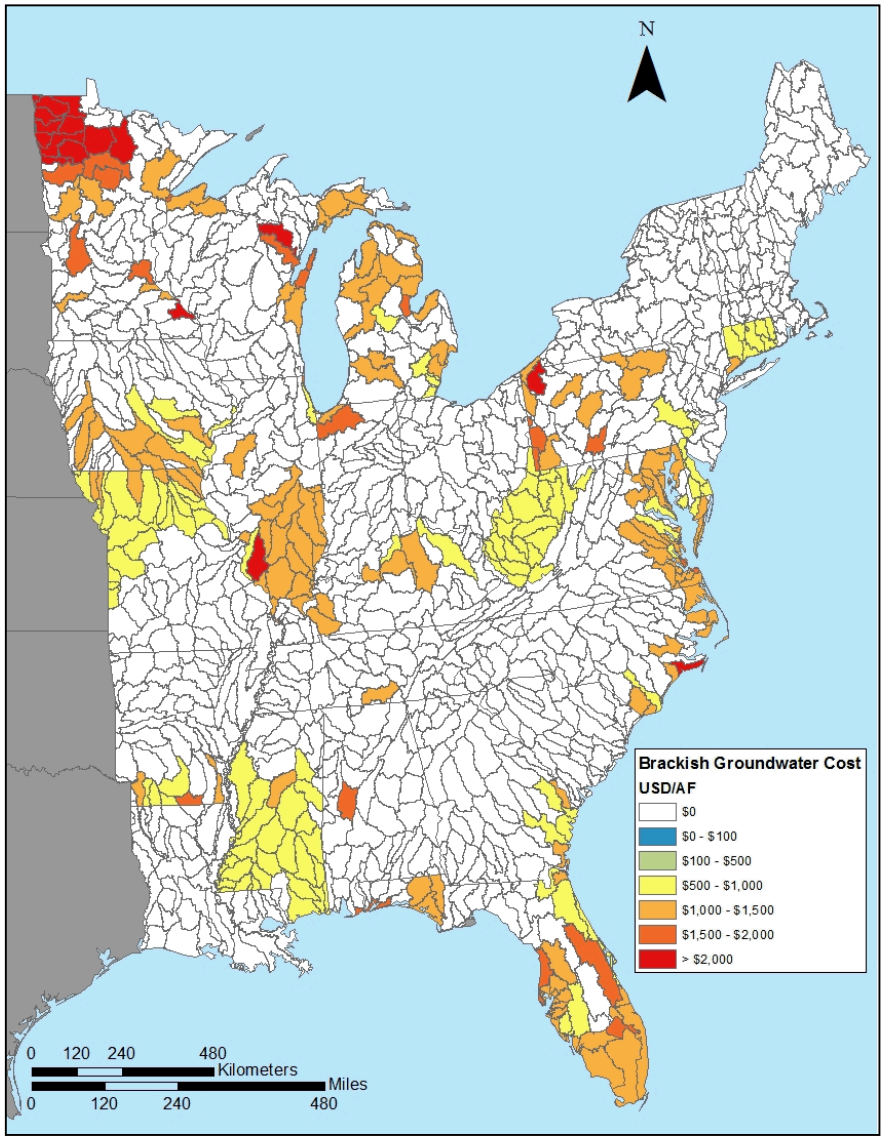
Relative Cost of Water: Municipal Wastewater



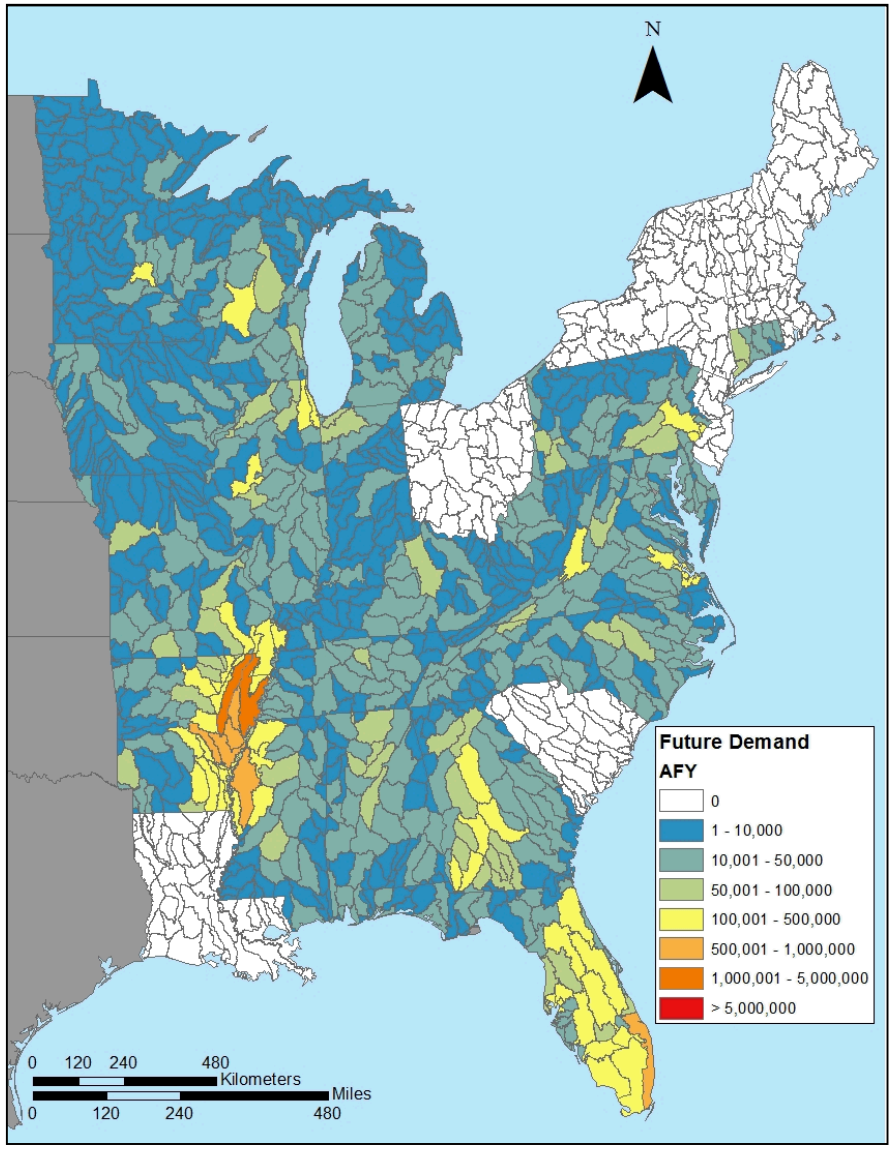
Relative Cost of Water: Potable and Brackish Groundwater

Sandia National Laboratories





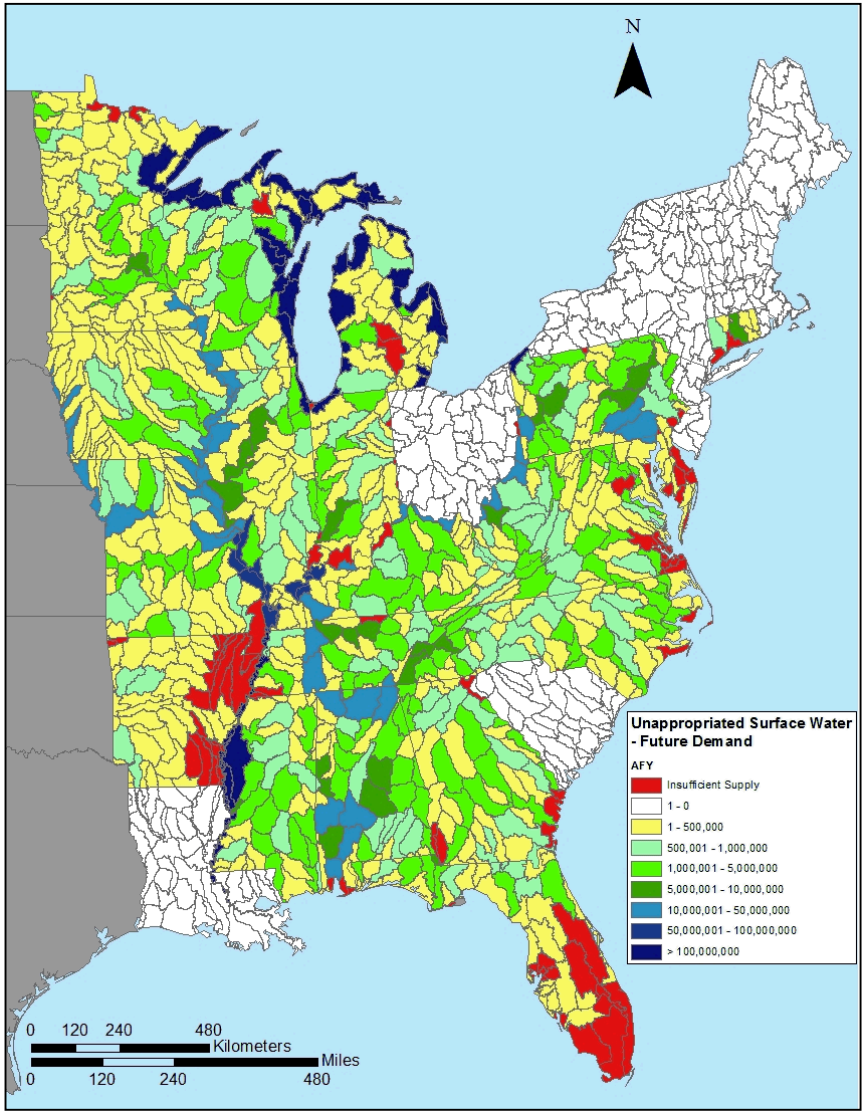
Future Water Demand



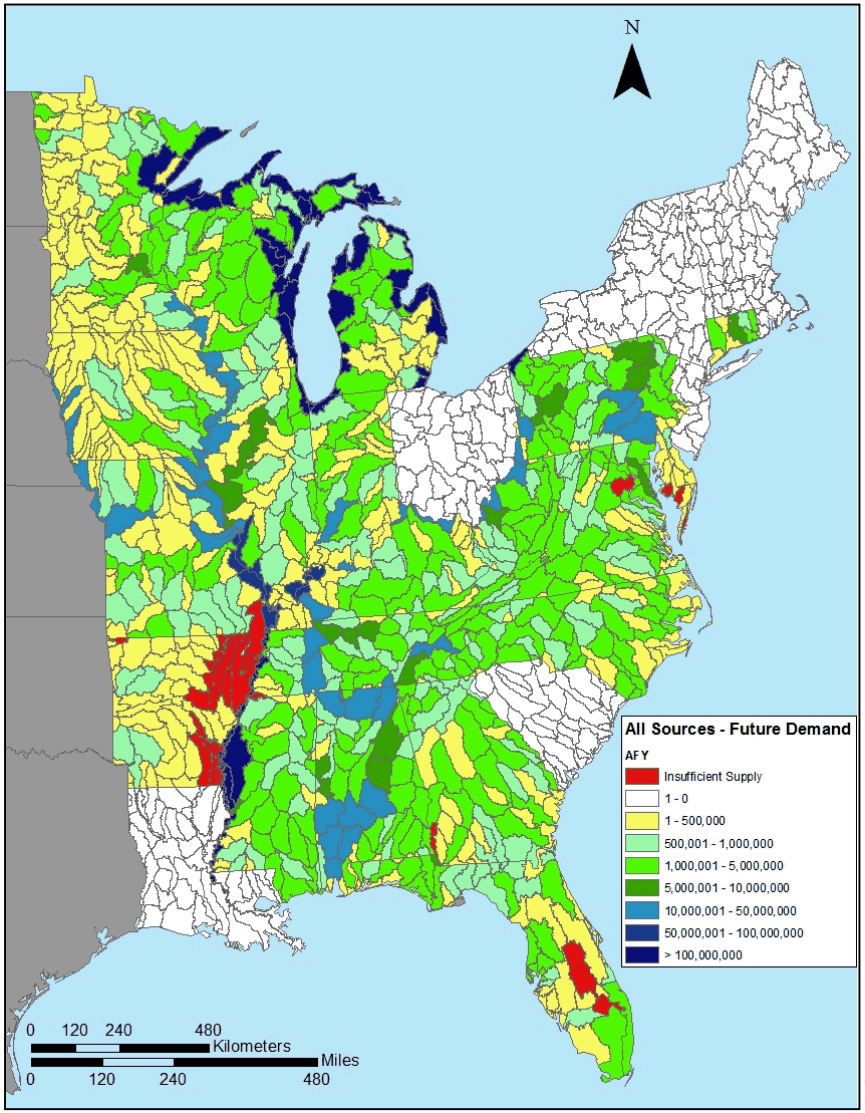
Shortage or Surplus of Surface Water

Sandia National Laboratories

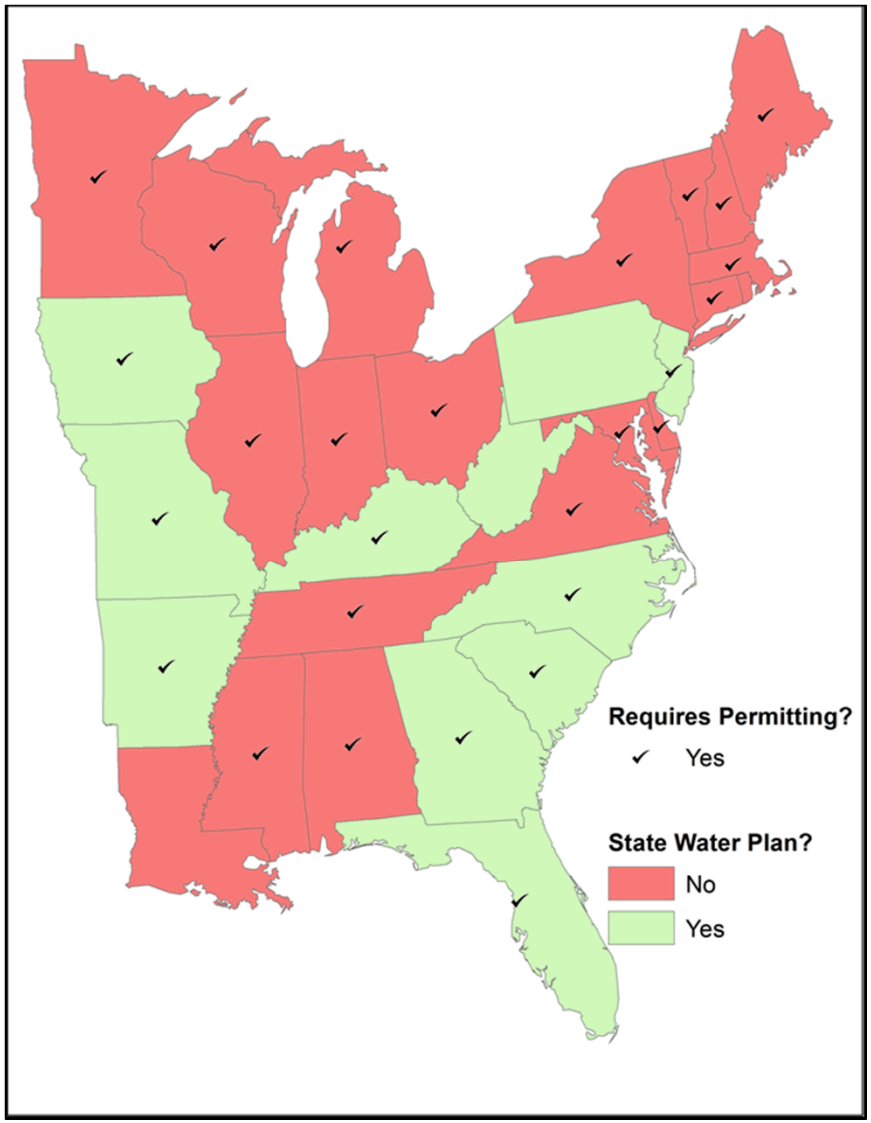
Unappropriated Surface Water – Future Demand

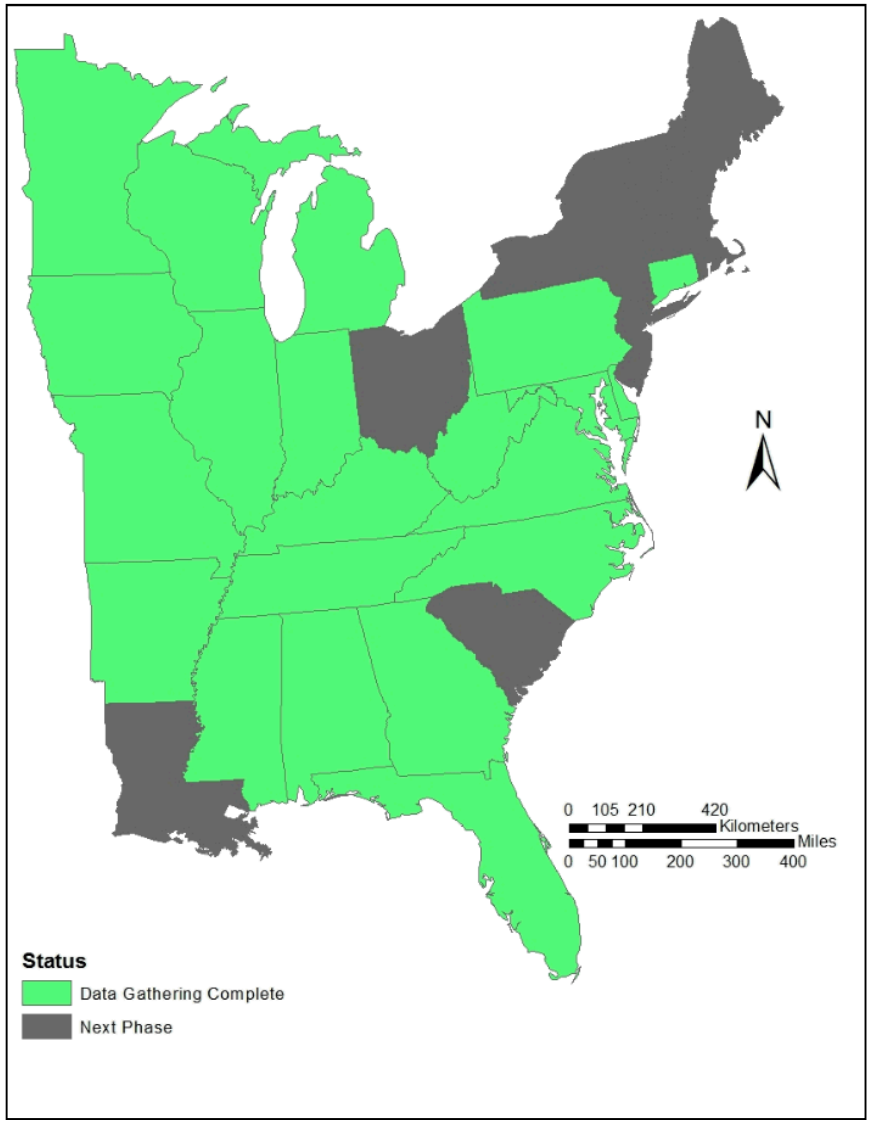


Total Water – Future Demand

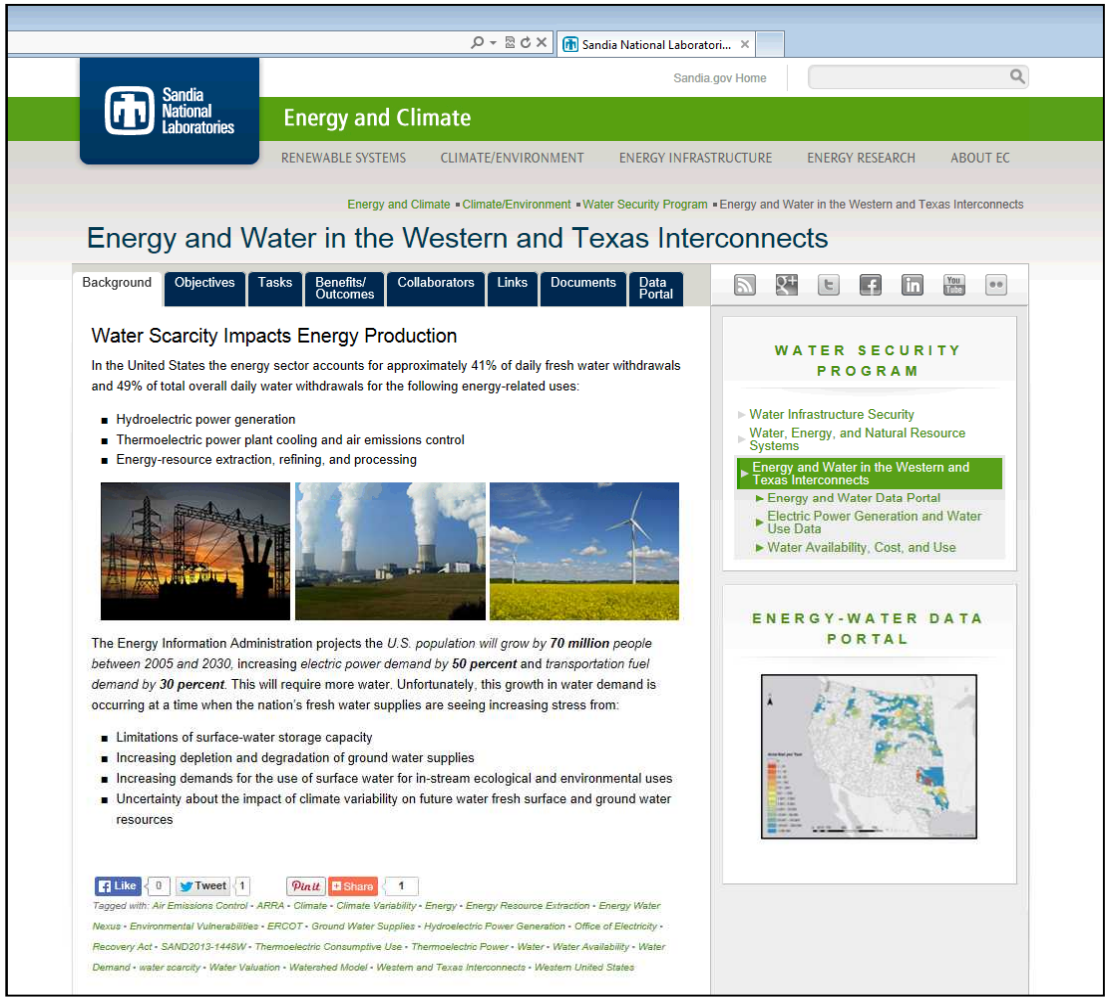


Project status: States Requiring Permitting & Data Gathering





Project Status: Data Portal

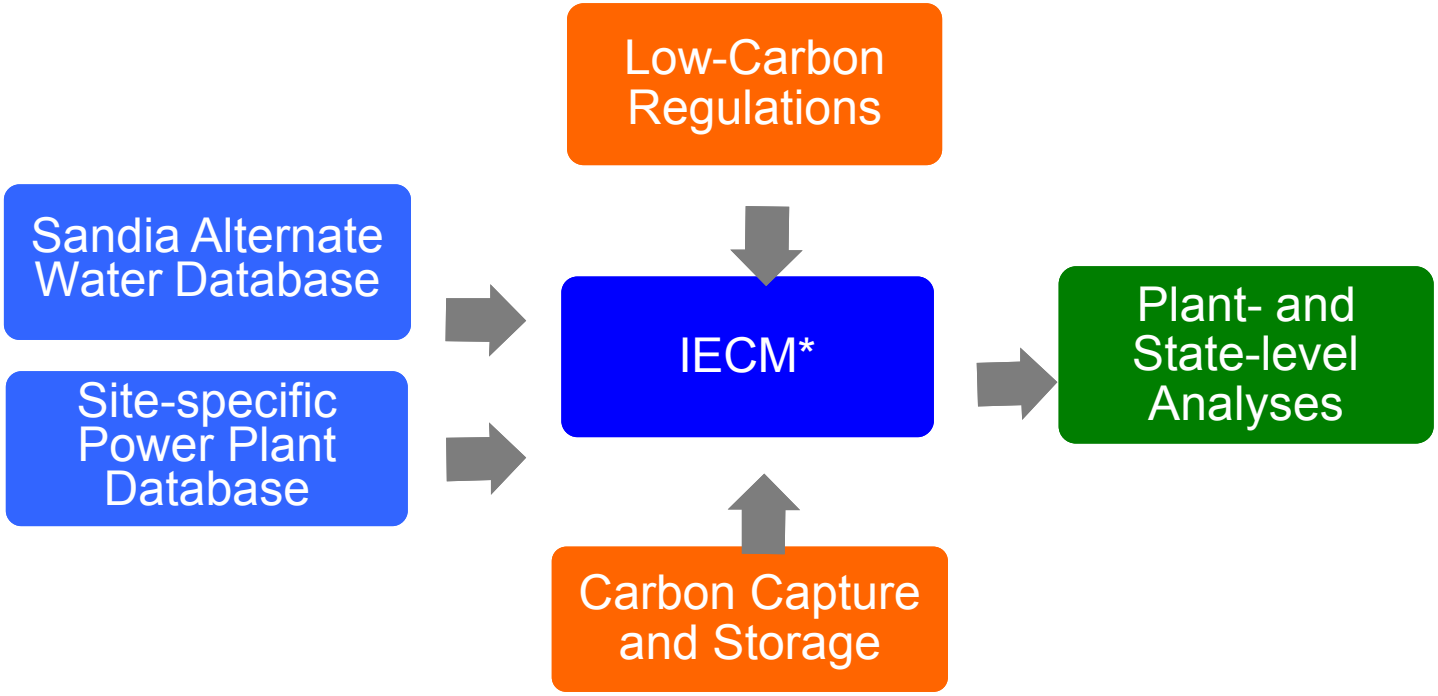


Partnering w/ Carnegie Mellon University:

Sandia National Laboratories

Water Study Objectives and Assessment Framework

- Estimate water use of thermoelectric power plants under low-carbon regulations
- Evaluate role of alternate water resources in reducing power plant freshwater use



*Integrated Environmental Control Model

Concluding Points

Sandia National Laboratories

- Conducted initial survey of states with water plans, states with permitting requirements and identified contacts
- Initial Results indicate most states have a modest amount of data on their water resources (some very little, others extremely detailed)
- Initial results encouraging as the team was able to calculate water availability and cost information using state-based partners and national sources
- What's next: Look to connect SNL data to CMU power plant modeling efforts

Exceptional service in the national interest

Sandia National Laboratories

Thank You

U.S. DEPARTMENT OF ENERGY

National Nuclear Security Administration

Sandia National Laboratories is a multi-program laboratory managed and operated by Sandia Corporation, a wholly owned subsidiary of Lockheed Martin Corporation, for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.